A Sentence Completion Task to Familiarize Students with Word Problem Structures

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Abstract

Marshall (1995) provided a classification scheme for arithmetic word problems. The most frequent types of word problems are the change, group, compare, restate, and vary situations. *Change* situations tell a story in which there is a change in a measurable quantity of a particular thing. *Group* word problems ask the solver to use combine members of the same classification before performing a mathematical calculation upon these. *Compare* situations require a student to complete mathematical calculations upon two or more things and to contrast their quantities for a conclusion. *Restate* word problems include both a relational statement between two or more things and a numerical value for expressing the relational statement in measurable terms. *Vary* situations are those where the relationship between two things is generalizable across other values of these things.

The basic premise of this article is that educators in the middle and upper elementary grades can use a modified version of the sentence completion task (fill-in-the blanks) to familiarize students with the various structures of word problems. By embedding the sentences comprising a word problem among unrelated sentences, teachers can challenge their students to a) find the sentences pertaining to the word problem; b) order these related sentences into a logical order with or without the aid of a graphic organizer; and c) solve the problem. With frequent exposure to this activity, students may learn the various word problem structures.

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Word problems are the "most ubiquitous kind of problem solved in schools and universities" (Jonasses, 2003). They may be found in mathematics and science classrooms from kindergarten to college. Similarly, fill-in-the-blanks exercises (sentence completion tasks) can be found in language arts and content area classes where they are used to reinforce knowledge of vocabulary words. Instances of where these two activities co-exist in the same class, however, are probably rare and instances of where the sentence completion task has been used to reinforce story problem solving are undoubtedly even more infrequent. This paper, however, presents a theoretical grounding for using the sentence completion task to scaffold elementary students' constructions of mathematical word problems in order to develop their understanding of math problem structures.

Mathematics word problems may be sorted into various categories or structures. Marshall (1995), for example, developed one classificatory scheme of structures based upon the sorting behavior of subjects, and an analysis of school textbooks and standardized tests. Marshall's scheme includes five basic word problem situations: change, group, compare, restate, and vary. In a *change* word problem, the value of a particular object is changed over time by some measure. For this structure it is necessary to have three known quantities: the amount prior to the change, the amount of change, and the resulting amount after the change. A *group* situation is one that involves the combining of two or more small groups (say, dogs, cats, and hamsters) into a larger group (the animals in a pet store). For this type of word problem, it is necessary to know the amount of things in each of the small groups in order to arrive at the number of things in the large group. For the *compare* word problem, it is necessary to determine which of the

two things is larger or smaller. A *restate* structure is present in a word problem if there is a linkage between two things by some relational statement (twice as many girls as boys) and a restatement of the problem using explicit numerical values (thirty-two girls). The final structure, the *vary* word problem, possesses a "hypothetical flavor." The essential feature of this structure is that the relationship between two objects remains the same whether the numbers of things increase or decrease. In textbooks, these five different situations may be found in their pure states or in combination with other situations. Examples of the five different situations are found in table 1.

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Insert Table 1 about here

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In her studies, Marshall (1995) examined the usage of these five types of word problems in sixth- and eighth-grade texts. At both grade levels, these structures accounted for approximately 70 percent of the story problems in those texts. In approximately 90 percent of the story problems, the five situations were used in combination with one or more of the other five situations. High percentages of these five situations were also found on standardized tests. Third-, sixth-, and eighth-grade standardized tests included over 80 percent of the five situations in their pure state or in combination with two or more of the five structures.

**A Modified Sentence Completion Task**

Teaching students to become proficient at solving word problems is an important part of the mathematics curriculum of the elementary school (van Garderen, 2004). Recently, educators have used their language arts classes to help students with solving

mathematical word problems in their classrooms. Martinez and Martinez (2000) suggest turning word problems into math stories to make them more interesting for students.  To exemplify, they suggest adding speed, time, and distance values to the story of "The Tortoise and the Hare." According to these authors, such stories word stories help to "represent mathematics as communication—a system of ideas, that like spoken or written language, can be used to communicate and interact with the real world" (p. 56).

The suggestions by Martinez and Martinez (2000) provide a segue to the basic premise of this article. Marshall's (1995) research demonstrated that mathematics word problems possess structure. So do stories and informational texts. Language arts and reading teachers make distinctions between narrative text and expository text. Narrative text is that which is found in stories and novels, while expository text is found in informational materials such as textbooks. Each type of text possesses its own set of structures or schemas. Narrative texts include characters, settings, conflicts, and resolutions of the conflicts. Expository text structures, such as compare/contrast, problem/solution, sequence, and enumeration, are correlated with the relationship between a main idea and its supporting details. Learning to recognize these expository structures provides learners with the cues necessary for abstracting information.

A modified sentence completion task has been used to develop student awareness of expository structures in language arts classes (Montelongo, 2004; Montelongo and Hernández, 2007) and science classes (Berber-Jiménez, Montelongo, Hernández, Herter, and Hosking, 2008;  Montelongo, Berber-Jiménez, Hernández, and Hosking, 2006). In its common form, the sentence completion task consists of ten to twelve incomplete sentences requiring the learner to choose the appropriate vocabulary word in order to

complete the sentence. In its modified form, the students still have to complete the sentences with the appropriate vocabulary word. In this new format, however, half of the sentences on the worksheet are related to each other. The students must abstract these related sentences by cutting them out from the worksheet. Because these related sentences form a cohesive expository paragraph, the students must order them logically before pasting them onto another sheet of paper. By working with the different sorts of paragraphs, students become acquainted with the various types of expository structures. Finally, the students are asked to re-write the abstracted paragraph in their own words. As may be seen, this modified sentence completion task seamlessly transforms a vocabulary activity into a reading and writing exercise.

Generalizing the use of this modified sentence completion task from the language arts and science paragraphs to arithmetic word problems seems natural for several reasons. Competent word problem solvers are not influenced by factors such as irrelevant numerical and linguistic information or the number of ideas presented (van Garderen, 2004). These students would thrive on separating the related sentences from the unrelated. Furthermore, the individual sentences in the modified sentence completion task may be seen to function as manipulatives that can be sorted into categories (related and unrelated) and arranged into a logical order conforming to a structure. And as noted throughout this paper, expository paragraphs and arithmetic word problems possess certain structures.

**Examples**

The *change* structure word problem in Table 1 is used to demonstrate the modified sentence completion task. As seen in Figure 1, the activity is completed in four

steps. In Step 1, the students complete the sentences with the appropriate vocabulary word or arithmetic figure. Next, they must abstract the five related sentences from the corpus of ten. Note that the unrelated sentences or "foils" may be made as obvious or as difficult as the teacher desires. The third step requires the students to arrange the related sentences in order. To assist them, teachers might initially use graphic organizers. These graphic organizers are important because they provide a visual representation of the structure of the word problem. They also serve to scaffold the ordering of the sentences

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Insert Figure 1 about here

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The usefulness of the graphic organizer may be seen in the example of a *group* situation in Figure 2. This particular graphic organizer is but one of many possible organizers that might be generated for this type of structure. In the figure, the vertical nature of the diamond-shape form captures the importance of the main idea sentence, "*Renate has a wide variety of books*," and the finality of the sum total, "*Renate has seventy-six books*." The middle of the figure shows that all three types of books are equally important in that they all contribute to the sum total, even though each is subordinate to the main idea.

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Insert Figure 2 about here

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Possible cognitive organizers for the *compare*, *restate*, and *vary* structures are presented in Figures 3, 4, and 5. Once again, these are just a few of the many graphic

organizers that might be generated for each of these arithmetic word problems structures. The intention of the graphic organizer for the compare situation in Figure 3 is to show the parallels between Jennifer's holdings and those of her brother, Jim. The bottom of the figure permits a conclusion as to which character has the most money.

―――――――――――――――――――――――

Insert Figure 3 about here

―――――――――――――――――――――――

The graphic organizer for the restate structure provides a scaffold for ordering the steps to solve the problem. As pointed out by Marshall (1995) there are always at least two descriptions in the restate situation. First, there is a linkage of two things by a relational statement. In the example, there is a linkage between gloves and helmets united by the statement that "*there are twice as many gloves as helmets*." There is also another linkage between helmets and bats given by the statement that, "t*here are three times as many bats as helmets*." The second requirement in Marshall's analysis of the restate situation is that there is a restatement of the relationships using numerical values in place of the relational statements. In the baseball equipment example, the statement of the known quantity, "t*here are thirty baseball gloves*," may be used to solve for the number of baseball helmets. The numerical value of the baseball helmets may, in turn, be used to solve for the number of baseball bats. In addition to depicting the stepwise nature of the process, the graphic organizer in Figure 4 attempts to capture the qualitative differences between the relational statements, which should be used to fill the rectangular boxes, and the numerical values, which should be placed in the circles.

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Insert Figure 4 about here

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The final situation is the *vary* classification. The distinctive feature of this situation is that a "specified relationship connecting two things" can be generalized to other instances of those things (Marshall, 1995). In the example from Table 1, the relationship between the six-packs and the number of sodas remains the same throughout. For the two six-pack and ten six-pack situations, there are still six sodas in each six-pack. Marshall also suggests that another feature of this classification is its hypothetical flavor. In this example, the character is imagining the situations with the two six-packs and the ten six-packs. The graphic organizer in Figure 5 tries to capture in deep structure that the units—the six-packs—are equal to the items—the individual sodas by including these in same-sized rectangles. Also, there is a vertical connection between the two units and a vertical connection between the items to show the constancy of the relationship.

**Conclusion**

Arithmetic word problems, like expository paragraphs, have basic structures. According to one classificatory scheme (Marshall, 1995) there are five basic structures— *change*, *group*, *compare, restate*, and *vary*. The simple idea in this article is that teachers can use a modified sentence completion task to familiarize students with these basic arithmetic structures in order to improve student performance with word problems. By embedding the sentences comprising a word problem among a set of unrelated sentences,

students must first abstract the necessary components and then organize them in order to

solve the problem.

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Table 1. Examples of the five arithmetic word problem situations found in textbooks.

| Type of Situation | Example |
|---|---|
| **Change** | William owned 250 baseball cards in his collection. He went out and bought 120 more. Uncle Frank sent him 45 more as a birthday present. Mandy, his sister gave him 70 more for washing her car. How many cards does William now have in his collection? |
| **Group** | Renate has a wide variety of books to read at home. She has twenty-five mystery books featuring many of her favorite girl detectives. She also has eighteen books written by many of the most famous junior authors. Her father has bought thirty-three books on topics ranging from dinosaurs to stamp collecting. How many books does Renate have? |
| **Compare** | Jennifer has thirty-nine dollars in the bank. She also has forty-five dollars in her piggy bank. Bill, Jennifer's brother, has twenty-seven dollars in the bank. Bill has fifty-eight dollars at home in a drawer. Which one has the most money? |
| **Restate** | At the Toy-Oh, Boy! store, there are twice as many baseball gloves as baseball helmets. There are also three times as many baseball bats as helmets. There are thirty baseball gloves. How many baseball helmets are there? How many baseball bats are there? |
| **Vary** | John was sitting on the corner thinking about soda pops. He thought about how nice it would be if he could buy two six-packs of sodas at the supermarket. He would have twelve sodas. He could have one for himself and give one to each of his friends. If he could by ten six-packs, John would have sixty beverages. How would John be able to distribute these evenly among himself and his friends? |

**Figure 1.  Steps for completing the modified sentence completion task for a *change* structure.**

**Step 1.**
Directions: Complete the sentences with the appropriate vocabulary word.

| additional | appearing | chores | collection | demanding | hobby |
|---|---|---|---|---|---|
| proved | purchased | seventy | 525 | 680 | 485 |

1.      Mary has over _____ stamps in her collection.

2.      He went out and _____ 120 more cards.

3.      Uncle Frank sent him an _____ forty-five more as a birthday present.

4**.**      Barry Bonds has been _____ on baseball card for over fifteen years.

5.      Mandy, his sister, gave him seventy more cards for doing her _____.

6.      Stamp collecting can be a profit-making _____.

7.      William had 250 baseball cards in his _____.

8.      Chess is an intellectually _____ game.

9.      He now possesses _____ baseball cards.

10      The main idea of a paragraph must be explained or _____ by supporting details.

Answers:  1. seventy   2. purchased    3. additional   4. appearing   5. chores
             6. hobby     7. collection      8.demanding   9. 485         10.proved

**Step 2.**
Directions: Find the related sentences:

He went out and purchased120 more cards.
Uncle Frank sent him an additional forty-five more as a birthday present.
Mandy, his sister, gave him seventy more cards for doing her chores.
William had 250 baseball cards in his collection.
He now possesses 485 baseball cards.

**Step 3. Paste the sentences onto the graphic organizer.**

|  | Initial Amount |  |
| --- | --- | --- |

|  | First Change in Amount |  |
| --- | --- | --- |

|  | Second Change in Amount |  |
| --- | --- | --- |

|  | Third Change in Amount |  |
| --- | --- | --- |

|  | Final Total Amount |  |
| --- | --- | --- |

**Correct Answers:**

William had 250 baseball cards in his <u>collection</u>.
He went out and <u>purchased</u> 120 more cards.
Uncle Frank sent him an <u>additional</u> forty-five more as a birthday present.
Mandy, his sister, gave him seventy more cards for doing her <u>chores</u>.
He now possesses 485 baseball cards.

**Step 4. Re-write the paragraph in your own words.**

Directions: Write a paragraph in your own words using the graphic organizer to help you. Add synonyms, antonyms, experiences, etc. to make this paragraph your own.

_____

_____

_____

_____

_____

_____

**Figure 2.** **Steps for completing the modified sentence completion task for a *group* structure.**

**Step 1.**

Directions: Complete the sentences with the appropriate vocabulary word.

adolescent     catalogue     eighty-two     epic     mystery     ninety-four

patrons     playwright     renowned     seventy-six     topics     variety__

1.    The Dewey Decimal System is used to _____ books in school libraries.

2.    She has twenty-five _____ books featuring many of her favorite girl detectives.

3.    _____ must use their library cards to check out videos and books from the collection.

4.    Her father has bought her thirty-three books on _____ ranging from dinosaurs to stamp collecting.

5.    Renate has _____ books in her collection.

6.    William Shakespeare is considered the world's greatest _____ .

7.    Renate has a wide _____ of books to read at home.

8.    The Iliad and the Odyssey were _____ poems written /L/ thousands of years ago.

9.    Many _____ readers enjoy reading books by R.L. Stine.

10.    She also has eighteen books written by many of the most _____ junior authors.

Answers:  1. catalogue     2. mystery     3. patrons     4. topics     5. seventy-six
          6. playwright   7.variety      8. epic       9. adolescent   10.renowned

**Step 2.**

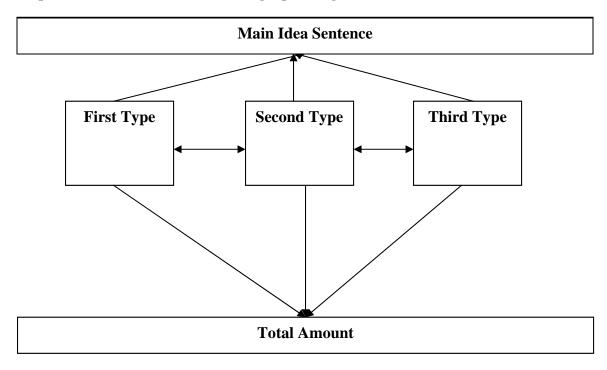Directions: Find the related sentences:

She has twenty-five <u>mystery</u> books featuring many of her favorite girl detectives.
Her father has bought her thirty-three books on <u>topics</u> ranging from dinosaurs to stamp collecting.
Renate has <u>seventy-six</u> books in her collection.
Renate has a wide <u>variety</u> of books to read at home.
She also has eighteen books written by many of the most <u>renowned</u> junior authors.

**Step 3. Paste the sentences onto the graphic organizer.**

| Main Idea Sentence |
| --- |

| First Type | Second Type | Third Type |
| --- | --- | --- |

| Total Amount |
| --- |

Correct Answers:

Renate has a wide <u>variety</u> of books to read at home.

She has twenty-five <u>mystery</u> books featuring many of her favorite girl detectives.

Her father has bought her thirty-three books on <u>topics</u> ranging from dinosaurs to stamp collecting.

She also has eighteen books written by many of the most <u>renowned</u> junior authors.

Renate has <u>seventy-six</u> books in her collection.

**Step 4. Re-write the paragraph in your own words.**

Directions: Write a paragraph in your own words using the graphic organizer to help you. Add synonyms, antonyms, experiences, etc. to make this paragraph your own.

_____

_____

_____

_____

_____

_____

**Figure 3. Possible graphic organizer for *compare* word problem situation.**



**Correct Answers:**

| Jennifer has thirty-nine dollars in the bank. | Bill, Jennifer's brother, has twenty-seven dollars in the bank |
|---|---|
| She also has forty-five dollars in a piggy bank. | Bill has fifty-eight dollars at home in a drawer at home. |

Bill has more money than Jennifer.

**Figure 4. Possible graphic organizer for *restate* word problem.**



**Correct Answers:**

> There are thirty baseball gloves.
> At the Toy--Oh, Boy! store, there are twice as many baseball gloves as baseball helmets.
> There are fifteen baseball helmets.
> There are also three times as many baseball bats as helmets.
> There are forty-five baseball bats.

**Figure 5. Possible graphic organizer for *vary* word problem situation.**



**Correct Answers:**

> John was sitting on the corner thinking about soda pops.
> He thought about how nice it would be if he could buy two six-packs of sodas at the supermarket.
> He would have twelve sodas.
> He could have one for himself and give one to each of his friends.
> If he could by ten six-packs,
> He would be able to distribute five sodas evenly among himself and his friends.