

Word Problem Strategies for Solving Word Problems with Special Education Students

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Introduction

Teaching students with special needs is a struggle, especially in Math. My students need support in Operations and Algebraic Thinking, especially 3.OA.8 (solving two-step word problems using the four operations). Word problems are especially tricky since they require multi-step, logical strategies which are dependent on both the student's reading level, which could be lower than the expected grade level, and based on the assumption that the child can understand information given in written form. This unit will address these deficiencies and allow the students to come up with a system to tackle these tricky problems. The students will learn to create an organizer and break the information into several key parts (what is the important information, what is it asking me to do, how could I solve it, answering the question) taught in several set steps to help solve and analyze the problem.

Demographics

My student population lives in Wilmington, DE. Our students are overall 84.3% low-income and 53.9% of the school is minority students. The students in grades 3-5 meet the standards, according to state data, on average with a score of 48% proficiency in Reading and 34.3% in Math. Since Math is a weaker area for the students at my school, my unit is based on addressing key concerns in the area. In particular, our 3rd grade students' received an overall rating of 30% proficiency on state testing in 2012-2013. The special education students is 9.1% of the school make-up from 2012-2013; all of those students are from grades 3-5. 80% of those Special Education students are qualified and listed as Learning Disabled.¹

Rationale

After looking at the background of the students at my school, one can see it is not only the weak academic preparation but also other factors that contribute the students' struggles. However, this unit will focus only on the academic side of student concerns. Since the students are having difficulty with concepts in this area of mathematics, this unit will address the following concern(s): what is the student truly struggling with? Is the problem the inability to understand the actual question, or is it a lack of strategic knowledge of the skills required in order to solve it?

To implement this unit, I would start by giving my students a modified pre-test that will allow me to figure out what exactly he or she is wrestling with -- be it not being able to use a strategy to solve a problem, using the strategies incorrectly or having no idea what to do at all. After giving them this modified pretest, I will be able to see where they need the most help. Since this is geared toward third grade special education students, the questions will be on basic third grade level skills: addition, addition with regrouping, subtraction, and subtraction with regrouping. Please see Appendix A for a copy of my pre-test. The problems are crafted to use different skills as well. According to Carpenter's *Children's Mathematics: Cognitively Guided Instruction*, there are many different types of questions that can be used in order to assess different types of mathematical proceduresⁱⁱ. The pre-test will also allow for a variety of strategies so I can also help those students struggling academically. Since my students are from low-income households and are finding math challenging, my assumption here is that they are working with a smaller set of arithmetic strategies due to these constraints. By breaking it down by skill-set, this will make it easier for me to remediate individually for each student.

If the pre-test shows that the students need more help in the skill, I will spend some time teaching the individual strategies such as Counting On and Counting On From. I have noted the different strategies each question is assessing on the pre-test. The different strategies will be discussed later. Once the students are more aware of these and are having some success, then it will be time to focus our instruction on breaking down word problems and how to solve them.

While working on our basic skills, we will also spend time going over several math strategies that we can use to solve problems, especially word problems. These strategies include working backward, making a chart/table, choosing an operation, and drawing a picture (all of which are connected to the strategies taught to solve addition and subtraction problems). Though I am not going into depth about each of these strategies in this paper, these are essential tools for success in our later lessons. I would give the students the chance to use each of them successfully so when the students are later asked to pick one to use, they will be comfortable with picking one that will help them solve the problem (or at least have seen them). Since my lesson is in addition to the whole group lesson, these skills will be taught twice: once in whole group and then again in smaller group. Repetition will be the key for success with my students in using these strategies successfully.

Then, as we are delving into word problems, and especially two part word problems, I would like to teach an organizer for the students to use in order to help break down word problems into small pieces of information. The idea of the organizer is to lead them in a set process of being able to understand what to do and how to solve the problems itself. One way to teach this will be telling them to read the whole problem, and then read it one

sentence at a time, adding a graphic source. This source and strategy is crafted using Polya's methodology: I would like to teach them the four "steps" to solving a problem: understanding, planning, carrying out the plan, looking back.ⁱⁱⁱ

According to Polya, one must understand the actual problem before one can do anything.^{iv} However, this is one of the biggest challenges for students who are struggling. By creating an organizer and teaching how to use this tool, it will break the information into several key parts (what is the important information, what is it asking me to do, how could I solve it, answering the question) and make it easier to solve the problem itself. This organizer will allow me to hit the first three phases of Polya's ideas of problem solving. By having the students use this, I hope to address the issue of not understanding what to do or what the problem is truly asking.

Next, after the organizer has been taught, I will start by using real world examples the students will be able to comprehend, as they are very literal and concrete thinkers. Word problems embedded in the contexts they love such as baseball, school, candy, etc. will allow my students to connect with the problems. I will use problems such as this: Tommy has 16 trucks. He loses 7 of them. How many does he have now? This type of problem is simple, but it shows a difficult concept for most 3rd graders (subtracting with regrouping).

Once again, since special education students are usually reading at a lower level than grade level, my questions will be less wordy and simpler to begin with. We will start using our organizer, which will be a simple chart like the handout shown in Appendix B. This gets to the meat of the question being posed without having the students struggling to understand what to do. This organizer would be printed out on paper for the children to get when needed; but it could also be created independently as necessary for state and/or national testing. Since the organizer walks them through the steps of solving a problem it will make taking the information, breaking it down, and trying to solve it easier.

On top of the organizer, all students will have access to a "key" words chart, which will break down which vocabulary words will mean what operation(s). This will be used as a "starting point" – the key words will identify which operation(s) it could be, and then the students will have to re-read the question to figure out which method the question truly needs. However, I will not ask students to just memorize them. Instead, this serves as a guideline to help students understand problems and choose appropriate operations to solve the problems. I also will have one with the strategies we practice (make a list, a chart, work backwards, draw a picture, etc.). This will help them at the beginning and make them more confident as problem solvers. Even though it is added to the chart, I will not expect the students to complete the last row by themselves at first. This row will have them think WHY this strategy was effective and WHY it required which operation(s); the idea behind this portion will help students make connections with math. I will model this verbally at first, asking questions initially for this step, and then have them fill it out

independently when the students understand the questions required to think about. This strategy also addresses the following Mathematical Practices from the Common Core State Standards for Mathematics (CCSSM) as well: making sense of problems and persevering in solving them; modeling with mathematics and using appropriate tools strategically^v.

This unit is not meant to be a given over a concrete time period. This is something that you can start at the beginning on the year and adapt as the school year progresses. For example, after the students can use the organizer, I would want to make the questions more challenging, like adding in new layers of information which will make the problems harder. This could include adding information that is not relevant, for example, all the way up to multi-step problems. Eventually, I would like to get to the other two operations if applicable (multiplication and division) as those are 3rd grade on-level skills. In my third lesson, I have a question that has multiple steps – incorporating that the students must do operation(s) more than once to solve it accurately. Along the way, we shall do several informal “assessments” like the pre-test, to see if there is growth on using the different strategies, as well as end in a post-test which they will all show improvement on. It will be easy to assess if they can appropriately take the information and place it into the chart. But, the overall idea is that they can use the skills and apply them to the questions.

Hopefully, this will allow my students to achieve higher order thinking and meet grade level standards, which will improve their belief that they can do these types of problems. Most of my students don't bother to read word problems. Instead, they search out numbers and then pick a strategy, whether it relates to the problem or not. By systematically breaking the questions down and introducing several strategies to pick apart word problems, this will allow my students to understand the problem more completely, have a strategy to tackle the problems with, and then ensure for future success.

Also, to address the students who are struggling with particular skills (such as addition and subtraction) I will be able to break down their particular issues by observing and asking questions while my students solve math problems. This way, I can pinpoint what my students' particular issue is and assist them. By combining these two strategies, the students will get what they need, not just a cookie cutter variation. Due to my small group, I am able to truly spend the time, dig deep, and remediate with my students; however, a regular classroom teacher may be able to use parts of this to remediate in their classroom. By giving the pre-test to all the students, they can use the data to differentiate classwork and homework. It can also allow the teacher to design center work and small groups during centers to help tackle these issues.

Lastly, to make sure that my students have shown growth, I will administer a post-test. The post-test will include word problems with extra information and be lengthier than the original pre-test. The concepts will be the same, but the problems will be less simple and

there will be space for our organizer. Since we have used the organizer all year, it is my expectation that the students will use it for the post-test.

Strategies

Since we are focusing primarily on addition and subtraction, my skill set is working off of the important methods of teaching different additive and subtractive strategies. The following strategies I will be focusing on and teaching are the following:

Counting On

This strategy is just what it sounds like -- a simple strategy that children use, traditionally with their fingers, when the student just starts counting on from the first addend of the problem, until they reach the second number in the problem. For example, a student has a problem in which they need to add two numbers together (John has 3 toys; he gets 2 new toys for Christmas, how many does he have now?) and the student would start at two and extend two fingers, and count on from 3 and deduces that the answer is five. This is a strategy that most of my students already use, but becomes tricky when they are adding more than ten since they run out of fingers.^{vi}

Counting On From Larger

The identical strategy as the one above, but instead of just starting on from the first addend in the problem, they count on from the larger addend. For example, if Mary had 4 flowers in the garden and planted 6 more, how many more plants will she have when the seeds grow? The student will start at 6 and count on 4 more, even though the problem started with only four plants. This is a strategy that some students use but most of my students have limited number sense, and usually pick the strategy above as that is the one that comes to mind first. It would be more efficient if they started at the bigger number, which is something we will discuss in our small group.^{vii}

Counting On To

This strategy is similar but is used for change unknown problem types. This is when the student starts with one number, counts on to the larger given number, and uses their counting method to see how many they had to use in order to get to the large number. This is a strategy that my kids usually use, but may make a mistake when counting the change. For example, if Troy had six carrots and his Mom gave him more; now Troy has 15 carrots. How many more carrots did his Mom give him? The student will start at 6 and count on until he or she reaches 15. Then, he or she will count how many fingers or any other types of manipulatives they used to get to 15 from 6.^{viii}

Counting Down

This strategy is similar to Counting On from Larger. The student will count backwards from the larger number until he or she has done the change in the problem. For example, Lori has 8 kittens; she has two friends each adopt one kitty, so now how many kittens does she have left? The student will start at 8 and count backwards to 2 to get their answer.^{ix}

Counting Down To

This strategy is usually for separate with an unknown change type of problems. The student will count from the bigger number to the small number in the problem. By counting down to the smaller number, the student will be able to count the change that has occurred in the problem. For example, Jonathan has ten cookies. He gives some to his friend Jacob. Now he only has 3 cookies. How many cookies did he give to Jacob? The student will count from 10 to 3 and that change will be the answer to the problem. Once again, this strategy is usually a good one for my students to use, but first they must choose the correct operation.^x

All these above strategies do require the students to use a model to keep track of how much they have added -- these can be manipulated using counters, using their fingers, or even making tallies on their paper. Once again, this is a good strategy for basic problems but when we reach higher numbers it becomes tricky as that student is either making multi-digit marks or using a lot of counters. Depending on the kind of problem the students will need to use one of the above strategies. Illustration A shows the flow chart that I would use to base my instruction of these topics. This way, based on that particular problem, the students will be able to use one of these strategies to answer the problem they are struggling with. The strategies I have named earlier (make a chart, draw a picture, and choose an operation) all stem from these concrete ideas. By keeping the same strategy names as whole class, the students will not feel singled out, however, all of those stem from these strategies listed above.

Most of my students struggle with basic operations, but it is the deficit of strategies that leave them to be unsure how to get the actual answer. By modeling and teaching them a variety of the strategies above, the students will be able to use one of these listed to solve word problems. The students need to use my word problem solving strategy in order to complete this portion of my unit. My lesson plans below will show how to introduce the chart and then how to implement this process. Each one of these lessons is around 30 minutes, as that is my small group time with my students.

At the end of this unit, I am hoping to have given my students a concrete method in order to tackle word problems. This is a strategy that I hope will follow them throughout their schooling, especially since they don't need an actual template to follow. If they

master the 5 questions to ask themselves, then they will have success in breaking apart any word problem in the future.

Lesson Activities

Lesson 1

Objective of Lesson 1: The students will learn and use the word problem-solving chart (Appendix A) and try to use it to solve and break down word problems.

CCSSM Standards Met: CCSS.Math.Content.3.NBT.A.2 Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction.

CCSSM Math Practice Standards Met: Make sense of problems and persevere in solving them; Model with mathematics; Use appropriate tools strategically; MP6 Attend to precision.

Mindset or “Warm-Up” Activity (3 min.)

First, have the students complete some basic addition and subtraction problems, see Appendix C. The students can use whatever manipulatives they would like, but this is just to get them in the mindset of math.

Instruction (10-15 min.)

Afterwards, I will give them the word problem on Appendix D: Christian is putting away his books on his bookcase. He has already put 25 books away, but has 43 books in total. How many books does he still have to put in the bookcase?

I will read it aloud to the kids, but before we solve it we will talk about the problem and what it really is asking us to do. We will talk about Christian and how many books in total he has (43) and how many he has already put away (15). I will ask the following questions: What are we trying to find out? What operation is this really asking us about? How can we organize all the information we just figured out?

I will talk about this strategy (henceforth referred to as the 5 Q's) and how this helps us organize the information to make the problem easier to answer and take apart. Explain each of the 5 Q's and what should go with what. The 5 Q's chart is Appendix B.

Guided Practice (10 min.)

Together we will take the information from the problem and insert it inside. As we go through and put the information in each part, I will be prompting them as we go along. When we get to the 'solve' part - we will talk about the previous strategies we have already discussed as the year has progressed (draw a picture, choose an operation, make a chart, work backwards, guess and check, make an organized list) and we will make the best choice. For this one, I would choose one as a group -- in the future, they can each choose their own.

For this one, the choice I'd recommend would be draw a picture or choose an operation, depending on the group of students. If they are lower, draw a picture would be the better choice. But, for my students, who have gone through a lot of previous work with our direct modeling strategies from above, I think they will be successful with choosing an operation (subtraction). The students and I will then set up an equation with the numbers we have found in the word problem and then try to solve the problem.

In our fourth segment, where the answer lies, this is a great opportunity to not only teach to answer question with complete sentences but also the remind students that they have to show where the answer is in Math. This step is essential so that the students know that notated the answer is the last step to having a correct answer! The final question is the step to allow students to reflect and think about the problem. I will prompt the students in this step initially, saying - "Why did subtraction work? How did our strategy help us get the right answer?"

Closure (3 min.)

The last step for this lesson is for us to come together and talk about this strategy. Some questions that I would ask the kids: Did you [the kids] like it? Did it help them solve the problem? Was there something in particular that they liked? Could they do this independently?

Lesson Two

Objective of Lesson 2: The students will use the 5 Questions strategy in order to solve word problems featuring basic addition and/or subtraction in pairs (this would take place shortly after the first lesson).

CCSSM Standards Met: CCSS.Math.Content.3.NBT.A.2 Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction.

CCSSM Math Practice Standards Met: Make sense of problems and persevere in solving them; Construct viable arguments and critique the reasoning of others; Model with mathematics; Use appropriate tools strategically; Attend to precision.

Mindset or “Warm-Up” Activity (3 min.)

First, have the students complete some basic addition and subtraction problems, like the original one in Appendix C. As the year progresses, I try to include harder facts - like multi-digit addition and subtraction and multiplication/division as we teach them. The students can use whatever manipulatives they would like, but this is just to get them in the mindset of math.

Instruction (2-5 min.)

Afterwards, I will give them the word problems on Appendix E. Together we will read both problems aloud and I will make sure the kids understand what they are asking. I will quickly review the 5 Questions strategy, and remind the students to use the chart. Then, I will put the students in pairs for them to work on.

Independent Practice (15-20 min.)

The students will partner up and work together. All students will work and finish at least the first question: There are 22 legs in my backyard. However, there are both dogs and kids hanging out there. How many dogs and kids are in my backyard? As they are working, I will be checking in with each group to make sure they are on task and able to complete it. The students will most likely choose drawing a picture/guess and check for the first one, but maybe even a chart. Since this has a variety of answers, I will make sure the students know there are multiple answers.

Closure (7-10 min.)

We will go over the first problem, the kids will discuss their strategies with the group, the answers and how the 5 Q's helped them. Since the students all worked separately, there should be some good discussion on which strategy worked and the answers they got.

Lesson Three

Objective of Lesson 3: The students will use the word problem-solving chart (Appendix A) and complete it independently. This is the culmination of the introduction of the chart, it should be kept alive in the curriculum as necessary. I would use this as the assessment of this unit.

CCSSM Standards Met: CCSS.Math.Content.3.NBT.A.2 Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction.

CCSSM Math Practice Standards Met: Make sense of problems and persevere in solving them; Model with mathematics; Use appropriate tools strategically; Attend to precision.

Mindset or “Warm-Up” Activity (3 min.)

First, have the students complete some basic addition and subtraction problems, see Appendix C. The students can use whatever manipulatives they would like, but this is just to get them in the mindset of math.

Instruction (5 min.)

Afterwards, I will give them the word problems on Appendix F. Like lesson 2, I will read the problems out loud to the students, making sure they understand the question itself. Then, I will quickly review the 5 Questions strategy, and remind the students to use the chart. Next, it’s time to give out Appendix F to the students and they must complete the work independently.

Independent Practice (15-20 min.)

The students will work independently, using any manipulatives they may need. As they are working, I will be checking in with each student to make sure they are on task and able to complete it. The students will most likely choose drawing a picture/guess and check for the first one, but maybe even a chart. Since it will be a graded assessment, I will ask general questions to any struggling student, but will not be able to break it down and help them if they are struggling. If I do see a student really lost, that would be something for me to notate and remediate further.

Closure (3 min.)

The last step for this lesson is for us to come together and talk about this strategy, much like we did on the first day. Some questions that I would ask the kids: Did you [the kids] like it? How has this strategy helped you become successful? Could you do it without prompting? Have they tried to do it outside of when I’ve asked them, etc?

Illustration A

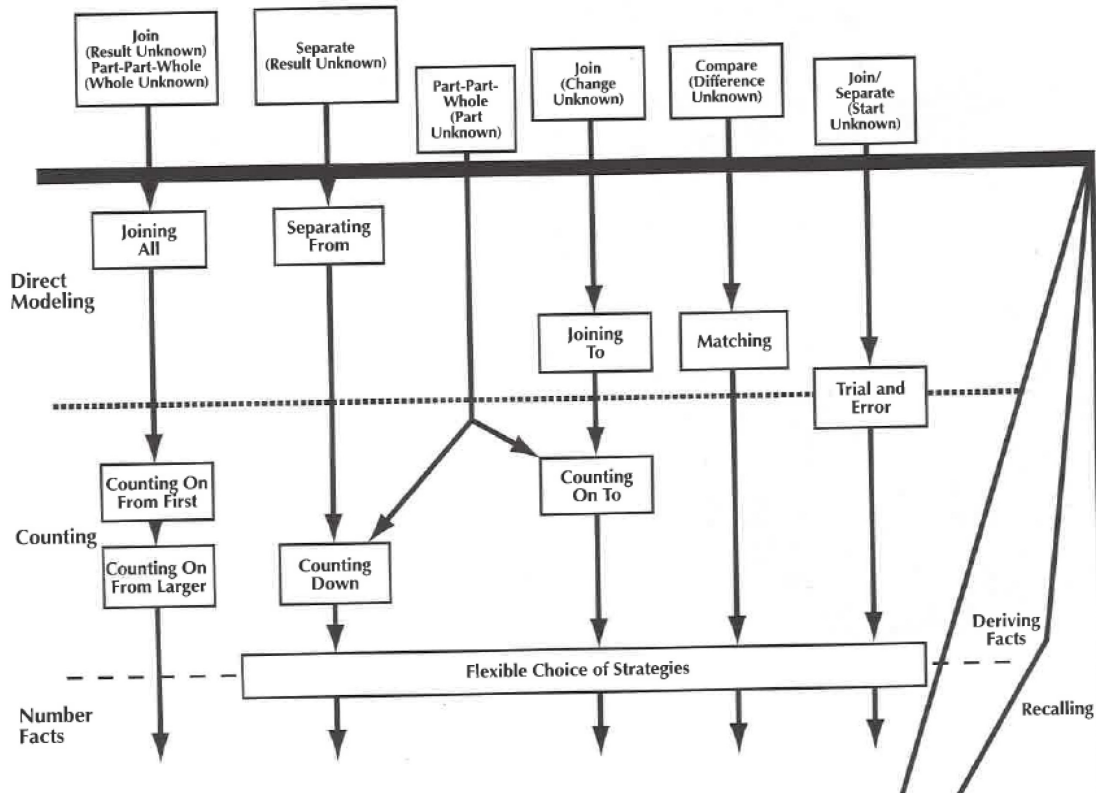


FIGURE 3.7 Children's Solution Strategies
XI

Appendix A

Pre-Test

Name: _____ Date: _____

Directions: Answer all the questions provided, showing all your work. Circle your answer.

1. Janice just ate 3 cookies. She started with 9 cookies. How many cookies does Janice have left? (addition, result unknown)
2. Chuck had 3 peanuts. Clara gave him more peanuts. Now Chuck has 8 peanuts. How many peanuts did Clara give him? (subtraction, or counting on, change unknown)
3. There are 8 puppies playing. 3 puppies swam away. How many puppies are still playing? (separating from – result unknown)
4. Ellen had 3 tomatoes. She picked five more tomatoes. How many tomatoes does Ellen have now? (joining all – result unknown)
5. Adjanae went to the library and took out 5 new books. Now she has 11 books. How many books did she already have? (join – start unknown)
6. Jayden has 3 PowerPaws. James has 8 PowerPaws. How many more PowerPaws does James have than Jayden? (compare – difference unknown)
7. Stephone has 28 dollars. He wants to buy a basketball for 40 dollars. How much more money does Stephone need to buy a basketball? (subtraction, with regrouping)
8. Mandy had 207 rubber bands. She lost 149 of them. How many does she have left? (subtraction, with regrouping)
9. The tiger weighs 99 pounds. How much will she weigh when she gains 53 more pounds? (Join-Result Unknown)
10. Jose watched television for 30 minutes on Saturday morning and 90 minutes total for the weekend. How many minutes of television did Jose watch after Saturday morning? (Separate-Change Unknown)

Appendix B

What is the key information?	
What are we trying to find?	
How can we solve this?	
What is the answer?	
WHY did this strategy work?	

Appendix C

Name: _____

Date: _____

Warm-Up #1

$$\begin{array}{r} 3 \\ + 8 \\ \hline \end{array}$$

$$\begin{array}{r} 7 \\ + 5 \\ \hline \end{array}$$

$$\begin{array}{r} 6 \\ + 2 \\ \hline \end{array}$$

$$\begin{array}{r} 1 \\ + 4 \\ \hline \end{array}$$

$$\begin{array}{r} 13 \\ - 9 \\ \hline \end{array}$$

$$\begin{array}{r} 9 \\ - 2 \\ \hline \end{array}$$

$$\begin{array}{r} 9 \\ - 4 \\ \hline \end{array}$$

$$\begin{array}{r} 2 \\ + 7 \\ \hline \end{array}$$

$$\begin{array}{r} 8 \\ - 4 \\ \hline \end{array}$$

$$\begin{array}{r} 12 \\ - 5 \\ \hline \end{array}$$

$$\begin{array}{r} 5 \\ + 5 \\ \hline \end{array}$$

$$\begin{array}{r} 6 \\ - 5 \\ \hline \end{array}$$

Appendix D

Name: _____ Date: _____

Christian is putting away his books on his bookcase. He has already put 25 books away, but has 43 books in total. How many books does he still have to put in the bookcase?

What is the key information?	
What are we trying to find?	
How can we solve this?	
What is the answer?	
WHY did this strategy work?	

Appendix E

Name: _____ Date: _____

Directions: Complete the question below. Make sure you and your partner use our 5 Q's strategy chart to help you answer the question!

There are 22 legs in my backyard. However, there are both dogs and kids hanging out there. How many dogs and kids are in my backyard?

What is the key information?	
What are we trying to find?	
How can we solve this?	
What is the answer?	
WHY did this strategy work?	

If you finish, turn the paper over and complete that problem as well! Make sure you use your 5 Q's chart to help you organize your information!

15 children were on the bus. At the last bus stop, more kids came onto the bus. When it arrived at school, there were 27 students. How many students got on at the bus stop?

What is the key information?	
What are we trying to find?	
How can we solve this?	
What is the answer?	
WHY did this strategy work?	

Appendix F

Name: _____ Date: _____

Directions: Complete the question below. Make sure you use our 5 Q's strategy chart to help you answer the question!

Janice's mom brought a dozen cookies to the party. Kayla's mom brought 15 cookies. How many cookies did they bring altogether to the party?

What is the key information?	
What are we trying to find?	
How can we solve this?	
What is the answer?	
WHY did this strategy work?	

The elephant had 55 peanuts. She ate 23 of them for breakfast. Then, 10 more for a snack in the late morning. How many peanuts does the elephant have left now?

What is the key information?	
What are we trying to find?	
How can we solve this?	
What is the answer?	
WHY did this strategy work?	

Appendix G

CCSS.Math.Content.3.NBT.A.2: Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction.

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- ⁱ (DOE n.d.)
 - ⁱⁱ (Carpenter 1999)
 - ⁱⁱⁱ (Polya 1945)
 - ^{iv} (Polya 1945)
 - ^v (Common Core State Standards Initiative n.d.)
 - ^{vi} (Carpenter 1999), p.20
 - ^{vii} (Carpenter 1999), p.20
 - ^{viii} (Carpenter 1999), p.21
 - ^{ix} (Carpenter 1999), p.21
 - ^x (Carpenter 1999), p.22
 - ^{xi} (Carpenter 1999), p. 31

Curriculum Unit Title

Word Problem Strategy for Special Education Students

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KEY LEARNING, ENDURING UNDERSTANDING, ETC.

- Students will use a graphic organizer to solve word problems in a scaffold manner.
- Students will use a variety of strategies to solve addition and subtraction problems.

ESSENTIAL QUESTION(S) for the UNIT

- What are strategies to solve addition and subtraction problems?
- How can we break a word problem down to figure out what it is asking us?
- What are some strategies that we can use to solve word problems?

CONCEPT A

CONCEPT B

CONCEPT C

Addition and Subtraction Strategies

Word Problems

5 Q's Graphic Organizer Strategy for Word Problems

ESSENTIAL QUESTIONS A

ESSENTIAL QUESTIONS B

ESSENTIAL QUESTIONS C

- What are strategies to solve addition and subtraction problems?
- How can I use manipulatives to help me solve addition and subtraction problems?

- How do I approach a word problem I don't understand?
- What are successful strategies for me to use to solve word problems?

- What information do I know from the problem?
- What is the problem asking me to solve?
- How can I solve it?

VOCABULARY A

VOCABULARY A

VOCABULARY A

Counting on, counting on from, counting on to, counting down, counting down from, counting down to

Guess and check, make a chart, draw a picture, choose an operation.

5 q's.

ADDITIONAL INFORMATION/MATERIAL/TEXT/FILM/RESOURCES

See lessons for Appendix for Organizer.