5-2023

Teaching Three-Digit Addition with Differentiated Instruction and Assessment Strategies

Regan Catterson

Saundra Shillingstad

Teaching Three-Digit Addition with Differentiated Instruction and Assessment Strategies

Regan Catterson
University Honors Capstone
College of Education, Health, and Human Sciences

University of Nebraska at Omaha
Senior Honors Project
Advisor: Dr. Saundra L. Shillingstad
May 2023

Table of Contents

Abstract

This capstone project includes a synopsis of the differentiated instructional and assessment strategies that were integrated throughout a second-grade math unit. The unit of instruction focused on three-digit addition with regrouping. The unit was taught over six days between the pre-test and post-test. Students were tested on their understanding of place value with three-digits, regrouping with addition, and solving three-digit addition from an equation. Following the analysis of student data, it was noted that students' understanding, and performance increased throughout this unit by using a variety of instructional strategies and assessment methods. I collected and analyzed the pre- and post-assessment data and found that praise and recognition, nonlinguistic representations, providing feedback, questioning, and written responses are effective instructional strategies and assessment methods for increasing student learning.

Keywords: instructional strategies, assessment strategies, nonlinguistic representations, praise and recognition, questioning, written responses

Background

For my clinical practice semester, I was placed at Westside School District, a suburban school in Omaha, Nebraska. I was in a second-grade class at Hillside Elementary School. My cooperating teacher has worked in education for 11 years. Hillside has almost 400 students which is one of the largest schools within the Westside School District. At Hillside 46% of the students qualify for free/reduced lunch and 38% of families utilize the school choice through option enrollment. Option enrollment is when a student does not live in the district bounds of the school, but they have the choice to enroll in that chosen school. At Hillside, 14% of students qualify for Special Education services, 8% of students qualify for High Ability Education, and 5% of students qualify for English Language Learner services. The participants for this unit of

study included nine boys and ten girls. One student had an Individualized Education Plan (IEP) under the category of Other Health Impaired, and four of the students were English Language Learners. The capstone project focused on three-digit addition with regrouping. Under the supervision of my cooperating teacher I planned, implemented, and assessed the unit of study.

Introduction

The goal for this unit was for students to be able to add three-digit numbers and show the regrouping strategy in their work. The students completed formative assessments throughout the unit which assisted me in tracking their progress. I used the data from the formative assessments to adjust my instruction as needed. Differentiated instructional strategies were embedded into the lesson to promote student engagement and meet the diverse learning styles of students.

Three guiding questions were written for the unit. These questions were used when planning, implementing, and assessing the unit : *Can students use their addition strategies to solve three-digit equations? Can students regroup when adding three-digit numbers?* and, *Can students justify their reasoning for their way of solving a given problem?*

The capstone project focused on the skill of three-digit addition. The unit was taught over six days. Baseline testing and summative testing were included in the timeline of the unit. The first day consisted of a pre-test for three-digit addition. The following four days I taught a variety of lessons building understanding on place value with three-digits, regrouping, and completing an equation. The final day time was allotted for review. The post-test was administered on day seven to assess student understanding of the skill. Research-based instructional strategies were integrated throughout this unit. The two strategies most used throughout the unit were praise and recognition and nonlinguistic representations. The strategies were integrated into the unit to promote student understanding.

Instructional Methods

Praise and Recognition

When a teacher reinforces a student's effort through providing praise, students are recognized for their effort and achievement. For example, a teacher ends a lesson and then provides directions for the seat-work or next task. For the student(s) that follow the directions the teacher immediately praises the student(s).

There is ample evidence supporting praise as an effective instructional strategy as the strategy has been noted to motivate and engage learners. In a study conducted by Burnett and Mandel (2010) that assessed how students respond to praise and recognition, 56 students and five teachers ranging from different grade levels, were interviewed, and observed about how they respond to this. When providing praise and recognition teachers give information on the specific cause of the praise, so students are aware of the reasoning which can probe more positive behaviors in future times (Burnett, Mandel, 2010). This in-turn helps to motivate students to excel academically because they want to see the recognition for showing effort and trying their best. Praise and recognition help to engage most students in the tasks they are completing.

Ferguson (2013) also examined how praise impacted motivation in the classroom. Ferguson identified and defined several types of praise (i.e., global praise, contingent praise, specific praise, age-related praise, and credible praise). A finding from Ferguson's research noted that the type of praise teachers give to their students depends on the purpose the teacher is hoping to achieve. She advised that teachers must make sure to praise students for effort rather than ability. Ferguson also noted that teachers must be aware that praising for effort is a key part in effectively using this instructional strategy in the classroom. Students who feel recognized for their work are more likely to put in the effort to achieve their academic goals.

Nonlinguistic Representations

The second instructional strategy that I implemented during this unit was nonlinguistic representations. Nonlinguistic representations express ideas in ways that go beyond words (i.e, graphic organizers, diagrams, demonstrations, etc.). Marzano (2010) discussed the importance of having students generate an understanding of representing information in a new way. Marzano conducted a meta-analysis of nonlinguistic representations and his findings noted that across 129 studies the average effect was a 17 percentile point gain in overall student achievement. He noted that the nonlinguistic representations need to identify the crucial information of a topic for it to be a useful tool in the classroom. He also noted that students should also be able to explain what they are doing when using different forms of nonlinguistic representations. He has found this instructional strategy to be one of the most effective ways for students to process information (Marzano, 2010).

Kelly (2020) also researched nonlinguistic representations and found the strategy to be a useful instructional tool. Kelly reported that when students are encouraged to use nonlinguistic representations to aid in their understanding of more complex concepts, the students had a deeper conceptual understanding of the content being taught and were able to visualize the information that they were trying to understand. They could demonstrate their understanding through a variety of drawings, models, and manipulatives.

Assessment Methods

Formative assessments were administered throughout the unit. The formative assessments assisted me in determining students' understanding as we progressed through the unit. Effective teachers use research-based assessment methods to evaluate students' performance. This capstone project reports on the integration of research-based assessment strategies implemented

throughout the unit. I chose assessment strategies that I believed would impact student learning of the math skills I taught.

Questioning

One of the assessment strategies that was implemented in the project was questioning. Cotton (2023) conducted research on the use of questioning and the relationship between a variety of student outcomes. Cotton's study tracked student achievement, retention, and level of student understanding following the use of questioning as an instructional strategy. Cotton found that using questioning with students during lessons resulted in teachers having a better understanding of student levels of comprehension. Cotton stated that "In addition to its long history and demonstrated effectiveness, questioning is also of interest to researchers and practitioners because of its widespread use as a contemporary teaching technique" (p. 3).

The questioning technique is useful for teachers to collect data on students understanding of a lesson. Cotton (2023) found that when instruction includes posing questions during the lessons, it is more effective in producing achievement gains than when instruction is done without questioning students. Questioning provides information to teachers and assists them in determining what skills need to be taught or reviewed. Cotton's study found that oral questions posed during classroom instruction are more effective in fostering learning than written questions are. Cotton also noted that when asking questions frequently during class discussions, it positively related to learning different pieces of information. Cotton concluded that when teachers lead students to draw inferences and give them practice is doing this, it resulted in higher cognitive responses and greater learning gains.

Written Responses

I also assessed students' written responses to assess their understanding of skills learned. Sahin (2019) examined different forms of written assessments such as exit tickets, worksheets, and other independent work (including technology-based) that are used in the classroom. Sahin also examined the effectiveness the assessments had on extended student learning and teacher feedback. He found that written responses were a great way for students to be able to express what they know independently. However, he noted that using applications that are technology-supported were statistically more useful than paper-based tests because students were generally more engaged on a technology-based response rather than written responses.

Carless (2015) conducted a study that focused on students' written responses following instruction. He found that written responses were an innovative way to gather information on student understanding. The participants in the study participated in a survey that evaluated the effectiveness of being assessed through short written responses. The survey findings evidenced that written responses were an effective assessment strategy. Carless also noted that written responses are useful in looking at what information students have been able to retain, and where growth needs to still occur. Implementing this assessment method can provide ample amounts of data on student understanding and how instruction may need to be modified.

Participants

This project was taught to a second-grade classroom with nineteen students. Ten of the students were girls, while nine of the students were boys. One student had an IEP and received special education services under the Other Health Impairments category (5% of the class). Four of the students were English Language Learners (ELL) students (21% of the class). Five students (26%) were pulled for an extra intervention for math. Most of the students are in whole group during the math lesson, with a few being pulled out for guided practice.

Methods and Materials

The goal for this unit study was for students to be able to solve three-digit addition using a variety of instructional strategies. The strategies included using drawings to solve problems, computing numbers from an equation, or breaking apart addends to help solve a problem. The Nebraska State Standards that align with this goal are the following: *2.N.4 Number and Operations: Students will compute using addition and subtraction and 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*. I used the State Standards to guide my writing of four objectives. The objectives are as follows: During the lessons the students will, (1) use drawings to represent three-digit addition, (2) decompose addends, (3) represent regrouping with addition, and (4) solve three-digit addition. Using these objectives and standards, I planned the lessons for the unit.

The Westside School District follows a 3-point proficiency scale for math in second grade. The number *one* on this scale demonstrates that a student has little understanding of the content that was taught. A score of *two* represents having a developing understanding of the content. Last, *three* represents proficiency in the content that was taught. A student receives a *one* for correctly answering two-out-of-eight or lower on the test. A *two* is for receiving between a three and five out-of-eight on the test. To receive *three* on the proficiency scale a student must correctly answer six-out-of-eight or more on the test.

Throughout this unit I used a variety of instructional strategies. Two instructional strategies that were focused on were using nonlinguistic representations and praise and recognition. Nonlinguistic representations were used in most of the lessons for students to visualize the numbers they were adding. Students were also encouraged to use this strategy when

solving problems during their independent time. The strategy was implemented via marker board drawings and drawings in student's workbooks. The second strategy that was focused on for this unit was using praise and recognition. Students were given specific praise and recognition in all times of the lesson. During the whole group students were recognized for the effort they were giving and when completing correct work for the group. During independent practice, praise was given when students were successfully completing their work (i.e., showing their work, using a strategy taught in class to solve, staying on task, etc.).

Various assessment methods were also implemented in this unit. I integrated questioning and written responses in the lessons. Questioning was used each day to probe their thinking and assist me in determining student understanding. Examples of questions I asked during instruction: *Why did you decide to solve this problem that way? What are different ways that we can solve?* and, *How do we know we need to regroup?* I also used written responses to assess student understanding. Students composed their responses in their workbooks, on whiteboards during whole group, and on the pre- and post- tests.

The pretest data (see Appendix A) guided my instruction for this unit. On the proficiency scale 84% of the students scored a 1 or 2. When I reviewed the scores, I decided that I would use direct instruction throughout the lessons of the unit as 84% scored below proficiency. I made the decision that all students would participate in the whole-class lesson which followed a gradual release model or instruction. The trend of questions missed on the pre-test related to breaking apart addends and regrouping with three-digits. This was determined to be a starting point for what direct instruction needed to be taught first for students to best gain an understanding of the new material.

This unit was broken up into six days, with four of the days being direct instruction. The first day of this lesson included the pre-test for Module 16. Students were not given any knowledge of this unit and they used this time to demonstrate what they knew using strategies they had been taught in the past. For the rest of the unit, I implemented a variety of instructional strategies. Each of the four instructional days, I followed a gradual release model of instruction during whole class instruction.

The second day of instruction the lesson focused on representing three-digit numbers with drawings. For this lesson, the focus was for students to use nonlinguistic representations to help them solve problems. Students were provided with a marker board to solve the problems. The problems were projected onto the whiteboard and the students were expected to follow along and engage in all parts of the lesson. The problems included three-digits that needed to be added together. Students used their marker boards to show each number using a visual model. They represented the hundreds-place with boxes, tens-place with lines, and ones-place with circles. This strategy helped the students to visualize the place values and aid in their addition. I asked each student a comprehension question to check their understanding of the content. When this was completed and checked for accuracy, students moved to independent work in their math workbook for the remainder of the lesson.

The third day of instruction focused on decomposing three-digit addends. When I analyzed the pre-test, I noted that students lacked understanding of this skill. A similar flow of instruction was done for this lesson. Students followed along with their workbooks during the whole-group lesson. During this time, praise and recognition was given to students who were following along with the expectations (i.e., completing the workbook when asked, raising hands to participate, sharing strategies during turn and talks, etc.). This was an important time for

students to be recognized to aid in the instruction that was being taught. When the whole class portion of the lesson was complete students were put into pairs for the rest of the workbook sections. Once students completed the workbook problems they were to individually work on IXL. IXL is an online application that helped sharpen their three-digit addition skills.

The fourth and fifth days of the unit included adding three-digit numbers with regrouping. This was the final objective for students before the post-test was administered. Similar to the first day of instruction, students used whiteboards during whole group to use a variety of strategies they have been taught to solve problems. Students could use nonlinguistic representations to solve the problems, decompose addends, or use the equation and regroup strategy. Recognition was given throughout these days. The students were asked to teach the class and show the strategy they used to solve the problem. Providing students with the opportunity to teach to their peers I found that levels of student engagement rose, and on-task behavior was amplified when using this strategy.

The sixth day of this unit included a review day of math rotations and then I administered the post-test (see Appendix B). Students were given 10 minutes in each rotation to review their skills and prepare for the test. The first rotation included using drawings to solve three-digit addition, the second rotation they practiced breaking apart addends to help solve the problems, and the third rotation was a partner activity. With their partner they were challenged to solve word problems. After the students completed the rotations, the post-test was administered.

Results and Data Analysis

Tables 1 and 2 show student scores for both the pre-and post- tests. The horizontal axis of each table represents the questions from the test and the total correct responses for each student. The vertical axis represents each student by number and the total correct answers from each

question. Each table is color coded depending on the level of proficiency students reached based off the scale. *Red* represents students scoring a 1 (below proficiency), *yellow* represents students scoring a 2, and *green* represents students scoring a 3 (below proficiency). Copies of the tests can be found in Appendix A and B. The pre-test was composed of 7 questions to assess student understanding, while the post-test was composed of 8 questions. A graph of both pre- and post-data is found in Figure 1 to show the comparison of scores for each student.

Table 1

Pre-Test Scores

Student	Q1	Q2	Q3	Q4	Q5	Q6	Q7	TOTAL CORRECT
1		X	X	X	X		X	5
2		X	X				X	3
3			X					1
4	X	X	X	X	X	X	X	7
5	X	X	X	X	X	X	X	7
6		X	X				X	3
7		X	X				X	3
8			X	X	X			3
9		X	X				X	3
10								0
11		X	X		X		X	4
12								0
13		X						1
14		X	X					2
15		X					X	2
16		X	X	X	X		X	5
17								0

18	X	X	X			X	X	5
19	X	X	X	X	X		X	6
TOTAL CORRECT	4	14	14	6	7	3	12	

Note: Table 1 shows data from the pre-test that students took prior to instruction of the unit. This information was used to plan instruction based on the number of correct and incorrect responses on the pre-test. I focused my instruction at the beginning of the unit on the red questions due to the number of students who scored below proficiency.

Table 2

Post-Test Scores

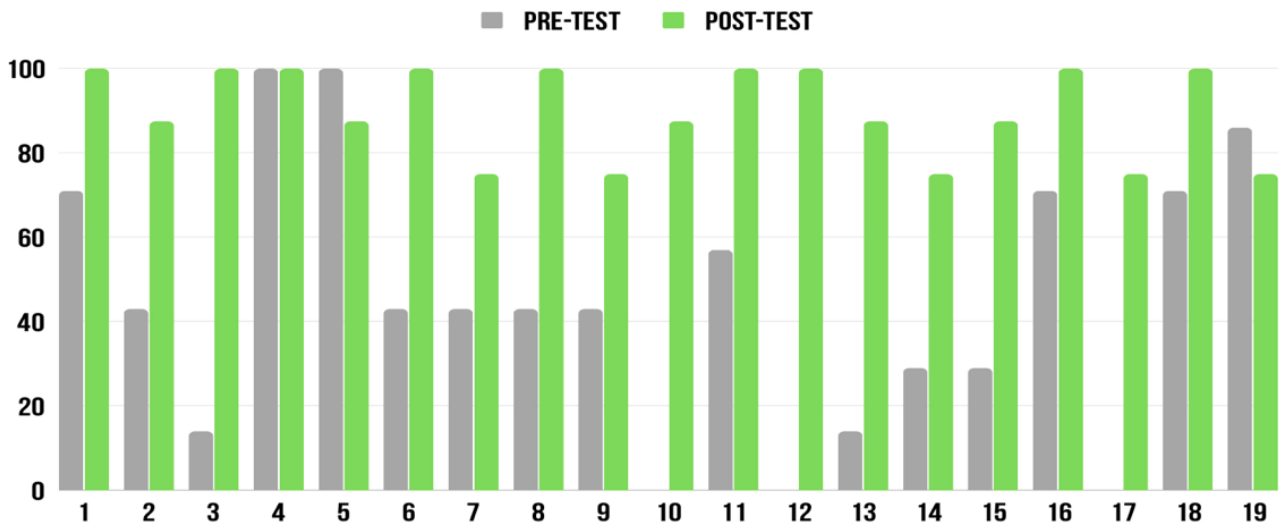
Student	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	TOTAL CORRECT
1	X	X	X	X	X	X	X	X	8
2	X	X	X	X	X	X		X	7
3	X	X	X	X	X	X	X	X	8
4	X	X	X	X	X	X	X	X	8
5	X		X	X	X	X	X	X	7
6	X	X	X	X	X	X	X	X	8
7		X	X	X	X	X	X		6
8	X	X	X	X	X	X	X	X	8
9	X	X	X	X	X	X			6
10		X	X	X	X	X	X	X	7
11	X	X	X	X	X	X	X	X	8
12	X	X	X	X	X	X	X	X	8
13	X	X	X	X	X	X		X	7
14		X	X	X	X	X		X	6
15		X	X	X	X	X	X	X	7

16	X	X	X	X	X	X	X	X	8
17	X	X	X		X		X	X	6
18	X	X	X	X	X	X	X	X	8
19	X	X	X	X	X	X			6
TOTAL CORRECT	15	18	19	18	19	18	14	16	

Note: Table 2 shows student data from the post-test. The post-test was administered to students at the conclusion of the. This table was used to determine students' level of understanding by the end of the unit. The data assisted me in determining if the strategies that were implemented impacted student comprehension.

Figure 1

Student Growth Graph



Note: **Figure 1** represents student data from both the pre- and post- tests. The vertical axis represents the percentage of accuracy students got on their test. The horizontal axis represents each individual student. Bars in grey represent the pre-test scores, bars in green represent the

post-test scores. This bar graph helps to compare scores and determine student growth after teaching the unit.

Discussion and Conclusion

When I analyzed the pre-test data three questions were identified as outliers as the responses were below proficiency. Students 10,12, and 17 scored 0% on their pre-test, showing that they had no knowledge of the content that was being covered. I used the data to guide my lesson objectives to address the students who scored below proficiency. The three students worked with me with more focused direct instruction lessons.

On the first day of instruction, five students were pulled into a small group when the remaining 14 students moved to independent work. I previously discussed students 10,12, and 17. These three student's scores were outliers on the pre-test. Students 3 and 13 were also outliers as they demonstrated limited knowledge of the unit. I assisted these students with the independent portion of the lesson and provided direct instruction to help with their understanding of the new concepts being taught. I was explicit and more focused the following days with these five students (3,10,12,13,17). Through explicit instruction they were able to move to independent work. By day three of the unit all students were able to complete work independently with accuracy. On day three I walked around the classroom and monitored the students completing their seatwork. If I observed a student needed extra help I stopped and worked with them individually.

The pre-test data also gave me an understanding of the students who scored proficiently. Students 4, 5, and 19 scored between 86-100% on the pre-test. From their pre-test data I provided them with more challenging work. These students continued to participate in whole-class instruction but were able to move on to independent work while students worked with

partners. The three students (4,5,19) who scored proficient on the pre-test were assigned a variety of tasks to complete once their independent work was done. Students were asked to use IXL and challenge themselves on the application that they chose, other students completed worksheets with more difficult problems, and I encouraged the class to work with partners. As the lessons progressed the class began to show that they understood the content through their independent work. As their skills progressed students started to do the extra work as challenges that showed what they knew. The extra work helped to engage many students in the math lesson. The extra work was discussed each day with students before they moved to independent work. When students checked their work with a teacher, they were able to move to the challenging work.

When looking at the post-test data, all students scored a 3 (proficient) on the 8 problems (75-100%). All students completed at least 6 of the 8 questions correctly. When I reviewed the post-data, the most common errors were with computation (i.e., miss counting, failing to count the digit that was to be regrouped). All students demonstrated their knowledge of the content, and used a variety of strategies to complete the questions. Students used drawings, counting on their fingers, and number charts to help them successfully complete the test. Following review of the data, their scores indicated they had an understanding of the math unit that was taught.

The instructional strategies that were implemented in this unit were found to be effective. When students were taught using nonlinguistic representations, they were able to visualize the concepts that were being taught and draw out their thinking. When we reviewed the nonlinguistic representations as a class the visuals led to great discussions about what they learned. Students were able to explain what their drawings represented and how it helped them solve the problem.

Praise and recognition, the second instructional strategy, was also effective as it kept students engaged in the lesson. This strategy helped to motivate students to complete their work

and follow along with the class instruction. I found praise and recognition throughout the lessons kept students focused on what they should be doing which helped them academically to stay on track with their learning.

The assessment methods that were used for this unit also were shown to be very effective. The first method that was focused on was using questioning to assess students' knowledge. Through the whole-class lesson, partner work, and independent work, probing questions were asked to students. Questioning helped engage students in deeper thinking. This strategy also assisted me in monitoring what information students knew and what they still need to work on. This form of assessment was helpful in understanding quickly what students might need additional instruction on and what areas of the lesson I could eliminate.

The second assessment method that I focused on was using written responses as a way to collect student data. I did this through students' independent work in their workbook, marker boards, and their tests. When students completed independent work, they would get it checked by a staff member in the room for accuracy. This strategy provided me with an understanding of what still needed to be focused on in the upcoming lessons. Marker boards were checked throughout the lessons and incorrect student responses were corrected when needed.

This project gave insight into how instructional and assessment methods are helpful when teaching. I found that through implementing differentiated instruction into each lesson it addressed the unique needs of all students. Through integrating the differentiated instructional strategies I met student's learning styles, academic levels, and learning needs. Planning for instruction that will meet the needs of all students is very important for the success of each student in the classroom. Using differentiated instructional strategies helped my students to reach their fullest potential in the math unit

Works Cited

Burnett, P. C., & Mandel, V. (2010). *Praise and Feedback in The Primary Classroom: Teachers' and Students' Perspective. Australian Journal of Educational & Developmental Psychology.* Retrieved January 19, 2023, from https://files.eric.ed.gov/fulltext/EJ906941.pdf

Carless, D. (2015, July). *Starting Small in Assessment Change: Short In-class Written Responses*. Taylor & Francis. Retrieved February 16, 2023, from https://www.tandfonline.com/doi/full/10.1080/02602938.2015.1068272

Cotton, K. (n.d.). *Classroom Questioning - Education Northwest.* School Improvement Research Series. Retrieved February 10, 2023, from https://educationnorthwest.org/sites/default/files/ClassroomQuestioning.pdf.

Ferguson, M. (2013). *Praise: What Does The Literature Say? What Are The Implications For Teachers?* Retrieved January 17, 2023, from https://files.eric.ed.gov/fulltext/EJ1025643.pdf

Kelly, C. (2020). *Let's Get Graphic: The Integration of Visual Representations to Demonstrate Learning*. Virginia Association of Teachers of English. Retrieved February 17, 2023, from https://digitalcommons.bridgewater.edu/cgi/viewcontent.cgi?article=1002&context=vej

Marzano, R. J. (2010, May). *Art and Science of Teaching/ Representing Knowledge Nonlinguistically* . Baltimore Polytechnic Institute. Retrieved February 17, 2023, from https://www.bpi.edu/ourpages/auto/2013/10/30/65126480/Art%20and%20Science%20of% 20Teaching.pdf

Appendix A

Pre-Test

Name PRE-TEST

Module 16 • Form A
Module Test

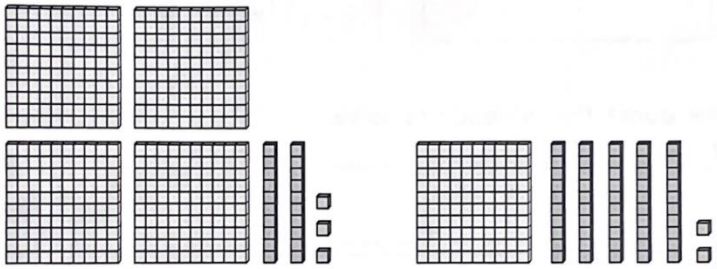
1 Break apart the addends to solve.

432 → _____ + _____ + _____

167 → _____ + _____ + _____

_____ + _____ + _____

2 Add 423 and 152. Use the visual model to add the hundreds, tens, and ones.



_____ hundreds _____ tens _____ ones

3 How can hundreds, tens, and ones be used to add?

	Hundreds	Tens	Ones
	4	2	1
+	3	7	5

Module 16 • Form A
Module Test

Name PRE-TEST

4 Mia plants 423 tomato seeds and 158 pumpkin seeds. How many seeds does Mia plant?

	Hundreds	Tens	Ones
	4	2	3
+	1	5	8

5 Jana adds 234 + 182. How can Jana add to find the sum?

	Hundreds	Tens	Ones
	2	3	4
+	1	8	2

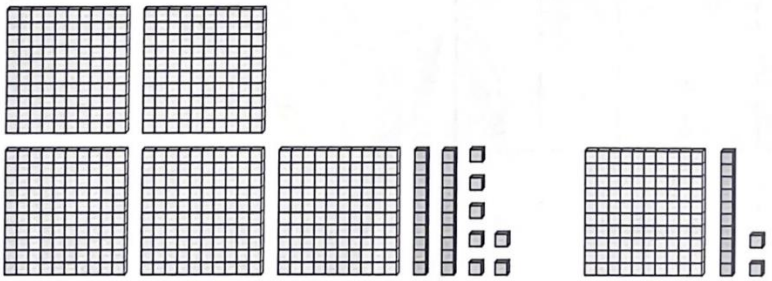
6 Break apart the addends to solve.

317 → _____ + _____ + _____

239 → _____ + _____ + _____

_____ + _____ + _____

7 Use the visual model to find how many hundreds, tens, and ones. What is the sum?



_____ hundreds _____ tens _____ ones

92

Appendix B

Post-Test

Name POST-TEST

Module 16 • Form A
Module Test

1 A store sells 117 red balloons. It also sells 193 yellow balloons. How many red and yellow balloons does the store sell?

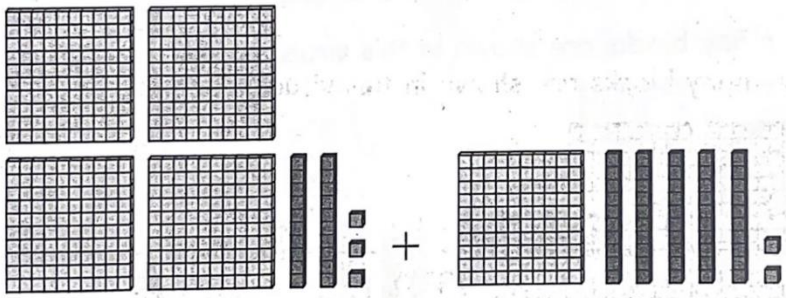
○ 210 ○ 300 ○ 310

2 What is the sum?

167
+ 452

100 + 400 = _____
60 + 50 = _____
7 + 2 = _____

3 What is the sum of the blocks shown in the visual model?



423 + 152 = _____

4 How can hundreds, tens, and ones be used to add?

	Hundreds	Tens	Ones
	4	2	1
+	3	7	5

Module 16 • Form A
Module Test

Name POST-TEST

5 What is the unknown digit when adding 423 + 158?

$$\begin{array}{r} 423 \\ +158 \\ \hline 5\square 1 \end{array}$$

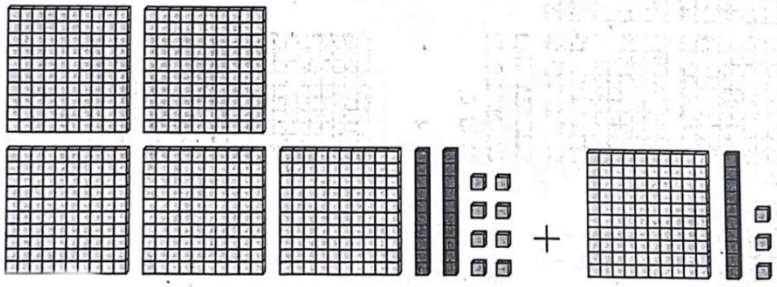
6 Jana adds 234 + 182. How can Jana add to find the sum?

	Hundreds	Tens	Ones
	2	3	4
+	1	8	2

7 What is the sum?

$$\begin{array}{r} 239 \\ +397 \\ \hline \end{array}$$

8 How many blocks are shown in this visual model?



92