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Teaching Addition and Subtraction Story Problems to Second Grade Students Utilizing a Differentiated Instructional Strategies

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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 semester, I was placed in a second-grade classroom in the Papillion LaVista Community School District. My cooperating teacher Melissa Price has been teaching for over thirty years in a variety of urban and suburban schools and currently teachers at Carriage Hill Elementary.

Carriage Hill has a Title I designation. Title I is a federal education program that supports low-income students throughout the nation. Title I schools receive extra benefits for students and staff. Some of the benefits Carriage Hill receives with the Title I designation include a lower student-to-teacher ratio, professional development opportunities for teachers, are additional funds for supplies and other necessities, free and reduced lunch for the students, and supplemental programs to support student success.

Introduction

For my capstone my cooperating teacher and I decided that I would benefit from teaching a unit on mathematics. I was assigned to plan and teach unit three which covered addition and subtraction. Unit three incrementally increased the number of addition and subtraction problems the students were expected to solve. The goal for the end of the year was for the students to be adding and subtracting within the 1000's.

After I planned the unit, I administered a pre-test prior to any instruction on addition and subtraction. At the end of the unit the students were administered a post test that closely mirrored the pre-test given. The tests assessed their knowledge of addition and subtraction story problems up to 100.

The pre and post-test had eight questions: (a) two problems requiring them to write out the problem, (b) two problems finding the missing addends, and (c) four story problems.

The goal for this five-lesson unit was for students to successfully apply the relationship between addition and subtraction They were expected to solve complex problems using fact families, mental math, or place value strategies to solve them. I taught the unit utilizing whole group. At the beginning of each math lesson, I reviewed addition and subtraction problems and the rules of operation (e.g., borrowing, when to add or subtract). I wanted the students to think critically and identify the strategy they were using to solve the math problems.   The guiding question of my capstone project was, *"How will implementing differentiated instructional strategies (i.e., graphic organizers, providing praise and feedback, turn and talks, and gradual release of instruction) impact students' performance on addition and subtraction story problems?"*

Understanding of Instructional Methods

Graphic Organizers

Throughout all my schooling I have been told that effective educators use research based instructional strategies to help improve student learning. One research based instructional strategy that I implemented into the unit was graphic organizers. Graphic organizers can consist of sematic maps, flow charts, display lists, categorical or hierarchal information, and others. These visual organizers assist students with various note taking strategies to help students organize information that is presented.

An intervention study conducted by Zakas et al. (2013) found that the integration of graphic organizers helped students to understand reading passages and answer comprehension questions. Their data evidenced a "functional relationship between the graphic organizer intervention and all three students' ability to answer comprehension questions" (p.1082). Graphic organizers are consistently a favorite instructional strategy of educators because of their versatility across grade levels and content areas.

Graphic organizers can be used to address students' misunderstandings and allow them to deepen the relationship between mathematics and their thinking. They can be utilized with other strategies, such as manipulatives, to help students who may be struggling in their mathematics curriculum. Math can be difficult for some students to grasp. Providing students with multiple ways of representing while solving problems can help improve their understanding of mathematics.

Turn and Talk

The second instructional strategy I implemented throughout the unit was turn and talk. Turn and Talk is a strategy that many teachers use during instruction. Its premise is allowing students to discuss content knowledge with a peer. Students are provided with a prompt and then

the student turns to their peer and answer the prompt while their partner listens. This strategy allows the student to orally express their understanding of materials.

Numerous research studies, including one by Karali and Aydemir (2018), have demonstrated the effectiveness of cooperative learning in developing positive attitudes towards school and encouraging student interaction. They found cooperative learning to be highly beneficial in enhancing students' learning experiences. Verbal communication between the students provided opportunities for them to be more involved in the whole lesson. When cooperative learning was integrated into a lesson it helped students maintain their focus and minimized unwanted behaviors which created a conducive learning environment.

Reinforcing Effort and Giving Praise

The third instructional strategy, though often overlooked, can be integrated seamlessly into instruction to enhance student success. Researchers and educators call it by many different names such as 'behavioral specific praise' and 'teacher-child interaction training' but it revolves around the same concept. Reinforcing effort and giving praise is used commonly in special education classrooms. The strategy is utilized by special education teachers to discourage unwanted behaviors and reward expectations that are being met by the students.

Reinforcing effort and giving praise can also be implemented into any educator's classroom with minimal preparation. Recognizing and rewarding effort can be done with verbal praise or any other means of appreciation. The strategy entails identifying a student or groups of students who are on-task and/or 'doing the right thing.' The teacher then gives praise that is specific to 'what the student(s) is doing right. Inzlicht et al. (2018) found that "If effort is consistently rewarded, people might learn that effort is valuable and become more willing to

exert it in general" (p. 297). I found that giving intentional praise was a simple yet powerful method to increase effort and engagement from the students.

Gradual Release of Responsibility Instruction Model

The fourth strategy integrated into the unit was a scaffolding strategy. The gradual release of responsibility instructional model (GRRIM) purposefully and gradually shifts the learning responsibility from the teacher to the students. The teacher moves from modeling to guiding instruction to providing students with opportunities to collaborate before they engage in an independent learning experience. The four-step strategy starts with 'I do.' The 'I do' is used during the beginning of the lesson and includes specific modeling by the teacher. The second step is 'we do.' This step provides students with the opportunity to practice the skill with teacher support. The third step is 'you do.' This step provides students with the opportunity to work with their peers and demonstrate what they have learned so far. Finally, when students have had practice with guided support, they are then given time to practice the in the last step 'you do alone.'

Research on the model was done conducted by Tan and Saligumba (2018) found that students who were taught with the gradual release of responsibility instructional model had higher post-test scores and a "high significant difference as compared to those exposed to non-GRRIM" (p. 276). Throughout my lessons I found the GRRIM an effective strategy to increase my student's understanding.

Understanding of Assessment Methods

Formative Assessments

Formative assessments are integrated into lessons to help teachers monitor student learning, providing ongoing feedback that teachers can use to improve their teaching and for

students to make gains in their learning. Formative assessment allows for student led instruction and allows the teacher to track how their students are doing during the lesson. Examples of formative assessments include checks for understanding, weekly quizzes, homework, in class review work, partner work, or small projects.

Teachers use formative assessments to help them plan their future lessons and understand where all their student are in the learning process. Teachers utilize data from formative assessments to inform their instruction 'in the moment.' The data informs the teacher when additional time may be needed or when to move on in the lesson or unit. Gezer et. al. (2021) conducted research on formative assessments, and they found "that formative assessment[s] can be more beneficial to encourage low achieving students in primary-grade mathematics classrooms" (p. 673). I found that for some of my students' mathematics was difficult. Through integrating formative assessments, I was able to identify what students 'knew' and what they 'didn't know,' which impacted the pacing of my instruction.

Pre and Post-Testing

In my unit I administered a pre and post-test that provided me with data to track individual student progress from the beginning of the unit to the end. The information from the tests helped me identify students who were struggling and implement targeted plans to support their learning. By documenting changes in the students' knowledge and skills, I was provided with evidence of the effectiveness of my instruction.

Participants

I taught the math unit utilizing whole group instruction. The unit started with 19 students and ended with 16. There were 9 boys and 7 girls who participated in the unit. None of the students had an Individualized Education Plan, however, five of the students had behavioral

plans (students 4, 9, 10, 14). The fifth student with a behavioral plan moved and was not

included in the final analysis of the data. Four of the students (1, 5, 6, and 15) were English

Learners.

Methods and Materials

This math unit is connected to four Nebraska state standards for second grade and was

taught across five lessons.

- 2.N.4.b Add and subtract using 100 strategies based on place value including properties
  of operations, relationships between addition and subtraction, and algorithms

- 2.N.4.e Add and subtract within 1,000 using concrete models, drawings, and strategies
  that reflect an understanding of place value and the properties of operations.

- 2.N.5.a Solve authentic problems involving addition and subtraction within 100 in
  situations of addition and subtraction, including adding to, subtracting from, joining, and
  separating, and comparing situations with unknowns in all positions using objects,
  models, drawings, verbal explanations, expressions, and equations.

- 2.N.5.b Create authentic problems to represent one-step addition and subtraction within
  100 with unknowns in all positions.

I aligned my daily lessons to the Nebraska State Standards and utilized the standards to create

objectives for the unit. The objectives are as follows: (1) the students will be able to verbally

share with a partner the relationship between adding 9 and adding 10 to a number in partners

with 100% accuracy, (2) the students will be able to use a 100 chart to help them solve double

digit addition and subtraction problems with 80% accuracy independently, (3) the students will

be able to use visual drawings of base 10 blocks to model double digit numbers and compare

them to other base 10 models with 5/6 correct, (4) the students will be able to correctly identify

adding 10 and adding 100 to a number by using the relationship between them with 70% accuracy, and (5) the students will be able to use a variety of strategies to solve comparison problems with bigger unknowns with 70% accuracy.

The Papillion-La Vista Community Schools District assesses students on four different levels based on their proficiency on unit tests. The levels are: (1) Level 1: Beginning, (2) Level 2: Progressing, (3) Level 3: Proficient, and (4) Level 4: Advanced. For this project, I reviewed each student's pretest scores and aligned them with the proficiency levels noted above.

An eight-question pre-test (Appendix A) was administered on the first day of instruction. The pre-test directly mirrored the post-assessment students took at the end of the unit. When students were completing the pre-test, I encouraged them to try their best. I read each pre-test question aloud. I encouraged the students to use highlighters to identify important information.

The pre-test scores impacted how I planned the lessons. I followed the same model of instruction throughout the unit: (1) whole class instruction utilizing gradual release of responsibility, (2) small group instruction, and (3) independent practice.

Analysis of the pre-test data noted that specific students were below proficiency levels and would need explicit instruction. I used the students' pre-test scores and split them into three math groups. The small math groups allowed myself and my cooperating teacher to address deficit areas. It was noted that the students made the most gains in small group. During small group instruction we were able to collect observational data to assess student's growth. At the end of math time the students would work independently. They were provided the opportunity to

work on math apps including preloaded math games on Clever or XtraMath, and be in a math

group with myself or my cooperating teacher.

On the first day of instruction the objective of the lesson was for students to add nine and

ten to a number. The lesson also introduced various strategies to assist them when solving higher

level addition and subtraction equations. During this lesson, it was important that the students

understood how they could add 10 to a number, and then subtract 1 to help them add nine. I used

the gradual release of responsibility instruction model at the beginning of the lesson to

demonstrate how adding ten and adding nine to a number were very similar. The students then

moved into math groups. In the small groups we addressed some of the important concepts that

students needed to understand and reviewed operations from the pre-test that were incorrect.

On the second day of instruction, the objective was to learn how to use a hundreds grid.

It's important for students to understand how they can use the hundreds grid graphic organizer to

help them solve higher level addition and subtraction equations. I started the lesson by allowing

students to identify how going up and down or left and right on the hundreds grid changes the

number. The students understood that moving down on the hundreds grid meant adding ten to

each number, while moving up meant subtracting ten from each number. The students then

practiced using the hundreds grid to help them solve addition and subtraction equations.

Following the practice the students moved into math groups where we continued using the

hundreds grid to solve equations.

On the third day of instruction, I introduced them to base 10 block drawings. Base 10

blocks (or drawings) are used to teach concepts related to place value. The physical base 10

blocks consist of blocks representing ones, tens, hundreds, and thousands, allowing students to

visualize numbers. I modeled and drew math equations on the board using base 10 to represent

the numbers. During the middle of the lessons the students practiced several equations. We then moved back into math groups and did addition and subtraction problems using base 10 drawings.

On the fourth day of instruction, we identified the zero's rule when adding 10 and 100 to a number. Students were asked to add multiple hundreds to a number. We did some fun and repetitive activities to provide additional practice on using the zeros rule correctly. Students then moved to small groups. In small group we reviewed the zeros rule for students who needed additional instruction and practice.

The fifth lesson higher-level math was introduced. I began by scaffolding high addition and subtraction equations and modeled how to use previous strategies to solve equations. The students were given the opportunity to choose a strategy to solve the problems. Giving the students the opportunity to use their own way of thinking to think through these complicated math problems was an effective strategy. We then moved back into math groups and worked on some more review of strategies for struggling students.

Throughout the entire unit I implemented four research based instructional strategies to determine if the strategies would have a positive impact on students learning. The first instructional strategy I used was graphic organizers. Graphic organizers are an instructional tool that can assist students with note taking and assist them in organizing new information. Graphic organizers can consist of sematic maps, flow charts, display lists, categorical, or hierarchal information. The graphic organizers integrated into the lessons allowed students to use hundreds charts and part, part, whole maps. The students completed an addition graphic organizer by using them as addition guides as shown in Appendix E. The graphic organizers allowed for explicit modeling of content and organization of the student's learning.

The next strategy I included in my unit was turn and talks. Its premise is allowing students to discuss content knowledge with a peer. Students are provided with a prompt and then the student turns to their peer and answer the prompt while their partner listens. I used turn and talks multiple times throughout my unit and allowed it for student interaction in different ways. I used a three-step procedure during the turn and talks. The students were asked to stand-up, hand up, and then pair up. I would give students a question or a prompt and students would then walk around the room. When I would say "stop," the students would go to the nearest student and discuss the question I asked. This allowed for students to have time to think of a response to the question while walking and provided interactions with other peers in the class.

I also used collaboration in math groups. I would oftentimes allow students to work with partners or other students, allowing them to discuss strategies or how they solved the problem. This too allowed for greater collaboration and interactions between the students. It also allowed them to see how their way of solving a problem wasn't the only way to solve the problem.

The third strategy I implemented was called reinforcing effort and giving praise. This is a strategy increases student motivation through behavioral specific praise. I praised the students by name during the lessons. I would recognize the student for on-task behavior, their responses to questions, and their engagement in the lessons. Praise was given to students who were 'doing the right thing.' When giving students praise, I always stated what they were 'doing right.' I paired this strategy into all my lessons when I used gradual release responsibility of instruction model. The pairing of the two strategies kept students motivated and engaged in the lessons.

The fourth strategy I implemented daily in my lessons was the gradual release of responsibility instructional model (GRRIM) that is outlined above. I used this strategy daily in

my lessons before moving students to the small math groups. The model allowed for scaffolding of the lesson and increased student participation and understanding.

To document student learning I administered a pre-test (Appendix A) before I began instruction and administered a posttest (Appendix B) at the end of the unit. The teaching manual had a pre and post-test built into the unit. The pre-test results provided me with a baseline of student's understanding of the unit objectives. The results also assisted in me planning the unit lessons. On the last day of instruction, I administered the post-test (Appendix B). I reviewed the student scores to determine if there was growth from pre to post-test.

I also integrated formative assessments throughout the unit. The formative assessments provided me with a snapshot of how the students were doing during the lesson as well as after the lessons. The formative assessment data from observations and worksheets provided me with immediate feedback on the student's understanding of the lesson. I also used the 1,2,3,4 hands up method. This strategy allowed students to show me their level of understanding and allowed me to modify continuous lessons immediately.

Results/Data Analysis

Appendixes A and C are the pre- and post-tests taken for this unit. Tables 1 and 2 represent the student and question data I collected from these assessments. The horizontal axis shows the question number, and the vertical axis shows the students (identified via numbers). The symbol 'C' designated questions that were answered correctly, the symbol 'I' noted incorrect responses, and the symbol 'PC' noted students who may have set a problem up correctly but did the math incorrectly.

Table 1

Pre-Test

Student Number	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Number Correct
Student 1	C	I	C	C	I	C	C	I	5
Student 2	C	I	C	C	C	C	C	I	6
Student 3	C	I	I	I	I	C	C	I	3
Student 4	C	I	C	C	C	C	C	C	7
Student 5	I	I	I	C	I	C	C	I	3
Student 6	C	I	I	I	C	C	C	I	4
Student 7	C	I	C	C	C	C	C	I	6
Student 8	C	I	C	C	C	C	C	I	6
Student 9	I	I	C	I	I	C	I	I	2
Student 10	C	I	C	C	C	C	C	C	7
Student 11	C	I	C	C	C	C	C	I	6
Student 12	C	I	I	I	C	C	C	I	4
Student 13	C	I	I	I	I	C	C	I	3
Student 14	C	I	C	I	C	I	C	I	4
Student 15	C	I	I	C	I	C	I	I	3
Student 16	C	I	C	C	C	C	C	I	6

Note. The table above reports the data from the pre-test given to students prior to the unit. The data shown in this table assisted me in planning this unit, with the whole group lessons and allowed me to group students in daily math groups based on the total number of correct responses per student.

Table 2

Post-Test

Student Number	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Number Correct
Student 1	C	C	C	C	C	C	C	I	7
Student 2	C	C	C	C	I	C	C	I	6
Student 3	C	C	C	C	C	C	C	PC	7
Student 4	C	C	C	C	C	C	C	C	8
Student 5	C	C	C	I	C	C	C	I	6

Student 6	C	C	C	C	I	C	C	I	6
Student 7	C	C	C	C	C	C	C	I	7
Student 8	C	C	C	C	C	C	C	I	7
Student 9	C	C	C	C	C	PC	C	I	6
Student 10	C	C	C	C	C	C	C	C	8
Student 11	C	C	C	C	C	C	C	C	8
Student 12	C	C	C	C	C	C	C	I	7
Student 13	I	C	C	C	C	C	C	I	6
Student 14	C	C	C	I	C	C	C	I	6
Student 15	C	C	I	C	C	I	I	I	4
Student 16	C	C	C	C	C	C	C	I	7

Note. The table above reports the data from the post-test used to assess students after the unit.

The data shown in this table assisted me in understanding the learning that took place throughout

the unit.

Figure 1

Student Growth

Pre and Post Test
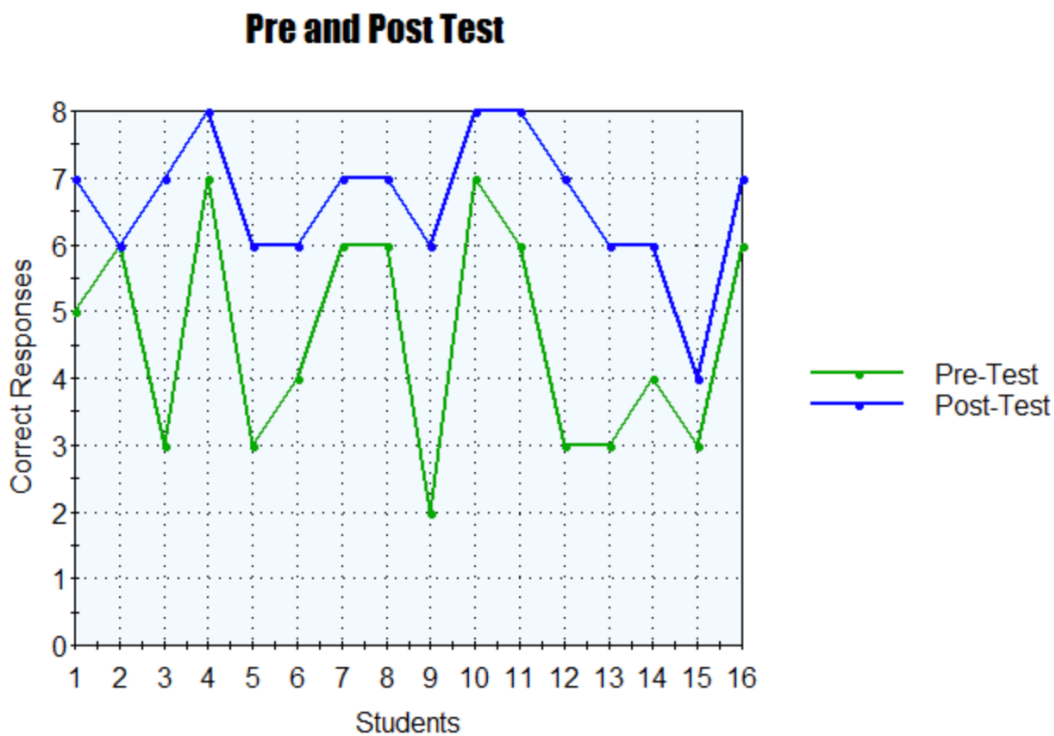
Note. This line graph represents students' pre-test scores compared to their post-test scores. The vertical axis shows the number of correct responses. The horizontal axis shows each student. The green line shows students' pre-test scores, and the blue line shows students' post-test scores. The line graph data shows that most students increased their score from the pre- to post-test.

Discussions and Conclusions

Using data from the pre-test helped me to identify students who were struggling or at risk, as well as those already performing at a second grade. Following review of the pre-test scores I identified the students at risk. Using the pre-test scores my cooperating teacher split the students into three groups. We used these groups daily and had times built in throughout the day that we see each student individually and scaffold instruction. In the small group lessons, we targeted two deficit areas: (1) carrying the one over when borrowing in subtraction problems, and (2) multiple-step subtraction story problems. I targeted my instruction to remediate the deficit areas.

Students 3, 5, 9, 13, and 15 were placed in one group together due to their lower scores on the pre-test. This group had the lowest scores on the pretest. With this group I integrated modeling, think aloud, and collaboration. I reviewed the math skills and was explicit in my instruction. Most of the students in this group were in the English Language (EL) program. Knowing that the students had an EL was important for me to know. The pre-test scores for this group may have been skewed as the test was in English. The EL students needed more time to process, and more practice to achieve to meet lesson objectives.

Students 1, 6, 12, and 14 were the 'mid-tier' group. These four students got about half of the questions correct on the pretest. In small group I focused on expanding their knowledge and skills in learning the strategies presented in the unit. My objective was to increase their understanding of the strategies and to learn how to generalize the strategies to other problems. The small group stations were successful for this group. The extra review time increased their understanding of when to use each strategy.

Students 2, 4, 7, 8, 10, 11, and 16 were considered my 'high' group. With this group, I emphasized using our higher thinking to think through problems and solve them. I observed several students tended to just 'see' the numbers and not double check their work. I noted that students in this group did not fully process the multiple steps needed to solve problems. This deficit area was addressed, and the students were encouraged to stop and think about the problems they were solving.

As mentioned previously, two students were not included in this data set. The students were not included due to one student missing about half of the school days, and the other having severe behavioral concerns that impeded their ability to work in the classroom during math instruction.

The data from the posttest revealed that my students applied the instructional strategies implemented throughout the unit. I observed that the students loved using graphic organizers. The tangible aid assisted them in their math comprehension. Not only did they demonstrate a clear understanding of how to use the graphic organizers effectively, but they also continued using them within the unit.

I believe the student's motivation and engagement was in part attributed to the praise and support they received during the unit. I observed that the more praise I gave, the more self-

motivated they were during the lessons. I believe that praising the students for their positive behavior also helped with my classroom management. Additionally, the praise-maintained students' engagement throughout the whole lesson. Based on my observation the students enjoyed collaborating with peers and learning how problems are solved differently.

The data from the formative assessments helped me understand which students were understanding what I was trying to achieve, and which students were struggling. I found the formative assessment data valuable as it informed my instruction,

After analyzing the pre and post test data, we found a ***20% increase*** in student achievement. The increase in student performance informed me that the instructional strategies and assessment methods implemented into the unit had positive effects on students' learning and achievement.

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Appendix

Appendix A: Example Pre-Test with Student Work

Directions: Read the following real-world problems and write an equation that represents the problem.

1. Julie has 65 stickers in her collection. She gives her friend 23 stickers. How many stickers does Julie have in her collection now?

2. Robert has 49 Pokémon cards. His mom gave him 46 Pokémon cards for his birthday. How many Pokémon cards does Robert have?

Directions: Solve the following problems. Show your work.

3.	$42 +$ _____ $= 99$	4.	$96 -$ _____ $= 30$

Directions: Read the following real-world problems. Write an equation and show your work. Circle your answer.

5. Sarah has a bowl of M&M's. She buys a king-sized bag of M&M's that has 45 inside. Now she has a total of 90. How many M&M's did Sarah have in her bowl to start with?

6. Phillip has 67 marbles in his collection. He went to a garage sale and bought a jar that had 30 marbles. How many marbles does he have now?

7. Emily has 27 gems in her collection. Natasha has 15 more gems than Emily. How many gems does Natasha have in her collection?

Directions: Read the following real-world problems. Write and equation and show your work. Circle your answer.

8. George went on a family trip. The first day they traveled 357 miles. The next day they traveled 330 miles. If they traveled a total of 900 miles for their whole trip. How many miles did they travel on the third day?

Note. This is an example of the pre-test.
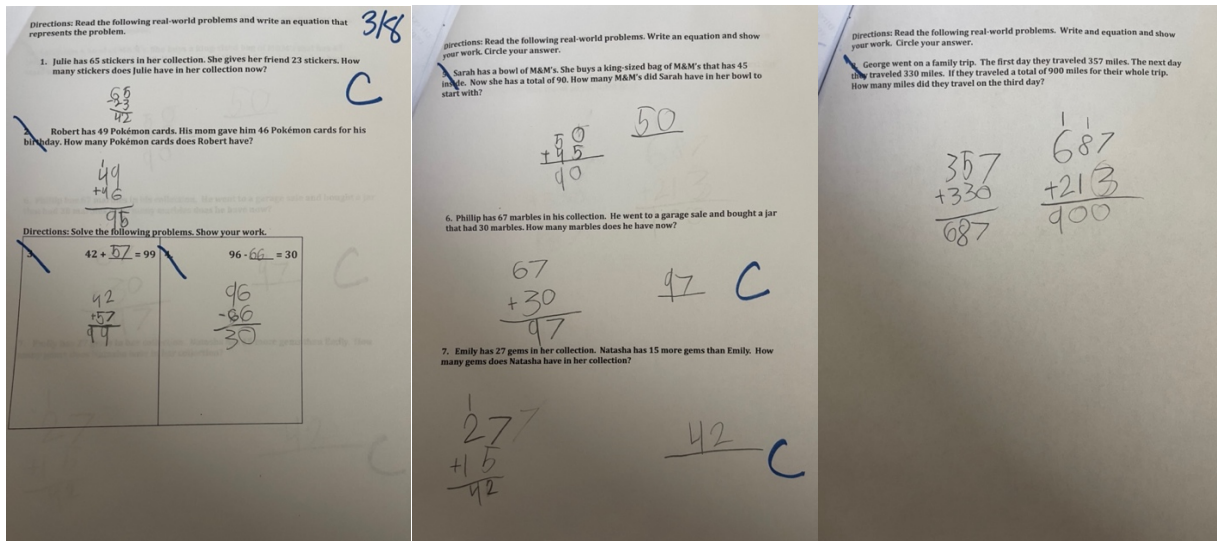
Note. Example of completed Student 3's pre-test.

Appendix B: Example Post-Test With Student Work

Level 2

Directions: Read the following real-world problems and write an equation that represents the problem.

1. Sally has 78 stickers in her collection. She gives her friend 49 stickers. How many stickers does Sally have in her collection now?

2. Juan has 59 Pokémon cards. His mom gave him 36 Pokémon cards for his birthday. How many Pokémon cards does Juan have?

Directions: Solve the following problems. Show your work.

| 3. | 62 + ____ = 99 | 4. | 86 - ____ = 42 |

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Level 3

Directions: Read the following real-world problems. Write an equation and show your work. Circle your answer.

5. Sandy has a bowl of M&M's. She buys a king-sized bag of M&M's that has 52 inside. Now she has a total of 87. How many M&M's did Sandy have in her bowl to start with?

6. Devin has 68 marbles in his collection. He went to a garage sale and bought a jar that had 24 marbles. How many marbles does he have now?

7. Elly has 37 gems in her collection. Tanisha has 15 more gems than Elly. How many gems does Tanisha have in her collection?

Level 4

Directions: Read the following real-world problems. Write and equation and show your work. Circle your answer.

8. Jakson went on a family trip. The first day they traveled 353 miles. The next day they traveled 325 miles. If they traveled a total of 900 miles for their whole trip. How many miles did they travel on the third day?

Note. This is an example of the post-test.
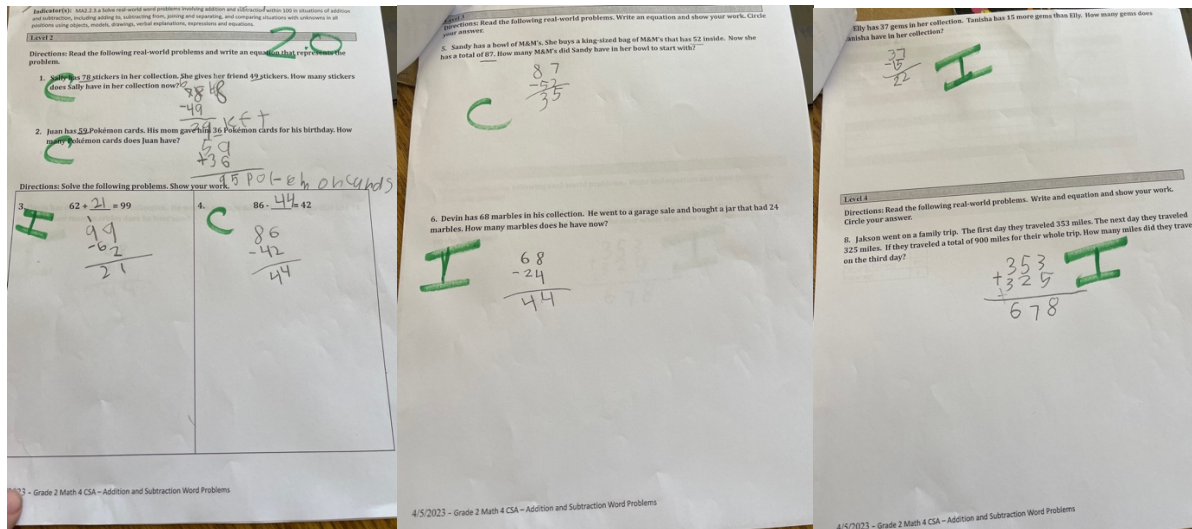
Note. Example of completed Student 15's post-test.

Appendix C: Graph of Student Data
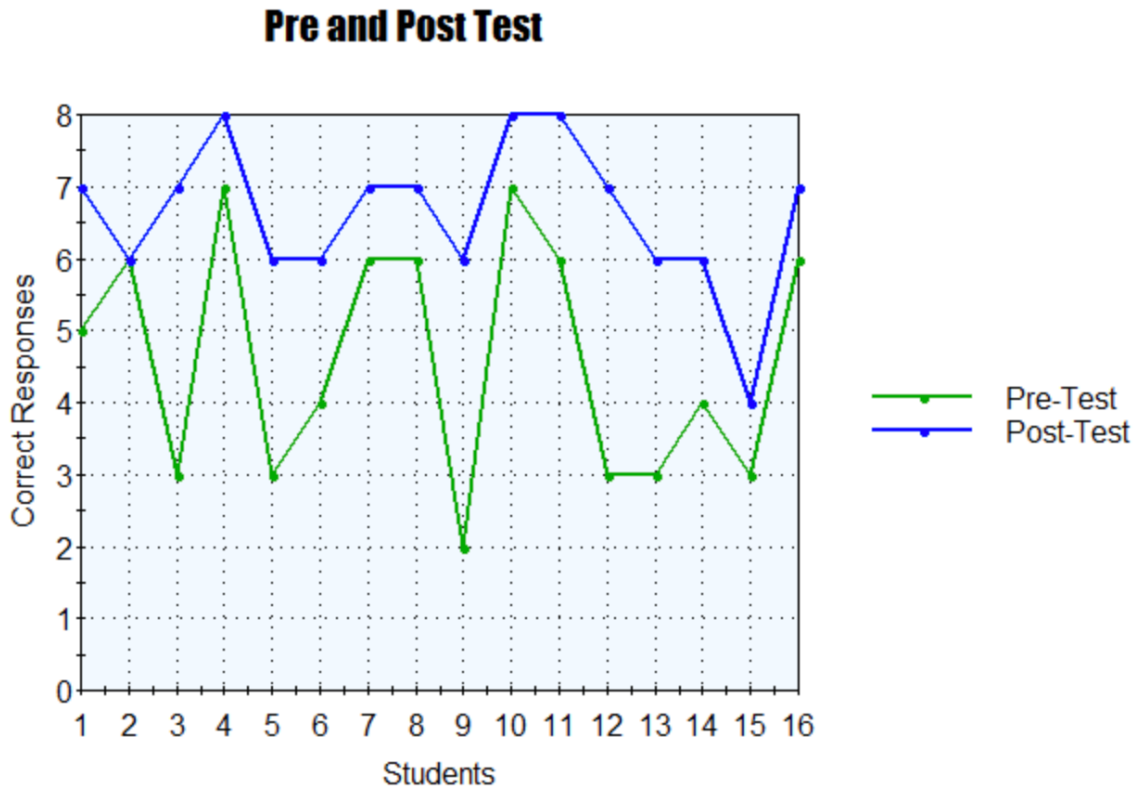
Student Number	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Number Correct	Student Number	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Number Correct
Student 1	C	I	C	C	I	C	C	I	5	Student 1	C	C	C	C	C	C	C	I	7
Student 2	C	I	C	C	C	C	C	I	6	Student 2	C	C	C	C	I	C	C	I	6
Student 3	C	I	I	I	I	C	C	I	3	Student 3	C	C	C	C	C	C	C	PC	7
Student 4	C	I	C	C	C	C	C	C	7	Student 4	C	C	C	C	C	C	C	C	8
Student 5	I	I	I	C	I	C	C	I	3	Student 5	C	C	C	I	C	C	C	I	6
Student 6	C	I	I	I	C	C	C	I	4	Student 6	C	C	C	C	I	C	C	I	6
Student 7	C	I	C	C	C	C	C	I	6	Student 7	C	C	C	C	C	C	C	I	7
Student 8	C	I	C	C	C	C	C	I	6	Student 8	C	C	C	C	C	C	C	I	7
Student 9	I	I	C	I	I	C	I	I	2	Student 9	C	C	C	C	C	PC	C	I	6
Student 10	C	I	C	C	C	C	C	C	7	Student 10	C	C	C	C	C	C	C	C	8
Student 11	C	I	C	C	C	C	C	I	6	Student 11	C	C	C	C	C	C	C	C	8
Student 12	C	I	I	I	C	C	C	I	4	Student 12	C	C	C	C	C	C	C	I	7
Student 13	C	I	I	I	I	C	C	I	3	Student 13	I	C	C	C	C	C	C	I	6
Student 14	C	I	C	I	C	I	C	I	4	Student 14	C	C	C	I	C	C	C	I	6
Student 15	C	I	I	C	I	C	I	I	3	Student 15	C	C	I	C	C	I	I	I	4
Student 16	C	I	C	C	C	C	C	I	6	Student 16	C	C	C	C	C	C	C	I	7

Note. Graph of pre-test and post-test scores and an item analysis of each question.

Appendix D: Example Formative Student Work

Note. Example of Student 2's formative work.

Note. Example of Student 11's formative work.

Appendix E: Graphic Organizers

H	T	O
□	□	□
− □	□	□
□	□	□

WHOLE	
PART	PART
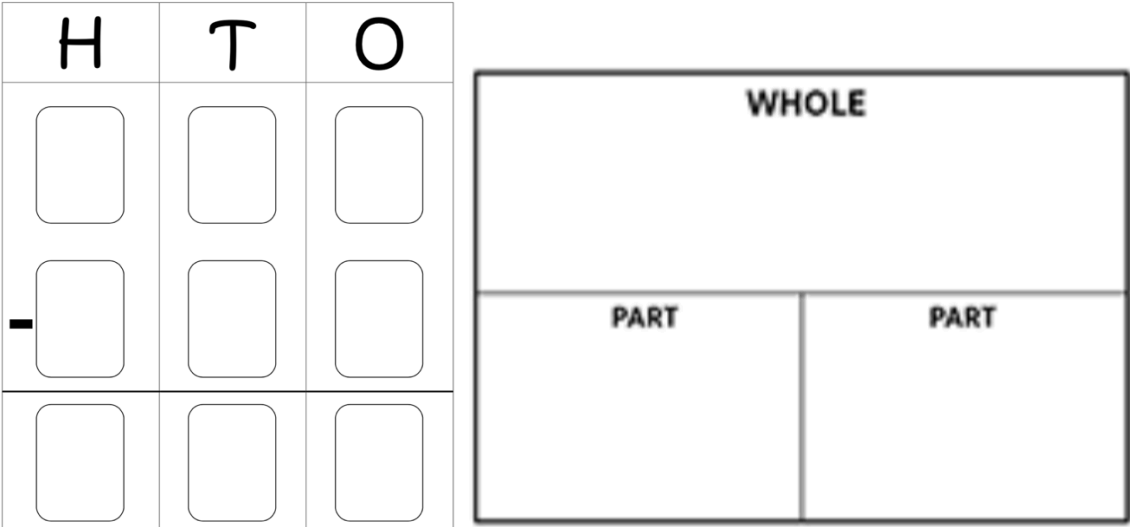
Note. These are examples of the two main graphic organizers used during the unit.