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EDCI 572

Fall 2023

**Design Document: Solving Word Problems**

**Overview**

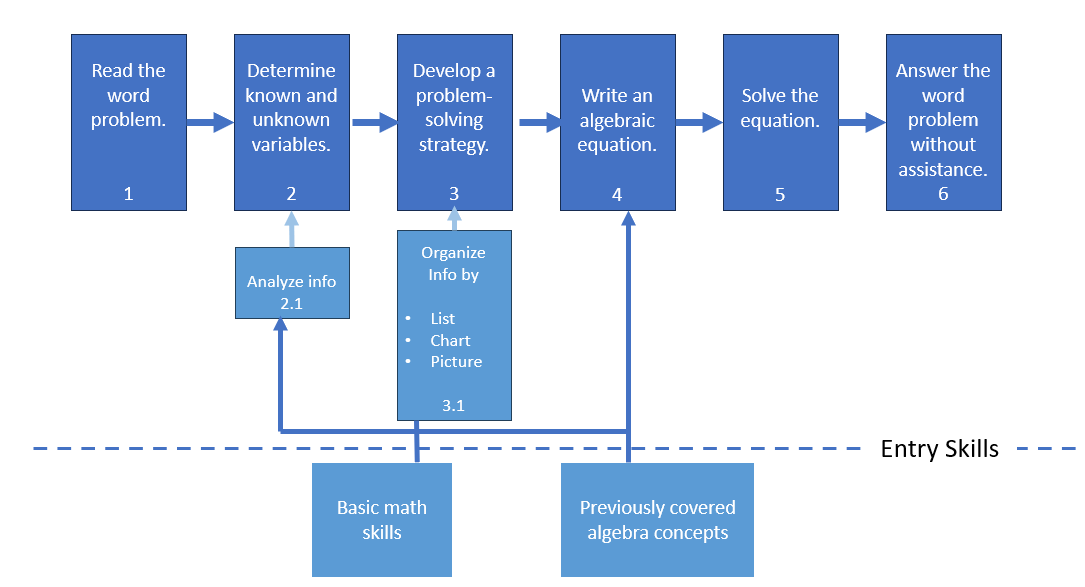
Word problems. Two of the most feared words in math class. Students fear word problems because they can be difficult. There is so much critical thinking that occurs while solving a world problem. Students must analyze the problem to understand which information is needed and which is not, then take that information to create an equation that relates the given information to each other, solve the problem mathematically (for this specifically, the students will use algebra), and use the calculated solution to answer the word problem all without the aid of the teacher, another adult, classmate, or Google. My students usually struggle to create the equation from the given information.

The approach to this learning module is the SME (subject matter expert) approach. After teaching in the classroom for eight years and also tutoring students in my class and students from other schools, story problems are a struggle for any age and any class (content). Considering that some concepts are recently learned, most students lack confidence while attempting the word problems. Other times, students know how to organize thoughts and identify key points, but they need help writing an equation (relationship) of the given information. Once, students have an equation to work with, most can solve the equation and then answer the question posed in the problem. My goal is to help the students gain confidence through more practice and to give them a checklist to go through so I do not need to be there holding their hand (so to speak) as they solve the problem.

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| **Desired Status** | **Actual Status** | **Need** |
| Students will be able to read a word problem, determine the givens and the variables, create a strategy to solve the problem, create a correct algebraic equation to solve the problem, be able to solve the equation, and then determine how to find the answer to the problem from the algebraic answer that was calculated. All were completed independently without the help of the instructor, Google search, friend, or guardian. | Students can read the word problem and identify the givens. Students can solve the word problem algebraically once given help to set up the equation. Sometimes students answer the question correctly from the answer of their algebraic equation, other times students answer the equation without reviewing the problem to see if that is the actual answer. | Students need to develop a system to be able to process the information in the word problem into an algebraic equation. This can be through pictures, charts, and lists, and then be able to determine if their answer from their problem is what the word problem is asking for. |

**Identification of Instructional Goal**

Given the performance context of given an algebra word problem for a homework assignment or test, algebra (both I and II) student learners will be able to use their tools of previous knowledge, critical thinking skills, and a calculator (if needed) to analyze and solve the problem while showing all work.

**Goal Analysis Diagram**

**Learner Analysis**

The learners for this module will be Algebra 1 and @ students. These students are usually in the 9th and 10th grades, but some 8th and 11th graders may be mixed in. The source of my data is through surveys and observation of my math classes and what other math teachers have said their students struggle with.

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| **Information Categories** | **Data Sources** | **Learner Characteristics** |
| 1. Entry Skills | **Interviews:** Previous instructors  **Observations:** Students’ previous class work | Most promoted students must pass content tests to move to the next level. Previous instructors can provide insight into which students struggled in certain areas of instruction. |
| 2. Prior Knowledge of Topic | **Observations:** Students’ previous class work | Based on how students perform in class, the instructor can assess who will struggle more with certain concepts and can provide extra help for mastery of concepts. |
| 3. Attitudes toward Content | **Interviews:** Previous instructors  **Observations:** Students’ participation and input in class discussions | Some students come into the classroom with an attitude of defeat or this is so complicated that I will not be able to do it. The teacher needs to reinforce positive thoughts and feedback and provide encouragement for students to have more of a willing attitude. |
| 4. Motivation for Instruction | **Published Report**: School and diploma regulations  **Survey**: Students’ interests and goals postsecondary school | Some students are internally motivated to work on subjects that do not interest them. For other students, there needs to be an outside motivation as to why they are taking the class and to keep them trying to pass the class. |

**Performance Context**

Students will be completing these word problems in the classroom or at home by completing homework or working out test and quiz problems. These are scenarios where the teacher will have little (homework) or no (test/quiz) interaction with the students while they complete the problems. The sources of my data are personal observations in my classroom and input from other math teachers.

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| Information Categories | Data Sources | Performance Site Characteristics |
| 1. Managerial/supervisory support | **Interview:** Administrators and instructors | Instructors will be available to provide limited support as students apply what they have learned from previous instruction to the current problems. |
| 2. Physical aspects of the site | **Interview:** Administrators and instructors  **Observations:** inspection of location and classrooms | Students will be given time to complete assignments overnight. But for tests and quizzes, students will only be given time in class to complete the word problems. Calculators and manipulatives will be available for students to use while in the classroom. |
| 3. Social aspects of the site | **Interview:** Administrators and instructors  **Observations:** observe student interactions with each other and instructors | Depending on the homework assignment, students may be able to work in small groups and be able to receive limited help from the instructor. During tests and quizzes, there will be no student interactor or aide from the teacher. |
| 4. Relevance of skills workplace | **Interview:** Administrators and instructors  **Observations:** observe students working in the classroom on assigned word problems | Students must show sufficient mastery of the subject to be able to pass the class which would allow students to receive a diploma to graduate from high school. |

**Learning Context**

The learning module will take place in person during a training session. This could be during a 50-minute class period or during a help class session that can be 30-60 minutes in length. The source of my information is from my observations in my classes and what I have heard from other math teachers.

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| **Information Categories** | **Data Sources** | **Learning Site Characteristics** |
| 1. Number/Nature of Sites | **Interviews:** Teachers and Administrators | Any classroom should do. The size of the classroom needed would depend on the number of students in the class. This should already be taken care of before the session starts. |
| 2. Site Compatibility with Instructional Needs | **Site Visit:** observe classroom set up for technology and whiteboards available | There needs to be ample space for the students to work. Plus, technology or a whiteboard/ chalkboard for students to get up and move provides a more interesting atmosphere which can spark creativity in students. |
| 3. Site Compatibility for Learner Needs | **Interview:** Administrator  **Site Visit:** observe classroom set up for technology and whiteboards available | Whiteboards/tablets are available for students. Dry-erase markers or chalk for students to work on. Other manipulatives like geometric shapes, paper, tape, and pens for students with learning disabilities or more visual learners to interact with representatives of the word problem scenarios. |
| 4. Feasibility of simulating workplace | **Observation and Survey:** what are the students interested in and what is their career or occupational goal once they graduate from high school | Depending on the career choices of the students, word problems can be adapted to real-life scenarios for the students. More budgeting and money problems will be applicable for students since everyone will have to work with money. |

**Performance Objectives**

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| **Main Goal:**  When given an algebra word problem for a homework assignment or test, algebra (both I and II) students will be able to use their previous knowledge, critical thinking skills, and a calculator (if needed) to analyze and solve the problem while showing all work. | **Terminal Objective:**  Using previous knowledge, critical thinking skills, and a calculator (CN), to analyze, develop a strategy, write and solve an algebra equation (B) to answer a work problem without assistance (CR). |
| **Step 1**  Read the word problem | **Performance Objective**  In a homework assignment or test (CN), the word problem will be read (B) to promote understanding of the given scenario (CR). |
| **Step 2**  Determine known and unknown variables. | **Performance Objective**  Using previous algebra knowledge (CN), to discern and label (B) accurately the known and unknown variables (CR). |
| **Step 2.1**  Analyze the information given. | **Subordinate Objective:**  Given the word problem and previous algebra knowledge (CN), think critically and strategize (B) to plan how to find an answer to the word problem (CR). |
| **Step 3**  Develop a problem-solving strategy. | **Performance Objective:**  After reading and analyzing the information (CR), basic arithmetic, geometric, and algebra knowledge will be accessed (B) to determine the best set-up and process to solve the word problem (CR). |
| **Step 3.1**  Organize info by list, chart, picture | **Subordinate Objective:**  Given the word problem and previous knowledge (CN), a list, chart, or picture will be formed (B) to organize the information that was given (CR) |
| **Step 4**  Write an algebraic equation. | **Performance Objective**  With the information organized and a strategy prepared (CN) arithmetic functions and variables will be compiled (B) to create an algebraic equation that relates all the given information (CR). |
| **Step 5**  Solve the equation. | **Performance Objective**  Using algebraic knowledge and the created equation (CN) arithmetic and algebraic processes will be used (B) to accurately solve the algebraic equation for the unknown variable (CR). |
| **Step 6**  Answer the word problem without assistance. | **Performance Objective**  Given the solution to the algebra equation and the word problem (CN) analyze and determine if further computation may be needed (B) to accurately answer the word problem (and complete if necessary) (CR). |

**Assessment Plan**

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| **Test Type** | **Designer’s Decision** | **Objectives Typically Tested** |
| Entry Skills Test | * Students should already know about previous classes to be promoted to the next level * A lot of observation will occur during the first grading period to determine the level of instruction the different students will need to complete work problems | * Basic math skills below the dotted line (on the goal analysis diagram above) * Basic geometric skills also below the dotted line (on the goal analysis diagram above) * These are observed by the teacher and tested by previous homework tests and quizzes. |
| Pretest | * No pretest will be necessary | * Instructors should be able to gage a student’s abilities to solve word problems based on how they can work on their other classwork |
| Practice Tests | * Active learner participation will be required for the practice/instructional session. * Students will be asked to contribute to the first few problems. * Students will be working out some of the practice problems with limited help on the board or a tablet. * A packet of word problems will be provided to the students for the class to work through together. * Instruction will gradually diminish as the packet is completed. | * Critical thinking skills will be tested as students have to analyze problems, organize their thoughts, and create an equation(s) that relate the known information to the unknown information. * Students will have guided practice at the beginning. As the students’ progress, the teacher should have less input and test the comprehension of students and their abilities to relate information. * Instructor can provide feedback and coaching for concepts that students have not quite mastered before moving on to the posttest. |
| Posttest | * Students will receive a second packet of 5–10-word problems to complete with minimal assistance from the instructor. * Problems will be checked by the instructor as the students work. * Instructor may tell students which problems are incorrect, and give minimal direction to go back and correct the issue. * Students who struggle to complete the posttest may be asked to go through another help training session. | * The final objective, can a student correctly answer a word problem without outside assistance? * The main steps of the session of analyzing and organizing the information, creating an equation, and answering the word problem. |

**Design Evaluation Chart**

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| **Step** | **Performance Objectives** | **Parallel Test Items** |
| **Step 1**  Read the word problem | **1.1**  In a homework assignment or test, the word problem will be read to promote understanding of the given scenario. | There is no test item for reading the problem. This needs to be done for the students to know what the problem will contain and help start critical thinking. |
| **Step 2**  Determine known and unknown variables. | **2.**1  Using previous algebra knowledge, students will discern and label accurately the known and unknown variables. | Students will start a list of the known and unknown variables on their paper. Unknowns will be given a letter (variable) and the known will put the known number by the variable. |
| **Step 3**  Develop a problem-solving strategy. | **3.1**  After reading and analyzing the information, basic arithmetic, geometric, and algebra knowledge will be accessed to determine the best setup and process to solve the word problem. | Students will create a list, chart, picture, or formula that will organize the information to help students create an equation. |
| **Step 4**  Write an algebraic equation. | **4.1**  With the information organized and a strategy prepared arithmetic functions and variables will be compiled to create an algebraic equation that relates all the given information. | Students will use one of the handouts along with their problem-solving strategy to create an equation that relates the known information to the unknown. Previous knowledge of formulas and key words to determine what mathematical operations will be used. |
| **Step 5**  Solve the equation. | **5.1**  Using algebraic knowledge and the created equation, arithmetic, and algebraic processes will be used to accurately solve the algebraic equation for the unknown variable. | Students will use their algebra knowledge to solve the equation for the unknown variable(s). Students should also check their answer(s) to make sure that they computed the correct answer. |
| **Step 6**  Answer the word problem without assistance. | **6.1**  Given the solution to the algebra equation and the word problem, students will analyze and determine if further computation may be needed to accurately answer the word problem (and complete it if necessary). | Students will take their answer and determine if it answers the given word problem. Sometimes extra computation will be needed to find multiple answers or take the calculated answer to answer the word problem. |

**Instructional Strategy Alignment**

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| **Learning Component** | **Design Plan** |
| **Cluster 1**  **Starting the word  problem** | **Objective**  **1.1** - In a homework assignment or test, the word problem will be read to promote understanding of the given scenario.  **2.**1 - Using previous algebra knowledge, students will discern and label accurately the known and unknown variables.  **3.1 -** After reading and analyzing the information, basic arithmetic, geometric, and algebra knowledge will be accessed to determine the best setup and process to solve the word problem. |
| **Content Presentation**   * Two reference handouts will be given to the students.   + [Keywords handout](https://drive.google.com/file/d/1j9bQJVXjGNgPuxGOWwfYf8St8HDJ59r5/view?usp=sharing)   + [Word problem step infographic](https://drive.google.com/file/d/1a7h7sDPdJM3tKvaMf7nu41g_0TSDXTnZ/view?usp=sharing) * A practice problem packet will also be given to the students for the whole group to work on throughout the workshop.   + [Practice Packet](https://docs.google.com/document/d/15ldsK9y6R64AgVJgmjwy5Kht7F87iT_3B8kgMwTTmyo/edit?usp=sharing)   + [Answers](https://drive.google.com/file/d/1jWfCwbaSwhQB7n30d6e2uFLsuZGDjEdw/view?usp=sharing) * As a group, we will work through steps 1-3 problems 1, 3, 5, and 7. * The instructor will guide the students through the problem, and help pick out clue words for the students to know what operations need to be used to complete the problem. |
| **Student Participation**   * Students will help read the word problems. They will also contribute by relaying some of the background information that they already know. * Through the guided questions, the students will help pick out the key information and use the keyword worksheet and infographic to help with the steps and know what operations need to be used to solve the problems. |
| **Cluster 2**  **Creating and solving the word problem.**  **Answering the word problem question** | **Objective**  **4.1 -** With the information organized and a strategy prepared, arithmetic functions and variables will be compiled to create an algebraic equation that relates all the given information.  **5.1 -** Using algebraic knowledge and the created equation, arithmetic, and algebraic processes will be used to accurately solve the algebraic equation for the unknown variable.  **6.1 -** Given the solution to the algebra equation and the word problem, students will analyze and determine if further computation may be needed to accurately answer the word problem (and complete it if necessary). |
| **Content Presentation**   * As a group, we will work on objectives 4-6 on problems 1, 3, 5, and 7. * Now we will take the set-up and work creating and solving the equation. * Then we will go back to the word problem, and evaluate if our calculated answer solves the word problem. * The instructor will ask guiding questions along the way to get student input. |
| **Student Participation**   * Students will answer the guided questions posed by the instructor. * They will use their previous knowledge to help solve the equation. * They will also think through their answer and the word problem to see if they answered the word problem. |
| **Cluster 3**  **Guided practice** | **Objective**  **1.1** - In a homework assignment or test, the word problem will be read to promote understanding of the given scenario.  **2.**1 - Using previous algebra knowledge, students will discern and label accurately the known and unknown variables.  **3.1 -** After reading and analyzing the information, basic arithmetic, geometric, and algebra knowledge will be accessed to determine the best setup and process to solve the word problem.  **4.1 -** With the information organized and a strategy prepared, arithmetic functions and variables will be compiled to create an algebraic equation that relates all the given information.  **5.1 -** Using algebraic knowledge and the created equation, arithmetic, and algebraic processes will be used to accurately solve the algebraic equation for the unknown variable.  **6.1 -** Given the solution to the algebra equation and the word problem, students will analyze and determine if further computation may be needed to accurately answer the word problem (and complete it if necessary). |
| **Content Presentation**   * The class will work out the other odd-numbered word problems (9, 11, and 13). * We will go through all the steps for each individual word problem. * The teacher will ask fewer guiding questions to allow the students to direct themselves in solving the answer. * These questions will be more of *What next? What does that mean? What should we do?* |
| **Student Participation**   * Students will verbalize the steps to solve the problem. * They will answer the guiding questions. * There will be students talking out loud through the steps that we need to complete next as well as how to set up each part. |
| **Cluster 4**  **Self-practice** | **Objective**  **1.1** - In a homework assignment or test, the word problem will be read to promote understanding of the given scenario.  **2.**1 - Using previous algebra knowledge, students will discern and label accurately the known and unknown variables.  **3.1 -** After reading and analyzing the information, basic arithmetic, geometric, and algebra knowledge will be accessed to determine the best setup and process to solve the word problem.  **4.1 -** With the information organized and a strategy prepared, arithmetic functions and variables will be compiled to create an algebraic equation that relates all the given information.  **5.1 -** Using algebraic knowledge and the created equation, arithmetic, and algebraic processes will be used to accurately solve the algebraic equation for the unknown variable.  **6.1 -** Given the solution to the algebra equation and the word problem, students will analyze and determine if further computation may be needed to accurately answer the word problem (and complete it if necessary). |
| **Content Presentation**   * The instructor will have students work as small groups to solve problems by themselves. (2-3 per group, max of 4 per group) * Students will work through the even-numbered problems on the practice packet. * The instructor will walk around the classroom and give more one-on-one help and instruction to students as they need it. * Instructor will try to use the same guiding questions from the previous cluster. |
| **Student Participation**   * Students work in small groups of 2-3 (max of 4) students.. * Students will work to complete the even-numbered word problems from the practice packet that the class has been working on. * Students will work on whiteboards, tablets, or paper where they can all see and contribute to the working through the steps to solving the word problems. |
| **Cluster 5**  **Test** | **Objective**  **1.1** - In a homework assignment or test, the word problem will be read to promote understanding of the given scenario.  **2.**1 - Using previous algebra knowledge, students will discern and label accurately the known and unknown variables.  **3.1 -** After reading and analyzing the information, basic arithmetic, geometric, and algebra knowledge will be accessed to determine the best setup and process to solve the word problem.  **4.1 -** With the information organized and a strategy prepared arithmetic functions and variables will be compiled to create an algebraic equation that relates all the given information.  **5.1 -** Using algebraic knowledge and the created equation, arithmetic, and algebraic processes will be used to accurately solve the algebraic equation for the unknown variable.  **6.1 -** Given the solution to the algebra equation and the word problem, students will analyze and determine if further computation may be needed to accurately answer the word problem (and complete it if necessary). |
|  | **Content Presentation**   * The instructor will hand out the [test packet](https://docs.google.com/document/d/15pEpqj15mEzD5hrT9sebp30ta5f026tCUOZhn7nWm38/edit?usp=sharing) to the students. ([answers](https://drive.google.com/file/d/17dkZnU2Uu1oh0-hrv7l8kBvvPWaunkWy/view?usp=sharing)). * The instructor will go through the packet and directions. * Students will be able to use previous handouts, calculators, and prior knowledge to complete the test packet. * The instructor is to give limited help during this time, since this is testing what the students are able to do without outside help. |
|  | **Student Participation**   * Students are to work individually on this test. * Students can use previous handouts and calculators to complete the test packet. |

**Implementation Plan**

The potential pilot testers for this module will be three former students who are now homeschooling and I currently tutor once a week. Two of the students are currently in Algebra 1 and 2. The third took Algebra 2 with me last year but still works with word problems in her geometry text.

The plan for conducting the pilot test will be an informal workshop. I will conduct this for an hour either during my normal tutoring time or an additional tutoring time for the students. Since the workshop is set up to be more of a help class that a teacher can conduct after school, I plan to complete the pilot in the same manner. There is a whiteboard that I can do the instruction on and then the students can also do their practice on.

**Evaluation Plan**

There will be two methods of evaluation for the pilot test. The first method will be an interview with the test students. There will be some basic feedback questions to see how the students think the module went; as well as what they think they still need for instruction or more practice. Some of those questions will be:

1. Was this workshop helpful? Why or why not?
2. What went well?
3. If you had to make changes to the workshop, what would you do differently?
4. Was there enough time to get everything finished or should this workshop be done in two parts?

The second part of the evaluation for the workshop will come from grading the test questions. There is a packet of nine-word problems that the students will complete at the end workshop or on their own time (depending on the students and time available). After grading the work and answers of the students, some adjustments may need to be made for future workshops. Some sample problems are below from the test packet.

1. Alyssa bought a soft drink for 4 dollars and 4 candy bars. She spent a total of 20 dollars. How much did each candy bar cost?
2. The sum of three consecutive odd numbers is 135. What is the smallest of the three numbers?
3. A plane set off to Atlanta at a speed of two hundred eleven mph. On the return flight of fourteen hours, the plane cruised at two hundred thirty-nine mph. How many hours long was the flight to Atlanta?