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ENHANCING GRADE 10 STUDENTS' FRACTION SOLVING SKILLS: ADDRESSING DIFFICULTIES IN ADDING AND SUBTRACTING MIXED AND IMPROPER FRACTIONS THROUGH THE NJJ TRIADIC APPROACH

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ABSTRACT

This study aimed to determine the effectiveness of the NJJ (Negative Concepts, Join Forces, and Journey to Mastery) Triadic Approach in enhancing Grade 10 students' skills in solving fraction problems involving the addition and subtraction of mixed and improper fractions. A quantitative research design was employed, specifically the one-group pretest-posttest method, a type of pre-experimental research. This design assessed the effects of the intervention by comparing student performance before (baseline) and after (end-line) its implementation. Additionally, the study sought to gather student insights regarding the use of the NJJ Triadic Approach in improving their ability to solve fraction problems. Thirty-nine Grade 10 students participated in the pre-test, underwent the NJJ Triadic Approach intervention, and completed the post-test. Ten participants were also selected for in-depth interviews. Results revealed that students initially demonstrated very low proficiency, with a mean pre-test score of 2.95% and a standard deviation of 1.17. Following the intervention, the mean post-test score increased to 22.18%, with a standard deviation of 3.38. While still within the very low range, this reflected a marked improvement. A paired samples t-test indicated a statistically significant difference between the pre-test and post-test scores, $t(38) = 6.56$, $p < .001$, with a large effect size (Cohen's $d = 1.05$). These findings indicate that the NJJ Triadic Approach had a significant positive effect on students' ability to solve fraction problems involving mixed and improper fractions.

The results suggest that the NJJ Triadic Approach is an effective strategy for enhancing students' skills in this area. Its implementation addressed common learning difficulties, making it a valuable tool for mathematics instruction. The researchers recommend the use of this approach to build foundational skills, improve student engagement, and boost learners' confidence and motivation. Moreover, this student-centered model may be adapted for other mathematics topics that require strong conceptual understanding.

KEYWORDS: *NJJ Triadic Approach, Fraction-Solving Skills, Fraction Problems, Philippines*

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INTRODUCTION

Mastery of fractions is essential for success in advanced math areas like algebra and calculus. However, many students, especially those struggling with math, have difficulty understanding and working with mixed and improper fractions. These challenges often stem from conceptual barriers, such as viewing fractions as parts of a whole or as ratios, and from a lack of procedural fluency in applying operations correctly (Dyson et al., 2020). Additionally, a research study found that poor teaching methods for adding fractions were a major reason why Basic 5 pupils struggled with adding fractions with like and unlike denominators (Mensah & Yankson, 2020). A recent study explored whether a computer tutor could improve adults' fraction skills and whether adding erroneous examples would enhance learning. Although all participants improved, there were no significant differences between the groups. Those with low prior knowledge showed greater gains with erroneous examples, but the effect was not statistically significant (Di Lonardo Burr, 2020).

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Consequently, in the United States, students continue to encounter persistent challenges in learning and applying fraction concepts. Although educational standards emphasize the importance of deep conceptual understanding, many students struggle to perceive fractions as single rational numbers, instead viewing them as two separate whole numbers (Fuchs et al., 2021). In South Africa, particularly in Grade 8, students display numerous errors in fractions due to a deficient mastery of prerequisite concepts. These errors stem from a lack of conceptual understanding, misconceptions, and the misapplication of rules related to the addition, subtraction, multiplication, and division of fractions (Makhubele, 2021). Research with Northern Irish pupils (ages 10–12) showed that while students had a strong understanding of fraction magnitudes, they struggled with fraction arithmetic, often incorrectly applying whole number strategies (Xu et al., 2024).

In the Philippines, studies highlight low levels of financial literacy and poor understanding of fractions among students. In Cateel, Davao Oriental, Grade 5 pupils at Cateel Central Elementary School struggled with fractions, as shown in a study where both control and experimental groups performed poorly in pre-tests (Bautista et al., 2023). In Zamboanga City, junior high school students also faced challenges due to lapses in concentration, hasty reasoning, and limited exposure to word problems, leading to poor retention of fraction concepts (Bayos, 2021). Similarly, The Case of Dumagat Elementary Students reported weak numeracy skills in basic operations and fractions—an issue that affects learners both locally and globally, limiting their ability to handle real-life mathematical tasks (Faustino, 2021).

At Asuncion National High School in the Division of Davao del Norte, many students have been observed struggling with fraction-related problems, even after receiving instruction on the topic. Their low scores in a recent summative assessment highlighted these difficulties. Further analysis and classroom observations revealed that students found it challenging to understand, apply, and interpret the concepts involved. Contributing to the issue are limited educational resources and a lack of early intervention programs to address learning gaps. Addressing these specific student needs is essential to creating focused interventions that promote a supportive learning environment and improve their mathematical skills and academic performance.

This study evaluates the improvement of students' fraction-solving skills following the implementation of the NJJ (Negative Concepts, Join Forces, and Journey to Mastery) Triadic Approach. A pre-test identified students' proficiency levels, after which the intervention was applied. A post-test measured its effectiveness, focusing on adding and subtracting improper and mixed fractions. The results were analyzed to assess the impact of the NJJ Triadic Approach on Grade 10 students' mathematical performance.

This study aims to apply the NJJ Triadic Approach to enhance the fraction-solving skills of Grade 10 students, using fraction problems from the Year Four Mathematics textbook. The researchers identified a gap in the fraction-solving abilities of students at the instructional and frustration levels, highlighting the need for targeted intervention. The goal is to align with school initiatives and support ongoing educational efforts by fostering mastery in fractions, ultimately improving students' overall mathematical competence.

Several related studies, such as Barbieri et al. (2020) on using number lines and cognitive strategies, and Hariyani et al. (2022) on learning obstacles in solving fractions, offer insights into improving fraction skills. However, these studies do not directly address the needs of Grade 10 students. This research aims to fill that gap by implementing the NJJ Triadic Approach to enhance the ability of Grade 10 learners to add and subtract mixed and improper fractions. It also supports school efforts to develop targeted interventions for students at instructional or frustration levels.

Research Questions

The study aimed to determine the effectiveness of NJJ Triadic Approach as an intervention in adding and subtracting mixed and improper fractions among Grade 10 students. Further, this study gathers relevant information to address the following questions:

1. What is the level of fraction-solving skills among Grade 10 students **before** the implementation of the NJJ Triadic Approach in adding and subtracting mixed numbers and improper fractions?
2. What is the level of fraction-solving skills among Grade 10 students **after** the implementation of the NJJ Triadic Approach in adding and subtracting mixed numbers and improper fractions?
3. Is there a significant difference between the pre-test and post-test scores of grade 10 students?
4. What insights can be derived from the participants regarding the implementation of the NJJ Triadic Approach in solving mixed numbers and improper fractions?

Proposed Intervention

The NJJ Triadic Approach is a structured teaching method designed to help students overcome challenges in adding and subtracting mixed and improper fractions. It consists of three phases: Negative Concepts, which addresses students' misconceptions; Join Forces, which fosters collaborative learning through group discussions; and Journey to Mastery, which offers individualized support for students needing further help.

The first phase of the NJJ Triadic Approach focuses on identifying students' understanding and misconceptions about adding and subtracting mixed and improper fractions. In week one, a pre-test was administered to assess their proficiency, especially those at instructional and frustration levels. In week two, a whole-class discussion addressed common misconceptions and clarified key concepts. A 5-item assessment followed to measure student progress. This phase aimed to build a shared foundational understanding to prepare students for deeper learning.

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The second phase of the NJJ Triadic Approach, implemented in week three, emphasizes collaborative learning through group discussions. Students were grouped based on pre-test results and engaged in guided practice, discussing strategies for solving fraction problems. The researchers provided problems and visual aids, offering support as they moved between groups. This phase promoted peer-to-peer learning, allowing students to reinforce their understanding by helping others.

The third phase, implemented in week four, focused on individualized support to help students master adding and subtracting mixed and improper fractions. Students who continued to struggle received one-on-one tutorials with personalized strategies and practice. Researchers monitored progress through formative assessments, providing immediate feedback and adjusting instruction as needed. In week five, a post-test was administered to evaluate the overall effectiveness of the NJJ Triadic Approach by comparing pre- and post-test results.

Table 1. Matrix of the NJJ Triadic Approach

Session/Phase	Estimated Time Duration	What will happen?
Session 1	1 hour	Students was informed of the things that they will be doing for the whole intervention period. After informing them, the Pre-Test are given.
Session 2	1 hour	In this session, the first phase will be implemented which is the "Negative concepts" that focuses on clarifying foundational concepts, such as the meaning of fractions, improper fractions, and mixed fractions, as well as the steps required to add and subtract them.
Session 3	30 minutes	After discussion, the students are given a 5-item assessment consisting of mixed and improper fractions to determine their progress particularly to create a shared understanding among the students and set the groundwork for more focused learning.
Session 4	1 hour	İn continuation, the second phase will be implemented which is the "Join forces" that students were grouped according to their initial performance in the pre-test to discuss different strategies for solving fraction problems and share their understanding of how to add and subtract mixed and improper fractions.
Session 5	1 hour	The researchers will provide fraction problems, and each group will work together to solve them while utilizing visual aids.
Session 6	1 hour	İn addition, the last phase will be implemented which is the "Journey to mastery" which focuses on individualized support to ensure that each student masters the skills of adding and subtracting mixed and improper fractions.
Session 7	1 hour	Finally, the students will complete a post-test to measure the improvement in their knowledge and skills compared to the pre-test.

METHODS

Study Design

This study conducted quantitative research using a one-group pretest-posttest design, a form of pre-experimental method. It examined the effects of an intervention by comparing values before (baseline) and after (end-line evaluation). Unlike experimental designs, pre-experimental methods lack a control group and focus on changes within a single group. Variations between baseline and end-line values are attributed to the project, indicating its impact (Wamunyima & Nyirenda, 2023). In this context, this method suits action research as it allows comparison of students' skills before and after the intervention, aiming to capture improvement from using the NJJ Triadic Approach. Although it lacks a control group, the differences in pre-test and post-test scores serve as indicators of this method's effectiveness in improving fractional comprehension.

Furthermore, this study adopted an experimental-qualitative design, combining measurable outcomes and students' experiential insights. The experimental part used a one-group pretest-posttest setup to assess the NJJ Triadic Approach in teaching addition and subtraction of mixed and improper fractions. Qualitative data were also gathered to explore learning behaviors, reactions, and challenges during the intervention. This combined approach enhances the research's ability to show both what works and why within the classroom context (Onwuegbuzie & Hitchcock, 2021).

In this context, merging quantitative and qualitative perspectives was valuable in addressing the varied, real-world nature of classroom settings. The NJJ Triadic Approach was evaluated through test performance and student reflections, offering insights into their conceptual development and engagement.

Lastly, the qualitative insights of students regarding the NJJ Triadic Approach. After the intervention, students were encouraged to share their opinions. Including student feedback in action research promotes learner-centered teaching and continuous instructional improvement (de Vera & Ireneo, 2021).

Participants

In this study, the respondents are 33 Grade 10 students enrolled for the 2024–2025 school year at Asuncion National High School. The researchers employed purposive sampling, a non-random selection strategy, to deliberately choose students who exhibit varying levels of proficiency in solving problems

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involving mixed and improper fractions. This aligns with the objectives of the NJJ Triadic Approach, which is specifically designed to address students' misconceptions and difficulties in fraction operations. By selecting participants based on their observed struggles in this area, the researchers ensure that the intervention targets those who can benefit most from the approach. Purposive sampling—also known as judgmental sampling—relies on the researchers' informed judgment to identify individuals who can provide the most relevant insights, rather than leaving participant selection to chance (Nikolopoulou, 2023).

Instrumentation

This study adapted one (1) questionnaire from a web source to measure the fraction-solving skills of the students. This instrument is derived from the study of Norga (2004). Moreover, the reliability coefficients of 0.87 and 0.79, calculated using the Cronbach Alpha Formula, indicate that the instruments used to measure students' fraction-solving skills are highly reliable, providing confidence in the validity of the results. The test comprised 10 questions focused on adding and subtracting fractions, divided into two sections: (A) Addition and (B) Subtraction. Each section contained 5 items, with each item worth 3 points for a correct answer. The total score for the test was 30 points, with 3 points awarded for each correctly solved problem in both addition and subtraction sections.

Percentage Range	Rating Quality	Interpretation
90% - 100%	Advance Mastery	This means the level of mastery in adding and subtracting mixed and improper fractions of Grade 10 students have an excellent grasp of the skill.
72% - 89%	Mastered	This means the level of mastery in adding and subtracting mixed and improper fractions of Grade 10 students have a strong understanding.
54% - 71%	Nearly Mastered	This means the level of mastery in adding and subtracting mixed and improper fractions of Grade 10 students show basic understanding but make occasional errors.
36% - 53%	Partially Mastered	This means the level of mastery in adding and subtracting mixed and improper fractions of Grade 10 students have limited understanding and struggle with consistent accuracy.
18% - 35%	Minimally Mastered	This means the level of mastery in adding and subtracting mixed and improper fractions of Grade 10 students show little understanding.
0% - 17%	Not Mastered	This means the level of mastery in adding and subtracting mixed and improper fractions of Grade 10 students lack foundational understanding.

Statistical Treatment of Data

The data collected from the questionnaires were processed and analyzed using various statistical tools. These tools were applied to the data to help identify patterns and relationships that can shed light on the study's objectives. The results of this analysis are then used to draw conclusions and make recommendations based on the findings.

Mean. This was used to determine the level of mastery in adding and subtracting mixed and improper fractions among the Grade 10 respondents.

Standard Deviation. This was used to measure the consistency of the students' performance in mastering addition and subtraction of mixed and improper fractions.

Paired T-Test. This was used to compare the pre-test and post-test scores of the students to evaluate the effectiveness of the NJJ Triadic Approach in improving their mastery in adding and subtracting mixed and improper fractions.

Cohen's d. This was used to measure the effect size of the difference between the pre-test and post-test scores of the students to evaluate the practical significance of the NJJ Triadic Approach in improving their mastery in adding and subtracting mixed and improper fractions.

Data Analysis

The researchers used thematic analysis to interpret participants' responses by coding and clustering similar ideas. Coding involved labeling key points from the data, followed by data reduction to organize and simplify the responses. These codes were then grouped into categories to identify emerging themes. To ensure credibility, the assigned themes were reviewed and validated by experts.

Procedure

The researchers utilized questionnaires before and after the implementation of the intervention and innovation. The pre-test questionnaire measured the average performance of students who had difficulty in adding and subtracting mixed and improper fractions prior to the implementation. The post-test questionnaire measured the students' ability to solve operations involving fractions after the implementation. To gather the necessary data for this research, the researchers followed these steps:

First, before starting the study, the researchers sent a request to the principal of the school where the participants were enrolled. Then, they administered a pre-test using the questionnaires to determine the participants' initial knowledge of fraction operations.

Following the pre-test, the NJJ Triadic Approach was introduced, which consisted of three phases implemented throughout the intervention period. At the end of the research process, a post-test was administered using the same questionnaire to evaluate any improvements in the participants' skills in adding and subtracting mixed and improper fractions. The data from the pre-test and post-test were then collected and tabulated.

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Ethical Considerations

The participants of this study were Grade-10 students from Asuncion National High School to ensure the sound conduct of the study, ethical considerations were addressed and considered accordingly.

Informed Consent. Informed consent involves providing participants with clear details about the study, what tasks they will do, how data will be used, and any possible risks. They must give active, signed consent, acknowledging their rights to access their data and withdraw anytime. It is a formal agreement between researcher and participant (Denzin & Lincoln, 2011).

In this study, the researcher included an informed consent question in the printed survey form, allowing respondents to decide freely if they wished to participate despite any risks. Voluntary participation was emphasized, and students were encouraged to respond sincerely based on the survey provided.

Risk of Harm, Anonymity and Confidentiality. The respondent's information must be consistently safeguarded and treated with utmost confidentiality, extending beyond mere anonymity by refraining from disclosing their identity or related details. Ensuring anonymity and secrecy are crucial to protecting individuals from potential damage (Denzin & Lincoln, 2011).

To prevent risks such as social liabilities, the researcher ensured all data remained private and secure. Respondents were assured that their identities and personal information would be protected. Identifiable details were removed from the data, which was anonymized and stored securely. All collected data will be destroyed three years after the study concludes.

Conflict of Interest. The researcher's current affiliations or past activities may lead to a conflict of interest, which must be openly declared in an ethics approval application. This allows the committee to offer guidance on managing the conflict (Blanco, 2023).

Nevertheless, the study's researcher affirms that the research was conducted independently, without any affiliations or financial connections that may be seen as a conflict of interest. This perspective asserts that external variables did not influence the research outcomes since the participants were also students, and the researcher had no conflicting interests with the study.

RESULTS AND DISCUSSION

This chapter presents the findings and results of NJJ Triadic Approach as a strategy to address difficulties in adding and subtracting mixed and improper fractions among Grade 10 students of Asuncion National High School. Analyses and interpretations of data were done parallel to the research objectives.

Research Question no. 1: What is the level of fraction-solving skills among Grade 10 students before the implementation of the NJJ Triadic Approach in adding and subtracting mixed numbers and improper fractions?

Presented in Table 1 were the results of the pre-test, which indicated the leve of fraction-solving skills among Grade 10 students before the implementation of NJJ Triadic Approach. The overall mean score was 2.95%, with a descriptive level of partially mastered, indicating that the level fraction-solving skills among Grade 10 students have limited understanding and struggle with consistent accuracy. The highest score was 5 out of 20, which had an equivalent percentage of 25%%, and was achieved by 1 student or 2% of the population (n=39). The lowest score was 0, achieved by 28 student or 72% of the population, with an equivalent percentage of 0%. This poor performance implied that the majority of the Grade 10 students struggled with the basic rules and procedures related to adding and subtracting mixed and improper fractions.

Table 2. Level of fraction-solving skills among Grade 10 students in Pre-Test

Pre-Test Scores	Frequency	Percentage
0	28	72%
1	5	13%
2	2	5%
3	3	8%
5	1	2%
Total	39	100.00%
Overall Mean		2.95%
Description		Partially Mastered
Standard deviation		1.17

To support the findings, a study analyzed the difficulties elementary students face in understanding fractions. Results revealed issues such as misconceptions about numerators and denominators, poor fraction representation and operation skills, and challenges in translating word problems. Contributing factors included low motivation, negative attitudes toward math, and limited parental support (Nur et al., 2025).

Similarly, Many students rely on memorized procedures without grasping the underlying concepts of fraction operations. Errors often stem from "whole number bias," where whole number knowledge interferes with fraction understanding. Operations like adding fractions with unlike denominators are especially challenging, and success largely depends on practice and quality instruction (Xu et al., 2024).

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In line with these findings, the study Learning Obstacles on Fractions: A Scoping Review highlights a range of learning difficulties and misconceptions faced by elementary students in fraction problem-solving. These challenges underscore the urgent need for targeted and strategic instructional interventions (Sari et al., 2024).

Research Question no. 2: What is the level of fraction-solving skills among Grade 10 students after the implementation of the NJJ Triadic Approach in adding and subtracting mixed numbers and improper fractions?

Presented in Table 2 were the results of the post-test, which indicated the leve of fraction-solving skills among Grade 10 students before the implementation of NJJ Triadic Approach.. The overall mean score was 22.18%, with a descriptive level of nearly mastered, indicating that the level of level fraction-solving skills among Grade 10 students show basic understanding but make occasional errors. The highest score was 18 out of 20, equivalent to 90%, and was achieved by 1 students or 2% of the population. The lowest score was 0, achieved by 5 students or 13% of the population, with an equivalent percentage of 0%. Meanwhile, the most frequent score was 3 recorded by 6 students, accounting for 13% of the population (n = 39). These results showed that the students made progress in mastering addition and subtraction of mixed and improper fractions. This improvement suggested that the NJJ Triadic Approach intervention helped reinforce their skills, even though the overall performance still required further enhancement.

Table 3. Level of fraction-solving skills among Grade 10 students in Post-test

Post-Test Scores	Frequency	Percentage
0	5	13%
1	1	2%
2	5	13%
3	6	15%
4	5	13%
5	4	10%
6	5	13%
7	2	5%
8	3	9%
9	2	5%
18	1	2%
Total	39	100.00%
Overall Mean		22.18%
Description		Minimally Mastered
Standard deviation		3.38

Supporting the post-test results, strategies such as peer tutoring, teacher-led demonstrations, and self-directed learning were shown to improve students' performance in mathematics. Students' perceived effectiveness of one-on-one peer tutorials, group study, teacher demonstrations, and video tutorials significantly contributed to their academic success. The study concluded that these scaffolding methods are effective in helping students overcome difficulties, particularly in mastering mixed and improper fractions (Esparcia et al., 2024).

Similarly, a study emphasized that experienced mathematics teachers often utilize a combination of contextualization, visual aids, and interactive teaching strategies to effectively address students' challenges in learning fractions, underscoring the importance of varied and adaptive instructional approaches (Ismail et al., 2024).

Furthermore, a study identified several barriers to student learning in operating fractions, including cognitive difficulties, negative attitudes, and lack of prior knowledge, suggesting that effective instructional strategies must also address students' psychological and foundational gaps to enhance mathematical understanding (Ibrahim et al., 2022).

Research Question No. 3: Is there a significant difference between the pre-test and post-test scores?

Table 3 shows the result of the paired t-test that was conducted to determine whether there was a significant difference in the scores before and after the intervention, $t\,(38) = 6.56$, $p < .001$. Since the p-value ($p<.001$) less than the level of significance ($\alpha=0.05$), the null hypothesis was being rejected. The results indicates that there is a statistically significant difference between the students' scores before and after the intervention. Therefore, it can be concluded that the intervention was effective in improving the learners' performance in integer addition and subtraction. Furthermore, the Cohen's d of 1.05 indicates a large effect size, meaning the intervention had a very strong impact on students' mastery of adding and subracting mixed and improper fractions.

This outcome aligns with a study that examined the effects of general, immersion, and mixed instructional approaches on high school students' critical thinking skills and dispositions.

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The findings indicated that all three approaches positively influenced critical thinking skills, with the general approach producing the most substantial impact. Specifically, the general approach yielded a large effect size on critical thinking skills, while the mixed and immersion approaches had moderate and small effects, respectively, on critical thinking dispositions (Orhan & Ay, 2022).

Table 4. Significant Difference Between Pre-test and Post-test Scores of the Grade 10 Students

Paired Sample T-test								
		t	df	p	Mean difference	SE difference		Effect Size
Post-test	Pre-test	6.56	38	<0.001	19.2	2.93	Cohen's d	1.05

Supporting these results, a meta-analysis confirmed that a range of instructional approaches to teaching critical thinking significantly enhance students' cognitive development. The analysis further emphasized the superior effectiveness of the general approach, followed by the mixed and immersion methods (Çeviker Ay & Orhan, 2020).

Moreover, a mixed-method meta-analysis evaluating the impact of critical thinking instruction on students' cognitive skills and academic achievement revealed a strong positive effect of critical thinking interventions, particularly in high school contexts, reinforcing the value of well-designed instructional strategies in promoting both conceptual understanding and higher-order thinking (Batdı, 2024).

Research Question No. 4: What insights can be derived from the participants regarding the implementation of the NJJ Triadic Approach in solving mixed numbers and improper fractions?

To address this research question, in-depth interviews were conducted with the participants. Several guiding questions were posed to elicit students' insights regarding the NJJ Triadic Approach. Table 3 presents the major emerging themes along with the representative responses from the participants. From their insights, eight major themes emerged: (1) Misconceptions in Fraction Concepts, (2) Structured and Clear Step-by-Step Learning Process, (3) Collaborative and Personalized Learning Support, (4) Effectiveness of One-on-One Teacher Support, (5) Improved Confidence and Mastery in Fraction Skills, (6) Effectiveness of the Multi-Level Learning Approach, (7) Enhanced Instructional Support and Differentiation, (8) Supplementary and Interactive Learning Materials.

Table 5
Themes and Supporting Statements on the Insights that the Students Shared about NJJ Triadic Approach.

Emerging Themes	Supporting Statements
Encountering Challenges in Adding and Converting Fractions	• *"It is very difficult for me to convert mixed numbers to improper fractions, especially when the denominator is large. I sometimes forget to multiply the whole number by the denominator first before adding the numerator, so my answer ends up wrong."* (IDI-01) • *"When adding improper fractions, I sometimes include the denominators in the addition. I know it is wrong, but it still happens when I work too fast."* (IDI-04) • *"I do not know whether I should keep the answer as a mixed number or an improper fraction. Sometimes there are no instructions, so I hesitate about which one is better or if both are acceptable."* (IDI-05) • *"Sometimes I add or subtract the numerator and denominator directly, without considering that there should be a common denominator first. That is why my final answer is wrong."* (IDI-06) • *"I really struggle to find a common denominator, especially when the numbers are large. Sometimes it takes me a long time to solve because I don't know how to find the least common denominator."* (IDI-08)
Gaining Clarity in Fraction Operations	• *"The NJJ Triadic Approach provided clear steps for me to properly convert mixed numbers to improper fractions. I no longer forget because there is a formula to follow."* (IDI-01) • *"It helped because the steps for subtraction were broken down, especially the borrowing part. I learned that converting to an improper fraction first makes it easier."* (IDI-02) • *"This approach taught me that the fraction should be simplified right after the operation. I no longer get confused because there is a specific step for that."* (IDI-03)

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	• *"They have a technique to avoid confusion with denominators—only one denominator is used even when adding. I no longer make mistakes in adding denominators because of this."* • *"They explained that the answer can either be a mixed or improper fraction, but it is better if it's simplified. I learned when to convert properly."*
Collaborative and Personalized Learning Support	• *"The NJJ Triadic Approach helped me because in the initial teacher discussion, I understood the basic concept. Then in the group, the leader explained again, which helped clarify my confusions. In the one-on-one session, my specific problems were really addressed."* (IDI-06) • *"The approach is good because we do not just listen to the teacher—we also share in the group and get help from the leader. That's why I understood the steps more easily and got to practice solving fractions."* (IDI-08) • *"Through the NJJ Triadic Approach, I learned that group cooperation is important and that asking the teacher for help when struggling is valuable. The one-on-one session really helped the teacher focus on my problems."* (IDI-9)
Strengthening Fraction Learning Through Collaborative and Individualized Support	• *"The one-on-one session with the teacher is really good because I can properly ask questions about what I'm struggling with. I'm not afraid to make mistakes because it's just me and the teacher."* (IDI-02) • *"The combination of the teacher's discussion, group activity, and individual session is effective. If I don't understand the lecture, it becomes clearer in the group, and if I am still confused, there's the one-on-one."* (IDI-03) • *For me, the one-on-one session is the most significant. Even if I try to understand in the group, there are still parts I get confused with. But after the private session, everything becomes clear."* (IDI-06) • *"The best part is the one-on-one session with the teacher because I can directly ask questions and he/she really explains what I am confused about."* (IDI-09) • *"For me, the best part is the teacher's help during the one-on-one session because I can easily clarify my questions and immediately correct my mistakes."* (IDI-10)
Improving Confidence and Mastery in Fraction Skills	• *"It really helped me because the approach is step-by-step. Before, I was afraid to answer, but now I am confident in solving—even mixed numbers."* (IDI-03) • *"My fraction skills improved by 90%! Before, I was at zero, but now I can solve even complicated fractions. The one-on-one session helped me the most."* (IDI-05) • *"Same as most, it is really effective. The combination of lecture, group work, and personal tutoring made it easier for me to understand. I am no longer afraid to answer in class."* (IDI-06)
Reinforcing Understanding Through Multi-Level Support	• *"It is really effective because we have three chances to understand: from the teacher, the group, and the one-on-one. If I forget from the lecture, I can recall it in the group discussion."* (IDI-09) • *"Same as most, it is really effective. The combination of lecture, group work, and personal tutoring made it easier for me to understand. I am no longer afraid to answer in class." (IDI-06)* • *"It really helped me because the approach is step-by-step. Before, I was afraid to answer, but now I am confident in solving—even mixed numbers." (IDI-03)*

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Addressing Learner Needs Through More Time, Examples, and Differentiated Support	• *"The time for one-on-one sessions should be extended because many of us need help. Sometimes, there's not enough time for everyone." (IDI-01)* • *"The teacher should give more examples, especially in difficult cases of addition and subtraction." (IDI-04)* • *Different learning paces should be considered. Some understand faster, while others need more repetition." (IDI-06)*
Enhancing Learning Through Interactive Tools and Practice	• *"It would be better if there were extra practice sheets after the sessions so we can practice more." (IDI-02)* • *"I would like it if there were visual aids or actual examples of fractions during the discussion. It would be clearer if I could see them." (IDI-03)* • *"It would be good if there were short video tutorials before the lesson starts so everyone already has a basic idea." (IDI-07)* • *"Follow-up activities should be done after the one-on-one session to test if the lesson was really understood." (IDI-08)* • *"Technology like fraction-solving apps should be used to make learning more fun and interactive." (IDI-09)* • *"Regular short quizzes should be done to monitor each student's progress—not just evaluation at the end." (IDI-10)*

The first theme that emerged is Encountering Challenges in Adding and Converting Fractions. Many students struggle with these operations due to applying whole number rules and lacking conceptual understanding. They often see the numerator and denominator as separate whole numbers, leading to errors (Lee & Boyadzhiev, 2020). Similarly, Tian et al. (2020) found that students' difficulties stem from how they process and compare fractions with decimals and percentages, affecting their understanding and performance.

The second theme is Gaining Clarity in Fraction Operations. Breaking down complex tasks into manageable steps through structured, step-by-step instruction enhances skill development and student confidence (Bates & Bates, 2021). Although not always directly improving problem-solving, such methods support learning through phases like planning, monitoring, performing, and reflecting. Purnomo et al. (2022) also emphasize that explicit, structured instruction improves both conceptual understanding and procedural fluency in fractions, helping students tackle difficult tasks more effectively and meaningfully.

The third theme is Collaborative and Personalized Learning Support. Research shows that combining collaboration with personalized learning enhances student engagement, motivation, and confidence. Jaya et al. (2025) found that peer interaction improves academic performance and helps students deepen understanding and develop communication skills. Likewise, Huang and Lajoie (2023) highlight the importance of emotional awareness in group tasks, emphasizing that learning is both cognitive and social-emotional. These findings support integrating collaborative strategies into personalized learning to boost both academic growth and emotional well-being.

The fourth theme is Strengthening Fraction Learning Through Collaborative and Individualized Support. Combining group-based learning with personalized instruction enhances fraction mastery. Loriente et al. (2025) found that tailored activities with feedback via Moodle improved students' understanding of fractions and decimals. Similarly, Sharma (2025) showed that integrating collaboration with individualized support deepens conceptual understanding and procedural fluency, effectively addressing diverse learner needs.

The fifth theme is Improving Confidence and Mastery in Fraction Skills, which highlights the importance of developing students' self-confidence alongside their conceptual and procedural understanding to achieve mastery in fractions. The study underscores that improving fraction learning necessitates strengthening foundational whole number knowledge, addressing misconceptions, and reducing math anxiety to enhance overall performance Xu et al. (2024). Supporting this, recent research emphasizes that students' mathematics self-efficacy plays a significant role in their achievement, and targeted interventions to boost confidence can effectively improve mastery of mathematical concepts, including fractions Yang, et al. (2024).

The sixth theme is Reinforcing Understanding Through Multi-Level Support. Studies show that differentiated instruction, such as the Multi-Level Learning (MLL) approach, is more effective than uniform teaching methods. Ouahabi et al. (2024) found that using diagnostic assessments to group students by learning needs led to significant academic gains across various performance levels. This structured approach—evaluation, grouping, and targeted instruction—boosts learning without requiring extra resources and is adaptable across subjects. Supporting this, Am et al. (2023) confirmed through a meta-analysis that differentiated instruction consistently enhances learning outcomes in diverse educational settings.

The seventh theme is Addressing Learner Needs Through More Time, Examples, and Differentiated Support**.** Research highlights the positive impact of differentiated instruction on

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student engagement, understanding, and performance. Tailoring content, teaching methods, and assessments to learners' needs—along with scaffolded support and timely feedback—creates a more inclusive environment. Tomlinson et al. (2021) stress that effective differentiation requires ongoing teacher training and resources. Similarly, Zens (2021) found that combining differentiated strategies with formative assessment and flexible grouping boosts achievement and motivation, especially for struggling and underserved students.

The eighth theme is Enhancing Learning Through Interactive Tools and Practice. Research shows that integrating interactive and supplementary educational tools boosts student achievement, engagement, and self-directed learning. For example, students using modular materials or topic-specific digital supplements, like those on the digestive system, showed significant gains in understanding and test performance. Ayado and Berame (2022) highlight that such tools, when learner-centered, enhance motivation, autonomy, and retention. Similarly, Duterte (2024) found that gamified quizzes and virtual simulations led to a 75% increase in motivation and a 10% rise in academic performance, underscoring the value of technology-enhanced learning.

CONCLUSION

The study found that Grade 10 students initially demonstrated a low level of mastery in adding and subtracting mixed and improper fractions, with a pre-test mean score of only 2.95%, classified as “Not Mastered.” This reflected a limited understanding and frequent errors, primarily due to confusion about the rules for adding and subtracting fractions and a lack of foundational knowledge. These findings underscored the need for a targeted intervention to strengthen their basic understanding of integers.

Following the implementation of the NJJ Triadic Approach, the post-test results showed a significant improvement, with the mean score rising to 22.18%, reaching the “Minimally Mastered” level. This progress indicated that students developed a basic understanding of adding and subtracting fractions and made fewer errors. The structured and student-centered phases of the NJJ Triadic Approach, such as guided instruction, collaborative learning, and individualized support, contributed to this improvement by addressing misconceptions, reinforcing key concepts, and promoting active student engagement.

Statistical analysis further confirmed the effectiveness of the intervention. A paired-samples t-test revealed a statistically significant difference between the pre-test and post-test scores, $t(38) = 6.56$, $p < .001$, indicating that students’ performance significantly improved after the implementation of the NJJ Triadic Approach. Furthermore, the Cohen’s d of 1.05 indicates a large effect size, meaning the intervention had a very strong impact on students’ mastery of adding and subtracting mixed and improper fractions. These results suggest that the NJJ Triadic Approach is an effective instructional strategy for addressing learning gaps and enhancing students’ conceptual understanding and procedural fluency in fraction operations.

Moreover, the qualitative findings from student interviews underscored the positive impact of the NJJ Triadic Approach on students’ insights. Themes such as gaining clarity in fraction operations, collaborative and personalized learning support, strengthening fraction learning through collaborative and individualized support, improving confidence and mastery in fraction skills, reinforcing understanding through multi-level support, addressing learner needs through more time, examples, and differentiated support, and enhancing learning through interactive tools and practice illustrated how the intervention fostered deeper understanding, increased engagement, and greater learner autonomy. While challenges like encountering difficulties in adding and converting fractions were noted, students overwhelmingly expressed appreciation for the structured, supportive, and engaging nature of the NJJ Triadic Approach, which helped them overcome misconceptions and build confidence in their skills.

RECOMMENDATION

Based on the findings of the study, it is recommended that the NJJ Triadic Approach be sustained and expanded in mathematics instruction, particularly when teaching complex topics like fractions. The significant improvement in post-test scores, alongside the large effect size, suggests that this structured strategy effectively supports students’ procedural and conceptual understanding. To build on this success, teachers may be provided with professional development opportunities to enhance their capacity to implement the approach effectively.

Despite the observed gains, the overall performance remained within the "poor" category, indicating that deeper learning gaps still need to be addressed. This suggests that while the intervention is showing good results, it may need to be supplemented with additional support mechanisms, such as targeted remediation and continuous monitoring of student progress. Moreover, fostering a positive classroom environment that encourages risk-taking, effort, and persistence can contribute to long-term academic growth. Future studies are also recommended to replicate this research in other contexts to determine the wider applicability and effectiveness of the NJJ Triadic Approach in improving fraction proficiency across diverse student populations.

REFERENCES

1. *Adams, D. L., Hord, C., Madden, M., Ryan, A., & University of Cincinnati. (2023). How does One-on-One tutoring support student Self-Efficacy? A case study of one high school student’s perceptions. In Insights Into Learning Disabilities (Vols. 1–1, pp. 37–48). https://files.eric.ed.gov/fulltext/EJ1379916.pdf*
2. *Am, M. A., Hadi, S., Istiyono, E., & Retnawati, H. (2023). Does differentiated instruction affect learning outcome Systematic review and meta-analysis. Journal of Pedagogical Research. https://doi.org/10.33902/jpr.202322021*
3. *Ay, Ş. Ç., & Orhan, A. (2020). Farklı eleştirel düşünme öğretim yaklaşımlarının eleştirel düşünme becerisine etkisi:*

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 11| Issue: 6| June 2025|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2025: 8.691 || ISI Value: 1.188

Bir meta analiz çalışması. Pamukkale University Journal of Education, 49, 88–111. https://doi.org/10.9779/pauefd.561742

4. *Ayado, D. M., & Berame, J. S. (2022). Effectiveness of supplementary modular learning materials to grade 12 students in science, technology, engineering, mathematics track in stoichiometry. International Journal of Educational Policy Research and Review, 9(4), 112–135. https://doi.org/10.15739/ijeprr.22.013*
5. *Barbieri, C. A., Rodrigues, J., Dyson, N., & Jordan, N. C. (2020). Improving fraction understanding in sixth graders with mathematics difficulties: Effects of a number line approach combined with cognitive learning strategies. Journal of Educational Psychology, 112(3), 628–648. https://doi.org/10.1037/edu0000384*
6. *Batdı, V., Elaldı, Ş., Özçelik, C., Semerci, N., & Özkaya, Ö. M. (2024). Evaluation of the effectiveness of critical thinking training on critical thinking skills and academic achievement by using mixed-meta method. Review of Education, 12(3). https://doi.org/10.1002/rev3.70001*
7. *Bates, A., & Bates, A. (2021, April 5). 11.9 Step seven: design course structure and learning activities. Pressbooks. https://opentextbc.ca/teachinginadigitalage/chapter/11-9-step-seven/*
8. *Bautista, J., Salompao L., Pingot L.P., (2023). TEACHING FRACTIONS THROUGH FRACZONES AMONG GRADE 5 PUPILS. https://ijariie.com/AdminUploadPdf/TEACHING_FRACTIONS_THROUGH_FRACZONES_AMONG_GRADE_5_PUPILS_ijariie21114.pdf*
9. *Bayos, L., (2021). olving Mathematical Problems Involving Fractions: Understanding the Error Patterns Exhibited by Junior High School Students. doi: 10.17051/ilkonline.2021.06.374*
10. *Bermejo, JL. & Vistro-Yu1, C. (2023). "It's Not Just the Language": Grade 4 Pupils' Understanding of Fractions https://ame.org.sg/TME/TMEv4n1/2%20-%20It's%20Not%20Just%20the%20Language%20-%20Grade%204%20Pupils'%20Understanding%20of%20Fractions.pdf*
11. *Duterte, J. (2024). Technology-Enhanced Learning Environments: Improving Engagement and Learning. https://www.researchgate.net/publication/385631227_TechnologyEnhanced_Learning_Environments_Improving_Engagement_and_Learning*
12. *Faustino, H. L. (n.d.). Learning Addition and Subtraction of Fractions Through the use of Indigenous Materilas: The Case of Dumagat Elementary Students. Archīum Ateneo. https://archium.ateneo.edu/theses-dissertations/535/*
13. *Fuchs, L. S., Schumacher, R. F., Long, J., Namkung, J. M., Malone, A. S., Wang, A., & Changas, P. (2021). Does understanding fractions uniquely contribute to predicting adolescents' mathematics problem-solving performance? Journal of Educational Psychology, 113(4), 685–701. https://doi.org/10.1037/edu0000508*
14. *Hariyani, M., Herman, T., Suryadi, D., & Prabawanto, S. (2022). Exploration of student learning obstacles in solving fraction problems in elementary School. https://eric.ed.gov/?id=EJ1357864*
15. *Hasturk, G., & Dogan A. (2020). Effect of triadic teaching approach in some environmental subjects: Prospective Science Teachers practice. The International Journal of Environmental and Science Education, 11(6). https://doi.org/10.12973/ijese.2016.323a*
16. *Huang, X. & Lajoie, S., (2023). Social emotional interaction in collaborative learning: Why it matters and how can we measure it?. https://www.researchgate.net/publication/368728254_Social_emotional_interaction_in_collaborative_learning_Why_it_matters_and_how_can_we_measure_it*
17. *Ismail, S. a. S., Maat, S. M., & Khalid, F. (2024). Understanding the Challenges and Strategies in Teaching Fractions: Insights from Experienced Mathematics Teachers. International Journal of Academic Research in Progressive Education and Development, 13(3). https://doi.org/10.6007/ijarped/v13-i3/22855*
18. *Isnawan, M. G., Suryadi, D., & Turmudi, N. (2022). Barriers to student learning in operating fractions. AIP Conference Proceedings, 2566, 020009. https://doi.org/10.1063/5.0114157*
19. *Jaya, A., Hartono, R., Wahyuni, S., & Yulianto, H. J. (2025, February 7). The Power of Collaborative Learning: How peer interaction Improves student learning outcomes? https://journal.horizonedukasipublisher.com/jeat/article/view/1?utm_source=chatgpt.com*
20. *Lee, H., & Boyadzhiev, I. (2020). Underprepared College Students' Understanding of and Misconceptions with Fractions. International Electronic Journal of Mathematics Education, 15(3). https://doi.org/10.29333/iejme/7835*
21. *Loriente, Á. P., González-Calero, J. A., Tirado-Olivares, S., & Del Olmo-Muñoz, J. (2025). Enhancing mathematics performance in primary education: The impact of personalized learning on fractions and decimal numbers. Education and Information Technologies. https://doi.org/10.1007/s10639-025-13428-5*
22. *Makhubele, Y. E. (2021). The Analysis of Grade 8 Fractions Errors Displayed by Learners Due to Deficient Mastery of Prerequisite Concepts. International Electronic Journal of Mathematics Education, 16(3), em0645. https://doi.org/10.29333/iejme/11004*
23. *Mensah, J., Yankson, C. N. (2020). Improving Basic 5 Pupils' Performance in Addition of Fractions of Like and Unlike Denominators using Fraction Paper Strips. https://www.ijirset.com/upload/2020/march/116_Improving.PDF*
24. *Namkung, J. M., & Fuchs, L. S. (2019). The role of cognitive processes in fraction learning difficulties. Journal of Educational Psychology, 111(5), 899–914. https://doi.org/10.1037/edu0000324*
25. *Nikolopoulou, K. (2023) What Is Purposive Sampling? Definition & Examples Retrieve From: https://www.scribbr.com/methodology/purposive-sampling.*
26. *Norga, S. Z. (2004, March 1). Adding or subtracting fractions: Relative effectiveness of the LCM and the equivalent fractions methods. https://ir.ucc.edu.gh/xmlui/handle/123456789/1253*
27. *Nur, Muhammad Awal and Saputra, Angga and Ramadhan, Muh. Ikhsan and Saifullah, muhd. and Anwar, Haeril, ELEMENTARY SCHOOL STUDENTS' DIFFICULTIES IN UNDERSTANDING THE CONCEPT OF FRACTIONS: A LITERATURE REVIEW (May 14, 2025). Available at SSRN: https://ssrn.com/abstract=5253448 or http://dx.doi.org/10.2139/ssrn.5253448*

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 11| Issue: 6| June 2025|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2025: 8.691 || ISI Value: 1.188

28. *Orhan, A., & Ay, Ş. Ç. (2022). How to teach critical thinking: an experimental study with three different approaches. Learning Environments Research, 26(1), 199–217. https://doi.org/10.1007/s10984-022-09413-1*
29. *Ouahabi, F. Z. E., Bouzaidi, R. D. E., Chaiba, A., Hamdaoui, L., & Erragragui, M. (2024). Effective Teaching Strategies for multilevel classes: A focus on alternating instructional modes. Journal of Curriculum and Teaching, 13(2), 22. https://doi.org/10.5430/jct.v13n2p22*
30. *Purnomo, Y. W., Pasri, Aziz, T. A., Shahrill, M., Prananto, I. W. (2022). Students' failure to understand fraction multiplication as part of a quantity. https://files.eric.ed.gov/fulltext/EJ1379854.pdf*
31. *Sari, I. P., Suryadi, D., Herman, T., Dahlan, J. A., & Supriyadi, E. (2024). Learning obstacles on fractions: A scoping review. Infinity Journal, 13(2), 377–392. https://doi.org/10.22460/infinity.v13i2.p377-392*
32. *Sharma, P. (2024). Revolutionizing Math Education: The Power of Personalized Learning. https://files.eric.ed.gov/fulltext/ED646968.pdf*
33. *Surr, W., Zeiser, K. L., Briggs, O., Kendziora, K., & American Institutes for Research. (2018). LEARNING WITH OTHERS: A study exploring the relationship between collaboration, personalization, and equity. https://files.eric.ed.gov/fulltext/ED592101.pdf*
34. *Tadeu, P. J. A. (2024). A synopsis of the importance of teaching fractions to children until K-10. EURASIA Journal of Mathematics, Science and Technology Education, 20(8), em2485. https://doi.org/10.29333/ejmste/14878*
35. *Tian, J., Braithwaite, D. W., & Siegler, R. S. (2020). How do people choose among rational number notations? Cognitive Psychology, 123, 101333. https://doi.org/10.1016/j.cogpsych.2020.101333*
36. *Tomlinson, C. A., Brighton, C., Hertberg, H., Callahan, C. M., Moon, T. R., Brimijoin, K., Conover, L. A., Reynolds, T., & The Association for the Gifted. (2021). Differentiating instruction in response to student readiness, interest, and learning profile in academically diverse classrooms: A Review of literature. In Journal for the Education of the Gifted (Vols. 27–27, Issue 2/3, pp. 119–145). The Association for the Gifted, Reston, VA 20191-1589. https://files.eric.ed.gov/fulltext/EJ787917.pdf*
37. *Vale, I., & Barbosa, A. (2023). Active learning strategies for an effective mathematics teaching and learning. European Journal of Science and Mathematics Education, 11(3), 573-588. https://files.eric.ed.gov/fulltext/EJ1385531.pdf*
38. *Wamunyima, N., & Nyirenda, T. (2023). Pre-experimental design in project evaluation: the case of the scaling-up nutrition (SUNI) project. SAGE Publications. https://dx.doi.org/10.4135/9781529628043*
39. *Xu, C., Di Lonardo Burr, S., McNally-Edwards, N., McShane, C., Wan, L., & Wylie, J. (2024). A holistic investigation of fraction learning: examining the hierarchy of fraction skills, misconceptions, mathematics anxiety and response confidence. Journal of Cognitive Psychology, 36(7), 815–833. https://doi.org/10.1080/20445911.2024.2388907*
40. *Yang, Y., Maeda, Y., & Gentry, M. (2024). The relationship between mathematics self-efficacy and mathematics achievement: multilevel analysis with NAEP 2019. Large-scale Assessments in Education, 12(1). https://doi.org/10.1186/s40536-024-00204-z*
41. *Zens, A. (2021). The Impact of Differentiated Learning Activities on Student Engagement and Motivation in the English Language Arts Classroom. https://red.mnstate.edu/cgi/viewcontent.cgi?article=1645&context=thesis*