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Preparing 3rd Graders for Addition & Subtraction Using Differentiated Instructional & Assessment Methods

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Abstract

This capstone project reports the effectiveness of four instructional strategies and two assessment methods that were integrated into a second-grade mathematics unit. The unit focused on addition and subtraction within 1,000 with missing numbers and story problems. The unit was taught over five days. The unit included both a pre- and post-assessment to assist in documenting student growth from the first to the last lesson. In my capstone, I will discuss the most effective instructional and assessment strategies and their impact students learning. After the completion of this unit, I analyzed the pre- and post-assessment data. I discovered that using graphic organizers, providing positive feedback, engaging in turn and talks, and gradually releasing instruction were important in improving students learning.

Background

For my clinical practice placement, I was placed at Prairie Queen Elementary in a third-grade classroom in Papillion-La Vista Community Schools District in Nebraska. Prairie Queen Elementary is composed of 500 students and the student-to-teacher Ratio is 17:1. The third-grade class I was placed in had 23 students. My capstone project was supervised by my cooperating teacher, Harley Thernka, who has been teaching for 5 years. My cooperating teacher and I decided that my capstone project would focus on math. I was assigned to work with five students. The group began with six students; however, one student was gone for 4 of the 6 lessons and was dismissed due to limited participation

Participants

The participants for this study were four third-grade students at Prairie Queen Elementary. There were 23 students in my whole class; however, 4 of those students (3 boys and 1 girl) were in my intervention group. None of my students qualified for special education

services or had an Individualized Education Plan (IEP). The students in the intervention group will be referred to as Student B, Student C, Student E, and Student L. Student B was the only boy in the group. He required a lot of redirecting and often made simple mistakes. Student C was quiet and eager to learn. She struggled in group discussions but when she did, she had great question and answers. Student E had high energy and high-volume. She loved to participate whether her answers to problems were right or wrong. She was not easily discouraged and was eager to learn. Student L was a loving and supportive of her classmates. She lifted students up and asked great questions. Student L was new to the school and did not participate in the fall math unit, and was selected to participate so we could assess her knowledge of addition and subtraction. The intervention lessons were implemented after evaluating the students' former assessments and their Measure of Academic Progress (MAP) scores from the fall of 2024.

Introduction

In the fall of 2024 school year, the third-grade teacher Ms. Thernka taught an introductory unit on addition and subtraction. Following the unit an assessment was administered. Four students did not do well on the post-test. Ms. Thernka created the intervention group to review and build student's knowledge before starting the next unit. The goal for this unit was for students to understand the relationship between addition and subtraction and to show their learning through multiple problem-solving techniques. The lesson focused on adding or subtract three-digit whole numbers. The remedial lessons included a variety of instructional strategies and the use of manipulatives.

My guiding question for the capstone project was, *"Will the integration of differentiated instructional and assessment methods impact student learning when learning addition and subtraction?"* For this project, students completed two formal assessments, a pre-test and a post-

assessment. Both assessments had 10 questions with the post-assessment mirroring of the pre-assessment.

While teaching the unit, I implemented three differentiated instructional and assessment strategies to determine if the strategies would have a positive effect on the students learning. The instructional strategies included graphic organizers, manipulatives, and number talks. The assessment strategies included exit tickets, observation, and the pre and post-test. During the unit I strived to draw meaningful conclusions regarding the impact of the instructional and assessment methods on student achievement. I also implemented reflective discussions with students during each lesson to gather feedback on their experiences with the instructional strategies and assessment methods.

Understanding of Instructional Methods

Graphic Organizers

Throughout my education, I have learned that effective educators utilize research-based instructional strategies to enhance students' learning in the classroom. One strategy that I have found particularly effective was the integration of graphic organizers. The graphic organizers helped students organize and process information and encouraged deeper thinking and understanding. The graphic organizers helped the students break down complex concepts into manageable components. Research has shown that graphic organizers benefit students across a variety of subject and learning styles.

I had students use a graphic organizer for their word problems. The graphic organizer helped the students to breakdown steps of a problem. Braselton and Decker (1994) noted "… the strength of graphic organizers lies in their ability to visually relate elements of a story (or story problem), layout and design are important" (p. 276). I found that the graphic organizer was a

simple and easy tool for the students to visually see each part of a story problem. Braselton and Decker (1994) also found in their study that "A student who can explain a problem in his or her own words has conceptualized the situation being described and is more likely to be successful with subsequent steps of the problem-solving process" (p. 276). Their research brought attention to the significance of understanding and conceptualizing a problem in one's own words as a crucial step in the solving process.

Manipulatives

Research supports the integration of manipulatives into elementary mathematics. Manipulatives include but are not limited to counting blocks, geometric shape, and measuring tools. These tangible aids support students in visualizing abstract mathematical concepts that then connect to a deeper understanding and retention. Hands-on experiences with manipulatives encourage exploration and experimentation. The goal of using manipulatives repeatedly is not only to keep students engaged, but to also create comfortability and repetition in using them. Moyer (2001) noted, "… actively manipulating these materials allows learners to develop a repertoire of images that can be used in the mental manipulation of abstract concepts" (p. 176). Moyer reinforced the idea that through active manipulation of physical materials, students can develop a concrete understanding of abstract mathematical concepts. The hands-on experience enabled learners to form mental images and connections, facilitating their ability to manipulate and comprehend abstract ideas. This process not only enhanced students understanding of specific concepts, but also equipped them with a versatile toolkit of mental representations that could be applied across various mathematical contexts.

In my unit study, I integrated base ten blocks as manipulatives. Base ten blocks provide concrete representation, enhancing student understanding of place value, directing their focus on

regrouping, and aiding in visualizing operations. Numbers can be a confusing concept to grasp and having visuals and a hands-on experience change how students understand and conceptualize addition for multi-digit numbers. Pagar (2013) noted, “Understanding the base ten system is a pivotal mathematical goal as it is foundational for more advanced mathematical understanding, for instance multi-digit written calculation” (p. 7). I found that integrating the base ten blocks into my unit-built students' confidence and understanding. Students were able to use the hundreds blocks as a strategy when solving problems during the lesson. Following the unit some students continued to use the base ten blocks to solve problems.

Number Talks

Number talks are often overlooked; however, number talks are short, daily math routines designed to engage students in meaningful mathematical discussions centered around mental math strategies and number sense. Number talks are not employed merely for repetition or rapid calculations; rather, they serve to foster a deeper understanding of various problem-solving approaches and to cultivate flexible thinking regarding numerical concepts. During number talks, students are encouraged to explain their thinking, listen to and respect the ideas of their peers, and consider multiple strategies for solving a problem. Parrish (2010) noted, “Mental computation is a key component of number talks because it encourages students to build on number relationships to solve problems instead of relying on memorized procedures” (p. 13). Mental computation is the ability to perform calculations mentally without the aid of written or electronic devices. Parrish (2010) concluded that when students participated in number talks, they were more likely to develop their mental math skills and became more confident problem solvers. I found that by engaging my students in mental computation during number talks, that the students gained a deeper understanding of mathematics.

Understanding of Assessment Methods

Exit Tickets

Exit tickets are a tool that provide educators with valuable insights into student comprehension. They are quick and efficient check-ins at the end of class or a lesson to assess student understanding. By prompting students to articulate their understanding of key concepts, exit tickets promote reflection. They also empower students to engage in self-assessment, promote accountability and ownership over their learning journey.

"Exit slips provide immediate feedback and diagnose the areas of improvement that can be helpful for teachers to guide about planning and presentation of the lesson" (Akhtar & Saeed, 2020, p. 84). Exit tickets, which can also be referred to as exit slips, can be one question or five questions, and are used to monitor learning in the classroom. I found that the integration of exits slips into my lessons provided me with immediate feedback of the student's understanding. Following analysis of the exit tickets I was able to identify areas that needed reteaching or improvement. The exit tickets informed my lesson planning and choice of presentation strategies. The feedback on the exit tickets enabled me to deliver lessons more effectively. I found that exit tickets cultivated a responsive learning environment, ensuring that all of my students received the support they needed to meet the lesson objectives.

Observation

Observing students as an assessment method is crucial for gaining insights into their learning process beyond what traditional paper/pencil assessments can reveal. By actively observing students' language use and learning, teachers gain insight into their strengths and areas for improvement. Informal data collected during observations can guide teachers to create

lessons to meet student's needs. Observing attentively, without assumptions or predictions, is key to adopting a formative assessment approach.

Observation methods may include field notes, running records, analysis, checklists, and observation guides. Classroom observations can serve as formative assessment strategy as they provide real-time insights into student learning. Unlike static assessments, observations capture students' engagement, interactions, and problem-solving in the moment, allowing for personalized feedback and instruction tailored to individual needs. In a study by Braund et al. (2021) they found that "… classroom observations showcased unique ways that participants were adapting self-assessment and peer-assessment to better fit within the Kindergarten context" (p. 8). The participants in this study were kindergarteners and my group included four third graders. Although there was a grade level difference, I too found that observations provided me with a holistic view of the student's academic progress, social interactions, and behavior. Through the observations I was able to continuously monitor and adjust the teaching strategies to support student growth effectively.

Pre and Post-Tests

Pre and post-tests serve as valuable tools for evaluating student learning and measuring growth over the course of a lesson or unit. Pre-tests help teachers gauge students' prior knowledge and identify any misconceptions or gaps in understanding before instruction begins. Using pre-test data provides teachers with the opportunity to tailor their lessons to meet the specific needs of their students and ensure that instruction is both relevant and engaging.

Post-tests, on the other hand, provide teachers with a means of evaluating student learning outcomes and determining the effectiveness of their instruction. By comparing pre and post-test results, teachers can assess student growth, identify areas of strength and improvement,

and make informed decisions about future instruction. Overall, pre and post-tests are valuable tools for informing instructional practice in the classroom. A study conducted by Allen and Simkins (2000) found that "…pretest results provide a benchmark for assessing teaching effectiveness at the end of the course" (p. 103). The results of the pre-test provided me with a benchmark to evaluate my teaching effectiveness. I compared the pre and post-test results and found that tracking student progress from the beginning to the end of the unit provided valuable insights into the impact of my instruction on student learning.

Methods and Materials

This math unit is connected to two Nebraska state standards for third grade.

- 3.A.1.a Add and subtract up to four-digit numbers with or without regrouping using strategies based on place value and algorithms.
- 3.A.1.b Determine the reasonableness of whole numbers with or without regrouping using strategies based on place value and algorithms.

Using the established standards and assessments, I crafted three objectives for students to meet through this unit: (1) the students will add or subtract three-digit whole numbers using number lines, (2) the students will add or subtract four-digit whole numbers using hundreds of blocks, and (3) the students will add or subtract three-digit whole number word problems using the word problem breakdown strategy. This unit not only focused on the importance of solving addition and subtract problems, but also aimed to provide with strategies to increase their problem-solving abilities. The 6 instructional days included the following: (1) Day 1: reviewing standard addition and subtraction, (2) Day 2: explaining and modeling how to use hundreds block to solve problems, (3) Day 3: explaining and modeling how to use a number line, (4) Day 4: explaining

and modeling how to form equations with provided data, and (5) Days 5 and 6: explaining and modeling a story problem strategy for addition and subtraction.

The unit was taught over 8 days and 2 days allocated for a pre and post-test. A ten-question pre-test (Appendix A) was administered on the first day. The pre-test directly mirrored the post-test students took at the end of the unit. I encouraged students to give their best effort on the tests. During the pre-test, I verbally stated each test question to students, while they independently completed the assessment. Following the evaluation of each student's pre-test, I utilized the gathered data to tailor instructional plans according to their individual needs. Based on the pre-test data, I decided that my students would benefit from an assortment of instructional strategies to assist them. I wanted students to know that there were multiple strategies that they could use to solve multi-digit addition and subtraction problems. The six lessons were taught outside of the classroom in a small learning space.

On the first day of instruction, I taught a lesson to review basic addition and subtraction rules. I observed from the pre-assessment that little mistakes in solving problems had a significant impact. Examples of the errors on the pretest included adding instead of subtracting, not carrying over numbers, or subtracting a number larger number than a small number. I reviewed problems that included these mistakes. I led a group review session with that was followed by independent work on problems.

On the second day of instruction, we focused on using hundreds blocks to help students visualize the problems. Together we explored how to visualize a given number using the hundreds blocks. I modeled how to break a three-digit number into hundreds squares, tens sticks, and ones pieces. During guided practice the students were given a number and they were to use the blocks to represent the number. I reminded the students that they would not have access to

physical hundreds blocks during tests. Therefore, I emphasized the importance of using pencil drawings to represent numbers. I demonstrated the process and provided ample opportunities for hands-on practice.

On the third day of instruction, I implemented a number line strategy. This strategy offered a visual representation of numerical relationships. I believe the number line enhanced student comprehension and their problem-solving skills. Through the number line, students learned the concept of place value and the magnitude of numbers. They also learned to decompose and combine numbers effectively. The number line served as a tool for building their conceptual understanding of addition and subtraction.

On the fourth day of instruction, students were introduced to forming equations based on mini story problem sentences. This lesson was a step towards solving story problems as it helped students to identify vocabulary words specific to math operations. When I analyzed the pre-tests, I identified that most of the students lacked understanding of the order of operations when adding or subtracting problems, or how to set up equations. Lesson four focused on equipping students with the skills needed to identify key words and phrases within story problems. Through guided practice and interactive exercises, the students gained confidence when they dissected a story problem. The students learned how to translate the words into math expressions, helping connect math concepts real-life situations.

The final two days of instruction were dedicated solely to story problem strategies. Two days of instruction were used to address story problems as all four students missed the last three questions on the pre-test related to solving story problems. To address this deficit area students were introduced to effective tools and strategies for solving story problems. One such tool was the integration of graphic organizers. The graphic organizers helped the students to

systematically organize the information presented in story problems. This visual aid provided a structured framework for students to identify key components and relationships within the problem. In addition to the graphic organizers, I also integrated the CUBES strategy. CUBES was introduced as a method to help students analyze and approach story problems systematically. I modeled the four steps of the strategy: (1) circle the numbers, (2) underline the question, (3) box the important words, and (4) eliminate what you do NOT need. The CUBES strategy equipped students with a clear and methodical approach to tackling complex problems. Through guided practice and application of these strategies the students were able to successfully navigate solving the story problems.

Throughout this unit, I also implemented three research-based instructional strategies. The first instructional strategy I implemented was 'number talks.' Number talks follow a teacher's prompt. Following the prompt students engage in conversations focused on mental math strategies and number comprehension. They are to engage with their classmates and share the methods used to solve math problems.

The next strategy I included were base ten manipulative blocks. As previously discussed, manipulatives are tangible representations to assist in solving problems. The manipulation of the blocks aid in understanding place value, regrouping, and facilitating visualization of operations. Given the abstract nature of numbers, integrating the base ten blocks provided a hands-on experience to assist in comprehension and conceptualization of addition with multi-digit numbers.

The third strategy I implemented was a five-section graphic organizer. The graphic organizer provided a tool to assist in breaking down information in a story problem. The graphic

organizer helped them ‘see’ the steps to solving a story problem (Appendix G). All students used the graphic organizers because it helped them break down the steps of a problem.

The unit also included three research-based assessment strategies (exit tickets, observations, and pre and post-tests). Exit tickets were a valuable assessment tool as they provided me with an immediate comprehension check. The exit tickets engaged students in self-reflection of the key concepts in the lesson. Each exit ticket consisted of three questions. The exit tickets provided me with insights into whether the students understood the objective of the lesson. By integrating exit tickets, I was able to create a student-centered learning environment that supported academic growth for all students.

Another assessment method I included was observations. Unlike static assessments, my observations captured the students' engagement, interactions, and problem-solving in the moment. Through my observations it allowed me to give students personalized feedback and instruction tailored to their individual needs. I learned how to be attentive to the level of the engagement of each student and to recognize when they understood or needed clarification.

As I reflected on the unit, I learned the importance of data derived from the pre and post-tests. When I compared the student scores from the pre and post-tests I was impressed how much students learned and how much they improved throughout the unit. The pre-test scores helped me see what students already knew, and where they might need more help. The scores helped me plan lessons that fit each student's needs.

On my last day with my group, I administered the post-test (Appendix B). I was excited to compare the pre and post-test scores to see how much the students had improved, and how well they understood the material. Following a comparison of both tests I was able to see how much the students have progressed, and what areas they still needed work. Overall, I found these

assessments were great tools for analyzing student understanding as well as helping guide the direction of the unit lessons.

Results/Data Analysis

Appendixes A and B include the pre and post-tests taken for this unit. Tables 1 and 2 display the data gathered from these assessments. The questions are listed on the horizontal axis, while each student is represented on the vertical axis. The "I" represented incorrect responses and the "C" represented correct responses. The far-right column is the total score out of 10 for each student.

Table 1

Pre-Test

Student Number	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Score
Student B	I	I	I	I	I	I	I	I	I	I	0/10
Student C	I	C	C	C	I	C	I	I	I	I	4/10
Student E	I	C	I	C	I	C	I	I	I	I	3/10
Student L	I	I	I	C	C	I	I	I	I	I	2/10

Note. The table above presents the data from the pre-test administered to students prior to the unit. The scores aided in both unit planning and instructional grouping. This data guided the planning of whole-group lessons and facilitated the formation of daily math groups, organized according to each student's total number of correct responses.

Table 2

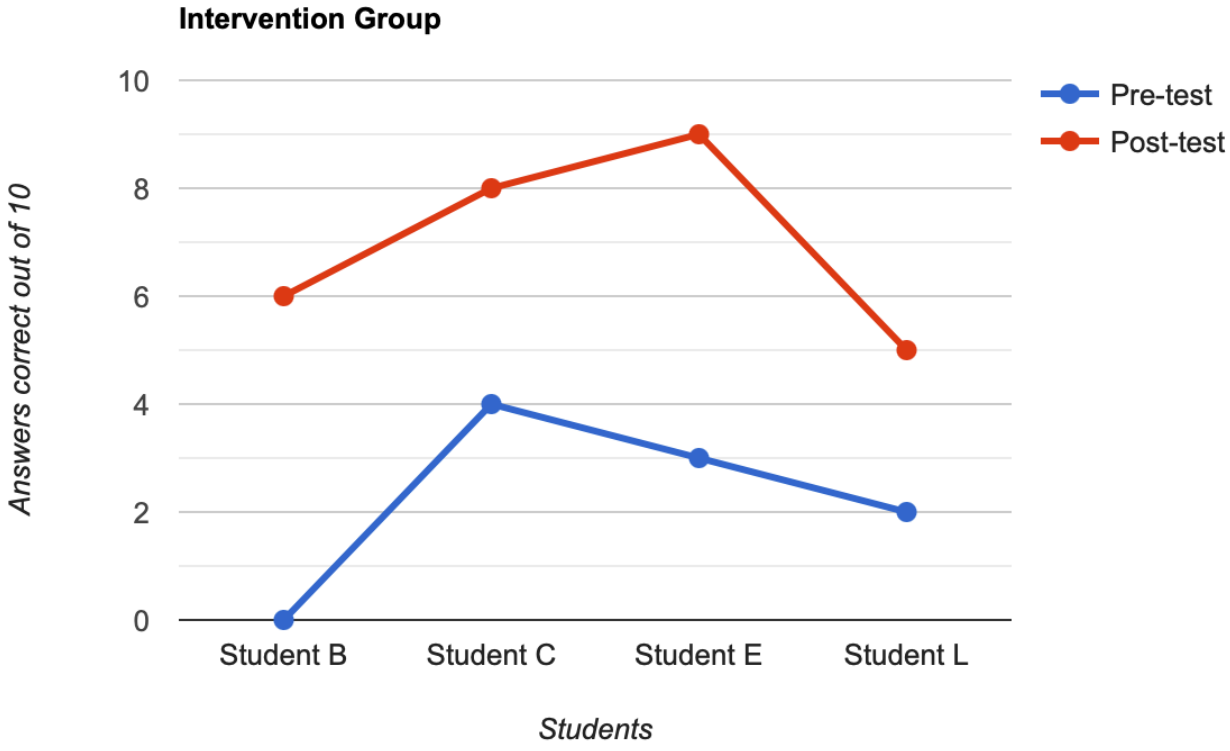
Post-Test

Student Number	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Score
Student B	I	C	I	C	C	C	C	C	I	I	6/10
Student C	C	I	C	C	C	C	C	C	C	I	8/10
Student E	C	I	C	C	C	C	C	C	C	C	9/10
Student L	I	C	C	C	C	I	I	C	I	I	5/10

Note. The table above presents the data from the post-assessment administered following the last day of instruction. The post-test provided insights into the learning progress achieved throughout the instructional period.

Figure 1

Student Growth



Note. The line graph illustrates the comparison between students' pre-test and post-test scores. Both axes represent the number of correct responses, with each student plotted along the horizontal axis. The blue line depicts the students' pre-assessment, while the red line represents their post-assessment scores. Overall, the data depicted in the line graph demonstrates that the majority of students improved their scores from the pre-test to the post-test.

Discussion and Conclusions

The data from the pre-assessment helped me to determine which students were struggling and what specific areas they were struggling in. The pre-test scores shown in Table 1 noted that students were performing at a variety of levels. As I analyzed the pre-test scores, I knew questions 8, 9, and 10 were about story problems. None of my group responded correctly to the three questions. As they demonstrated a lack of understanding of story, I chose to teach two lessons over story problem operations.

I integrated a variety of assessment methods to monitor student understanding. I reviewed their work daily to help me gauge their understanding of the concepts taught. The student assessments guided my teaching approaches. Through immediately reviewing their work 3it, enabled me to identify areas for improvement, as well as determine who was prepared to advance and who would require additional support.

The data from the post-assessments showed student improvement between 30% and 60%. I concluded that the instructional and assessment methods integrated into the lessons positively impacted student learning. The results show a noticeable boost in how much students understood and remembered from the pre-test to the post-test.

I have learned throughout my clinical practice that every student has a unique way of learning. Utilizing research based instructional strategies and assessment methods, I believe,

significantly enriched my teaching practice. Reflecting on the positive outcomes of this capstone project, I am determined to integrate these methods into my future practice. Through the integration of differentiated strategies, I was able to create an inclusive learning environment that nurtured every student, regardless of their abilities.

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Appendix

Appendix A: Pre-Assessment

Pretest

Name: _____

Use an efficient strategy to solve.

1. 534 – 176 =

2. 492 + 288 =

Select the correct equation

3. Which equation can you use to find the difference between 82 and 150?

    a. 82 + 150 = m
    b. 82 – 150 = m
    c. 82 + m = 150
    d. m – 82 = 150

Write an equation to represent the problem.

4. Linda got 132 dollars for her birthday. She already had 21 dollars. How much money does Linda have now?

5. Peg made 144 cookies for her school bake sale. She sold 96 of her cookies. How many cookies are left.

Solve for n.

6. 56 + 33 – 21 = n

7. 84 – 35 + 47 = n

Solve the word problems below.

8. Lilly has $125. She buys new dance shoes for $45 and a new doll for $37. How much money does Lilly have left?

9. Tim collects football cards that he buys and sells. He started with 582 football cards. He sells 231 football cards. Then he buys 197 football cards. What is the total number of football cards Tim has now.

10. Frankie had 350 pounds of sand for the community sandbox. He used 90 pounds of sand in the first section and 213 pounds of sand in the second section. How many pounds of sand does Frankie have left?

Appendix B: Post-Assessment

Posttest

Name: _____

Use an efficient strategy to solve.

1. 463 – 128 =

2. 791 + 385 =

Select the correct equation

3. Which equation can you use to find the difference between 34 and 140?

    a. 34 + 140 = m
    b. 34 – 140 = m
    c. 34 + m = 140
    d. m – 34 = 140

Write an equation to represent the problem.

4. Linda got 132 dollars for her birthday. She already had 21 dollars. How much money does Linda have now?

5. Peg made 144 cookies for her school bake sale. She sold 96 of her cookies. How many cookies are left.

Solve for n.

6. $65 + 43 - 31 = n$

7. $94 - 75 + 42 = n$

8. Grace has $205. She buys new shoes for $25 and new glasses for $173. How much money does Lilly have left?

9. Pat collects baseball cards that he buys and sells. He started with 643 baseball cards. He sells 336 baseball cards. Then he buys 156 baseball cards. What is the total number of baseball cards Pat has now.

10. Polly bought 500 pounds of flour for her bakery. She used 173 pounds of flour for cookies and 294 pounds of flour for bread. How many pounds of flour does Polly have left?

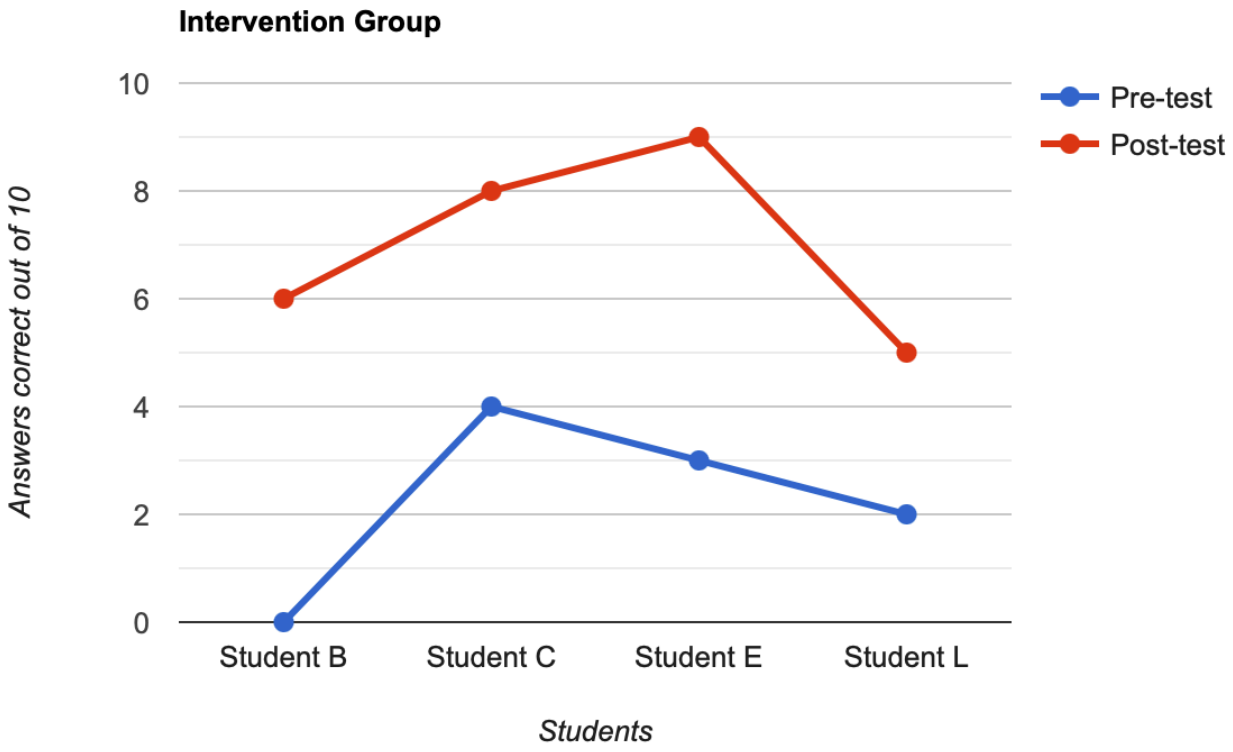
Appendix C: Pre-Assessment Data

Student Number	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Score
Student B	I	I	I	I	I	I	I	I	I	I	0/10
Student C	I	C	C	C	I	C	I	I	I	I	4/10
Student E	I	C	I	C	I	C	I	I	I	I	3/10
Student L	I	I	I	C	C	I	I	I	I	I	2/10

Appendix D: Post-Assessment Data

Student Number	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Score
Student B	I	C	I	C	C	C	C	C	I	I	6/10
Student C	C	I	C	C	C	C	C	C	C	I	8/10
Student E	C	I	C	C	C	C	C	C	C	C	9/10
Student L	I	C	C	C	C	I	I	C	I	I	5/10

Appendix E: Graph of Student Data



Appendix F: Student Exit Ticket Data

Date	Student B	Student C	Student E	Student L
Exit Ticket 1	2/3	1/3	2/3	1/3
Exit Ticket 2	2/3	2/3	3/3	2/3
Exit Ticket 3	3/3	2/3	3/3	2/3

Appendix G: Story Problem Graphic Organizer