

**Adapting Reading Comprehension Strategies to Support
Mathematical Word Problem Comprehension**

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Action Research Proposal

Abstract

Mathematical word problems are challenging and difficult for students. Students struggle with comprehending mathematical word problems, which leads to students not answering the word problem accurately. Comprehension of mathematical word problems is a challenging and difficult skill to acquire. Throughout my teaching career, I have observed the challenges mathematical word problems pose on students every year. There are numerous factors that contribute to a student's ability to successfully answer all parts of a math word problem, but comprehension seems to be the leading factor for student's ability to answer all parts of a mathematical word problem accurately. The purpose of this action research was to analyze the effects of using reading comprehension strategies in the mathematics classroom, specifically, while reading word problems. Over the course of ten weeks, student's accuracy, completion, conceptual understanding, visual representations, and ability to comprehend a mathematical word problem improved.

Problem of Practice and Context

There are a variety of reasons I decided to become an educator, specifically, in the community I grew up in. One, I felt that personally, education had changed my trajectory in life and opened a lot of opportunities I would not otherwise have. Two, I wanted to support and continue to uplift my community by helping to close the equity gap. Being an English Language learner, school was challenging, English Language Arts was challenging, but I always felt that mathematics was a language I could speak

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in English or Spanish. I felt confident in mathematics because I could participate.

However, I remember being faced with challenging word problems and not being able to understand what the problem was asking. This feeling I remember really had an impact on my confidence, but also allowed me to seek help from my teachers and work hard to really understand what a problem was asking. Being a novice mathematics teacher, for the past three years, I have observed students struggling with comprehending mathematical word problems. From my observations in class and on assessments, mathematical word problems are intimidating for my students. Students continue to not answer all parts of a mathematical word problem which is resulting in incorrect answers and a lack of confidence and hesitation from students when presented with a word problem.

I wanted to gain more insight and luckily, I participate in content meetings, once a week, at my school, with all of the other mathematics teachers in grades three through six. I brought up my concern in my content meeting about my student's struggling with mathematical word problem comprehension and I was curious if this is because of me being a novice teacher or if they are seeing any of this in their classrooms. I wanted to know their thoughts, their experiences, and what they were observing. I really admire and respect my peers who are veteran teachers. I am the youngest mathematics teacher at my school and everyone else in my content team has taught a minimum of seven or more years, I really look up to them as role models and look up to them to become the best teacher that I can. I was relieved to hear that, they too, had students who were struggling with mathematical word problems. This validated my observation

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and made me realize that mathematical word problems are challenging for our students at our school, and made me want to learn more.

As a network, the twelve schools across the bay area, come together a few times a year to do a large scale professional development. Every content team comes together, in my case, all of the math teachers come together and we split up into grade levels. We have all of the math teachers in one room and we split up into each grade level so that all of the 6th grade math teachers from our twelve school are together and we analyze a recent interim assessment that our students have all taken. In our analysis, the 6th grade mathematics teachers had observed two major trends. The first trend, was that students were not able to answer all parts of a math problem. The second trend, was that students could not explain or justify their answers. This was another data point for me, in that this is happening in all sixth-grade classroom across my network, I became even more curious. After the analysis, all of the mathematics teachers from grades three through eight came back together to share their trends. We did a gallery walk of the two trends that each grade level had observed on the assessments. As we were doing the gallery walk the trend that kept coming up in grades three through eight was that students were not answering all parts of a mathematical word problem. This was a pinnacle moment because it validated everything I was observing in my classroom. Clearly, this is not a trend I am only observing or a trend occurring because of me being a novice teacher. This is clearly happening across my network in all twelve schools in mathematics classrooms in grades three through eight. This revelation motivated me to want to learn more about

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what are the strategies that are currently out there to better support my students in this process and learn more about mathematical word problems.

Literature Review

Introduction

California's transition to the Common Core State Standards, CCSS, and the Standards of Mathematical Practice, SMP, has been a transition for students, teachers, and parents. The hope behind this transition is to yield mathematically proficient students. The standards of Mathematical Content are a balanced combination of procedure and understanding. (CCSS, 2017). The Standards for Mathematical Practice are what educators at all levels should develop in their students. The first of these are the National Council of Teachers of Mathematics, NCTM, process standards of problem solving, reasoning and proof, communication, representation and connections (CCSS, 2017). The second, are the standards of mathematical proficiency: adaptive reasoning, strategic competence, conceptual understanding (comprehension of mathematical concepts, operations and relations), procedural fluency (skill in carrying out procedures flexibly, accurately, efficiently and appropriately), and productive disposition (habitual inclination to see mathematics as sensible, useful, and worthwhile, couple with a belief in diligence and one's own efficacy) (CCSS, 2017). This shift and emphasis on procedure and understanding makes it imperative that students are able to be proficient in both areas. Unfortunately, recent data at our schools suggests that our students in grades 3 through 8 are struggling with understanding a math word problem and

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answering all parts of the problem. Based on our recent regional professional development it was clear, that as a region, teachers noticed two trends our students grades three through eight were struggling with. The first trend, teachers noticed, was that students were unable to answer all parts of a math problem, which suggested a lack of reading comprehension. The second trend, teachers noticed, was that students were unable to justify and explain their thinking when problem solving. After speaking with colleagues at our regional professional development it became clear that these two trends continue to impact student performance at our schools. In addition, we discussed that students need to master making sense of a problem before being able to justify and explain their approach. Research suggests that solving word problems is one of the most challenging tasks in mathematics for most students (Supap, 2011). It became clear that addressing students' math problem comprehension is of utmost importance and an issue that needs to be supported immediately by teachers in all grade levels in our region. In this literature review I present literature related to mathematical word problems and mathematical reading comprehension. I argue that when students read a word problem at least three times with a different objective each read, receive feedback, and work with a partner, student's comprehension of mathematical word problems will develop and their academic achievement on mathematical word problems will be impacted.

Mathematical Word Problems Challenges and Structure

Data at our recent professional development lead me to believe that students in grades three through eight are not adequately prepared to solve mathematical word

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problems, suggesting that more needs to be done to close this skill gap. Mathematical word problems are an essential tool used by most mathematics teachers and curricula. Mathematical word problems are used to relate mathematics to real life situations. Providing student's, the opportunity to practice with real world problem situations can help students understand the importance of mathematics and develop their critical and problem solving abilities (Chapman, 2006). There are a variety of challenges students face when solving mathematical word problems, but one of the main reasons is that solving word problems requires a range of skills, such as reading comprehension, understanding the vocabulary, identifying relevant information, choosing the correct operation, writing related equations, solving the problem and expressing the answer correctly (Supap, 2011). The importance of supporting students at an early age is imperative because word problems are used throughout a student's mathematical career. Student's begin to see word problems starting in elementary school all the way through college. Efforts have been made by researchers in trying to identify the challenges faced by students when solving mathematical word problems and the reason behind these difficulties.

Based on our recent regional professional development, the mathematical practice standard 1, is an area of growth for our students and therefore an area that I would like to focus on to better support my student's ability to solve problems. The CCSS Practice Standard 1, make sense of problems and persevere in solving them is a challenging area of math instruction for students. According to the CCSS, mathematically proficient students are able to explain the meaning of a problem and think of strategies to solve the problem. Older students are able to analyze the context

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of the problem and use the information that is provided within the math problem to find a solution. Lastly, mathematically proficient students are able to check their answers to problems and continuously ask themselves, “does it make sense?” they can understand the approaches of others to solving complex problems and identify similarities between different approaches. In order for students to be proficient in this mathematical practice they need to be able to comprehend and understand the problems. Specifically, I would like to focus on mathematical word problems and help support students improve in this mathematical practice.

Most mathematical word problems follow a three-component structure (Gerofsky, 1996):

1. A set-up component, establishing characters and location of the story.
This information is often not essential to the solution of the problem.
2. An information component, which provides the information needed in solving the problem.
3. A question.

In addition to the component structures, mathematical word problems are normally solved in two major phases (Supap, 2011): problem representation and solution solving. In the first phase, the mathematical word problem must be read carefully and be translated into an appropriate equation. In the second phase, the solution of the translated equation must be solved correctly. According to research, students often make a mistake in the first phase, which leads to a wrong answer in the end. The problem representation phase consists of three steps; comprehension, extraction, and constructions of equations while the solution phase comprises of two steps; equation

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solving and answer checking (Ahmed, Salim & Zainuddin, 2008). The comprehension step is about reading the word problem and understanding the given problem. Students need to be able to understand mathematical language and translate it into their own meaning and language. The comprehension step is challenging for students because they have trouble with language processing (Russel & LeBlanc, 1996). The reason is the mathematical vocabulary can be difficult to learn and remember in comparison to colloquial words. The extraction step is about what information is most important and will be needed in order to successfully solve the problem. The construction of equation step is about having scholars being able to create appropriate equations that will be needed to solve the word problem. The second phase of the word problem solving process is the solution solving phase. In which students solve the equation and check their answer.

Mathematical Reading Comprehension

From a very young age students are asked to problem solve and solve mathematical word problems. Mathematical reading comprehension can be defined as the ability to read a text, process it, and understand its meaning (Ozcan, 2017). Mathematical reading comprehension is challenging for most students because mathematical word problems use mathematical language and conceptual understanding. In addition, mathematical word problems ask students to translate words into symbols and meanings. Mathematical reading comprehension requires students to use their math content knowledge, predicting, questioning, and determining meaning of vocabulary in context (Basurto, 1999). It is frequently stated in literature that students

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who have difficulty with mathematical reading comprehension have difficulty understanding the problem in the text, which results in students unable to reach a correct solution (Ozcan, 2017). There has been a shift in views of the role of literacy in mathematics over the years. Teachers used to believe that they were two separate entities, but with the shift in ideas that every teacher is a literacy teacher as well as the recent implementation of the common core mathematics teachers need to be able to teach reading comprehension when it comes to mathematical word problems (Fogelberg, 2008). Over the years, this change has encouraged a variety of research and strategies to better supports students reading comprehension when it comes to mathematical word problems.

Visual Representations

One strategy that students and teachers are using in the classroom that has been effective to help support reading comprehension in mathematical word problems is the use of visual representations. Visual representations has been is a valuable tool used by teachers and students to help students grasp mathematical concepts as well as mathematical word problems (Goldin, 2002). Visual representations help students make sense or problems and allow students the ability to explain the problem and communicate their thinking to others (NTCM, 2000). Researchers have stated that before visual representations students would be unsuccessful in understanding and representing the problems correctly. This approach was referred to as a “compute first and think later” and “number grabbing” (Littlefield & Rieser, 1993). The shift to visual representations as a strategy to use is because researchers believe that effective

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problem solvers are able to translate a mathematical word problem into a visual representation. However, the difficulties that arise with creating accurate visual representations for word problems is stemming from the fact that for years many math lessons were too focused on solving equations rather than on emphasizing problem representation skills (Brenner, Mayer, Moseley, Brar, Duran, Reed, & Webb, 1997). Teachers and students are now expected to create accurate visual representations when reading a mathematical word problem, but there are still challenges because this is a recent change strategy being implemented by teachers and used by students. With this strategy there is a significant relationship between student success in solving a mathematical word problem if they use visual representations (Edens & Potter, 2008).

Three Reads Protocol

The Three Reads Protocol is adapted from a reading comprehension strategy called a close read. Close reading is an instructional practice, primarily used at the middle school and high school level, for helping students comprehend a text (Richards, 2016). In a close read, students read a text multiple times assisted by teachers' scaffolds and discussion that ultimately leads to deep comprehension of the text (Fisher, 2016). The way a close read is transferred in a mathematics classroom is through the Three Reads Protocol. Research suggests that a close read of complex math word problems or task is beneficial to comprehending a mathematical word problem (SFUSD, 2015). San Francisco Unified School District uses is the *Three Read Protocol*.

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This strategy includes reading the math problem three times with a different goal each time. This is typically done with a partner and encourages team work. The first read, is to understand the context, students are typically asking themselves, “What is the problem about?” The second read, is to understand the mathematics, students read the problem again, but this time ask themselves, “What is the question in the problem and what are we looking for?” The third read, is to elicit inquiry questions based on the scenario, students reread the problem one last time and ask themselves, “What information do you need to solve the problem? What information do you have? What information are you missing? Draw a diagram (picture or bar model) of the problem and label all information you know.” The reason this school district is using the *Three Read Protocol* is because they believe this strategy engages students in sense-making and focuses attention on the importance of understanding problems rather than rapidly trying to solve them. They also believe this strategy allows for natural differentiation within the classroom (SFUSD, 2015).

K-W-C

The K-W-C strategy is adapted from the K-W-L chart in English Language Arts. The K-W-L chart is a specific reading comprehension strategy for asking questions (Blachowicz & Ogle, 2001). The acronym stands for reading questions before and after reading, What do you know? What do you want to know or want to learn more about? and What have you learned? This KWL chart is a common reading comprehension strategy used by teachers to help students activate their schema prior to reading, improve reading comprehension during reading, and organize their thoughts following

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reading. This reading comprehension has been effective for helping students with find meaning within the text. The K-W-C strategy adapted in math is used in a similar manner of helping students ask questions as they are reading a word problem and help with comprehending the word problem. The acronym K-W-C stands for reading questions before and after reading a word problem, What do I know for sure? What do I want to find out? and Are there any special conditions that I have to watch out for? (Hyde. 2006). Research has expressed that this reading strategy adaptations has provided mathematics students with a structure and helped them connect the mathematical word problems to their prior knowledge. Not only that, but researchers found that adapting this reading comprehension problems to traditional story problem, to more open-ended or extended-response tasks, the quality of student's work, especially their explanations of the concepts improved dramatically (Hyde, 2006).

Conclusion

Research shows that comprehending mathematical word problems affects mathematical achievement. One way to support comprehension of mathematical word problems in mathematics, is to incorporate and adapt reading comprehension strategies into the classroom. Based on my analysis, I propose that adapting reading comprehension strategies in mathematics will improve student's ability to answer all parts of a math word problem, build confidence in students when faced with a word problem, and improve their overall academic achievement in mathematics. Specifically, I plan to adapt and implement these reading comprehension strategies into my math classroom. I plan to explicitly teach the Three Reads Protocol, K-W-C, visual

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representations when applicable, provide students with plenty of opportunity to practice these strategies, and provide students with feedback about how they are using the strategies. Students will have the ability to practice these adapted reading comprehension strategies when working on a mathematical word problem. I will have single step problems, multi step problems, and performance task problems for students to work with and practice these adapted reading comprehension strategies. Throughout the intervention, I plan to provide students with feedback on how accurate they are using the adapted reading comprehension strategies and support students throughout the process.

Theory of Action

Problem of Practice	Literature Review	Intervention	Expected Outcome	Research Methods/Data Collection
Middle school math Students do not answer all parts of a mathematical word problem.	Reading comprehension challenges contribute to students unable to answer all parts of a mathematical word problem or inaccurate answers.	Adapting reading comprehension strategies <ul style="list-style-type: none">• KWC• 3-Read Protocol	<ul style="list-style-type: none">• Students will feel more confident in answering mathematical word problems.• Students will identify what the question is asking• Students word problem comprehension improves.	<ul style="list-style-type: none">• Pre and post intervention survey around mathematical word problems and comprehension.• Recordings and observations of mathematics classroom.• Student materials and work samples.

Intervention and Data Collection Plan

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Research shows that adapting reading comprehension strategies to mathematics has a positive impact on students ability to understand and comprehend a mathematical word problems. This is why, I will be implementing reading comprehension strategies into the classroom. My hope is that student's will be able to feel more confident when faced with a mathematical word problems and that comprehension of mathematical word problems increase. Additionally, by focusing on comprehension of mathematical word problems my hope is that these strategies lead to more accurate results when solving mathematical word problems.

Intervention Action Plan

Problem of Practice: 6 th grade math students do not answer all parts of a math word problems.
Theory of Action: If I teach students how to read and comprehend a mathematical word problem, provide clear modeling, and feedback to students on their comprehension, then students will be able to answer all parts of a mathematical word problem.
<ul style="list-style-type: none">• Overarching research question(s):• How will focusing on the comprehension of a mathematical word problem help students answer all parts of a math word problem?• What strategies are effective for teaching scholars how to read a mathematical word problem?• Are the 3-reads protocol and KWC strategies effective for solving mathematical word problems?• Why is making sense of a problem and perseverance in solving them an important indicator of mathematical proficiency?

	Component	Activities	Purpose/Sub-Question to be answered	Data to be Collected	Type of Data (process v. impact)
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1	Pre-intervention: Record scholars solving a mathematical word problem	Ask scholars to explain and reason their thinking of the word problem.	Do scholars answer all parts of a math problem? Can scholars explain and reason their thinking?	Video/transcript of scholars working through a math problem.	impact
2	Pre-intervention: Record scholars working together and discussing what the problem is asking.	Listen to student dialogue and feedback they provide each other	Observe scholars giving feedback and see what type of feedback they provide.	Video/transcript of scholars working through a math problem.	impact
3	Paper of three read strategy and objectives to give to scholars while reading a mathematical word problem.	Observe scholars using the three read strategy	What strategies are effective for teaching scholars how to read a mathematical word problem? Why is making sense of a problem and perseverance in solving them an important indicator of mathematical proficiency?	Video/transcript of scholars working through a math problem. Responses to word problem	Process/Impact
4	Paper of KWC strategy to give to scholars while reading a	Observe scholars using the KWC strategy	What strategies are effective for teaching scholars how	Video/transcript of scholars working through a math problem.	Process/Impact

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	mathematical word problem.		to read a mathematical word problem? Why is making sense of a problem and perseverance in solving them an important indicator of mathematical proficiency?	Responses to word problem	
5	Paper of feedback rubric or paper to use while giving and receiving feedback	Observe scholars giving and receiving feedback.	Can scholars provide feedback to peers effectively?	Video/transcript of scholars working through a math problem. Responses to feedback	Process/Impact
6	Debrief of comprehension	Observe Scholars debrief comprehension	What strategies are effective for teaching scholars how to read a mathematical word problem? Why is making sense of a problem and perseverance in solving them an important indicator of mathematical proficiency?	Video/transcript of scholars working through a math problem. Responses to word problem/discussion.	Impact

Intervention Design

The overall intervention was designed to observe and record data from thirty-one students in one 6th grade mathematics classroom over the course of ten weeks. This intervention took approximately ten weeks and observed student's ability to comprehend a mathematical word problem. The intervention specifically looked at student's accuracy, completion, conceptual understanding, and visual representations used to solve the word problems. Students were provided with word problems taken directly from the California's Smarter Balanced practice test. In this way, the word problems were directly aligned with common core state standards, as well as, provided rigorous problems for students to practice the intervention skills learned.

To begin the intervention, I conducted a pre-intervention survey to obtain their reflections on word problems and gain understanding of accuracy, completion, conceptual understanding, and visual representations used. In this survey, students expressed that what they found most challenging about word problems were understanding what the question was asking (38% of students) and getting the correct answer (30% of students). These two data points, reaffirmed my belief of implementing this intervention to better support word problem comprehension was important, but also encouraged me to think about how to help students check their answer and check if their answer made sense. In addition to the pre-intervention survey, students were also provided with a pre-intervention test. In this test, students were provided three word problems to solve, I took notes on accuracy, completion, conceptual understanding, and visual representations used to solve the word problems.

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Following the pre-intervention survey and test, students met with me once a week for nine weeks and were taught the three reads strategy as well as the KWC strategy. Students were provided a hand out with one word problem and questions to answer about the problem. Each session took approximately thirty minutes and students would work in pairs to solve the word problems. In addition, I would randomly select a pair of students to record and observe while solving the word problem. I took notes on their process of solving the word problems as well as accuracy, completion, conceptual understanding, and visual representations used. The word problems, ranged from one-step to multi-step and included a variety of concepts learned in 6th grade.

Following the intervention, students took a post-intervention test as well as post-intervention survey. In this way, students could reflect on the intervention experience and I could compare and contrast student responses to the beginning of the pre-intervention test and survey. Specifically looking at accuracy, completion, conceptual understanding, and visual representations used.

Research Methods

The intervention was implemented to one or of my three 6th grade cohorts. I decided to collect specific data on my homeroom class, because students in this class varied in ability, reading level, and gender. Within my homeroom, there were fifteen girls and sixteen boys. There were four students with individualized education programs (IEPs), five students were new to the school, and eleven students were classified as English language learners.

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For this action research project, I collected a variety of impact and process data sources. The impact data was used to assess the effectiveness of my teaching and the process data was used to make appropriate changes to the intervention design and to learn more about what supports student's word problem comprehension.

Impact Data

The impact data I collected were from student surveys, observations and transcripts of student discussions, student work, and student tests. The pre-intervention survey I conducted, provided me with an understanding of student accuracy, completion, conceptual understanding, and visual representations used. In addition, it provided me with student feelings around word problems and what they found most challenging. I administered a similar post-intervention survey to analyze any shift in responses or thinking.

Similarly, I conducted a pre-intervention test, that consisted of three word problems to help me understand student accuracy, completion, conceptual understanding, and strategies used. I administered a similar post-intervention test to analyze and shift in responses or thinking. Again, my focus was to understand student accuracy, completion, conceptual understanding, and visual representations used and if there were any shifts in responses or thinking.

For each word problem, I randomly selected a pair of students to record and transcribe their interactions and discussions. I typed what the students said word-for-word, and later looked at their student work to analyze what they were saying to what they had written on the paper. I also analyzed student work for closer review. I had

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provided prompts for students to answer while solving the word problems and I analyzed student accuracy, completion, conceptual understanding, and visual representations used on these word problems.

Process Data

Throughout the intervention I used a researcher's journal where I recorded reflections, thoughts, and brainstormed next steps. In this journal, I recorded any thoughts, trends, what I was observing that was working, needed improvement, or was ineffective. This journal provided me the opportunity to make appropriate adjustments and improvements to my intervention. This tool, allowed me to stay focused on my intervention and keep separate from the day-to-day challenges I was faced with in my classroom that may or may not be related to my intervention.

In addition, I used most of my impact data to help with process data. The impact data, allowed me to analyze and come up with next steps and improve student's comprehension of word problems. The student work, discussions, and surveys better informed my understanding of how students were approaching and feeling about word problems. This supported my next steps and how I was going to plan for future lessons.

Data Analysis Methods

All student work and discussions were transcribed and transferred to a spreadsheet for analysis. In addition, the pre-intervention test and survey as well as the post-intervention test and survey were also included. I coded each data with a letter

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code that was connected to my overarching research questions. Additionally, I sorted the data by session and tracked their changes over time.

Data Analysis and Findings

In analyzing the findings, I sought to understand what impact literacy comprehension strategies had on student's ability to answer and comprehend mathematical word problems (Hyde, 2006). Did students become more knowledgeable and reflective on their ability to comprehend a mathematical word problem. In the pre-intervention survey, students explained that the most challenging part about a word problem was being able to understand what the problem was asking and obtaining the correct answer. Through the intervention, I realized that students were used to reading a word problem once and attempt to solve immediately after. The intervention provided students with strategies on doing a close read of the word problem and really spending time unpacking the word problem to better comprehend and be able to solve a mathematical word problem (Fisher, 2016). It was apparent at the beginning of the intervention, that students had not spent a lot of time doing close reads and unpacking word problems to help them comprehend and solve. Through the intervention and implementation of the literacy comprehension strategies, the evidenced showed that the intervention improved student's ability to comprehend and solve mathematical word problems accurately.

The impact data suggested that students internalized the idea of doing a three reads strategy combined with KWC strategy better supported them in being able to comprehend and solve a mathematical word problem. These strategies increased

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student's self-confidence when faced with mathematical word problems. The process data suggested that implementing a three reads strategy coupled with a KWC strategy increased student's ability to comprehend and solve mathematical word problems accurately. The findings in this action research suggests the importance of comprehending mathematical word problems and student's ability to successfully solve mathematical word problems.

Three Reads and KWC Strategies and its Impact on Word Problem Accuracy

At the beginning of the intervention, students were asked to self-reflect on what they found most challenging about word problems. 38% of students claimed, "understanding what the problem is asking," and 30% of students claimed, "getting the correct answer." These two challenges students expressed about word problems, directly aligns with research that claims students who have difficulty with mathematical reading comprehension, results in students unable to reach a correct solution (Ozcan, 2017). These two challenges are consistently discussed in literature, therefore, I wanted to analyze if the three reads strategy combined with the KWC strategy had an impact on word problem accuracy.

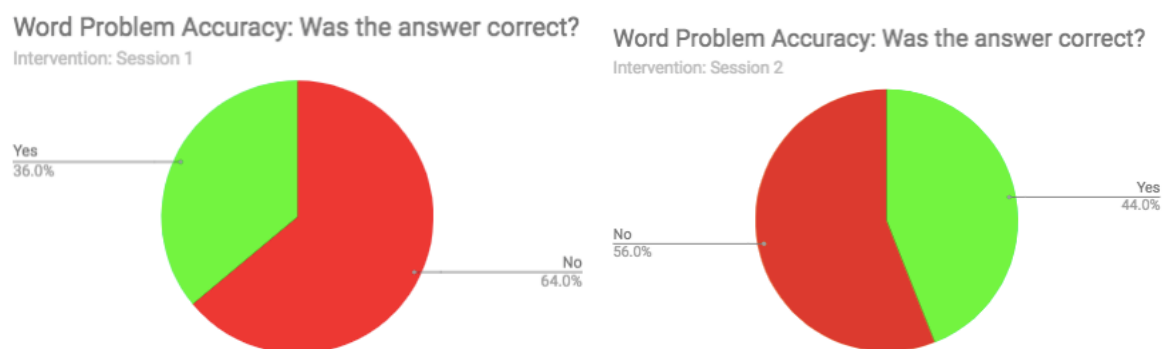
I chose to analyze accuracy over time to determine if there had been any changes with students getting the correct answer. I looked at the first two sessions, two middle sessions, and two last sessions. I compared the percentage of students who obtained the correct answer and looked to see if the percentage of correct answers had changed over time. In sessions one and two, 36% and 44% of students correctly answered the word problem respectively. In sessions four and six, 57% and 70% of

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students correctly answered the word problem respectively. In sessions eight and nine, 89.7% and 96.2% of students correctly answered the word problem respectively. The increase in student's accuracy over the course of the intervention did suggest that student's word problem accuracy had improved over time. This data observation suggested that students mathematical reading comprehension had also improved, because research suggests that reading comprehension and ability to obtain the correct answer go hand in hand (Fogelberg, 2008).

In the post-intervention discussion, students claimed that they felt more confident in comprehending word problems as well as felt more confident in their final answer. One student explained that the strategies, "helped me understand the problem better," and another student explained, "working with a partner was helpful because we could work together to get the right answer."

Beginning Sessions

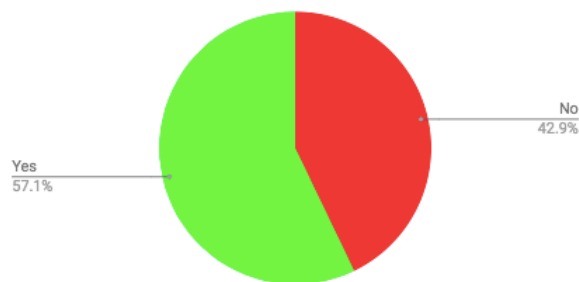


Middle Sessions

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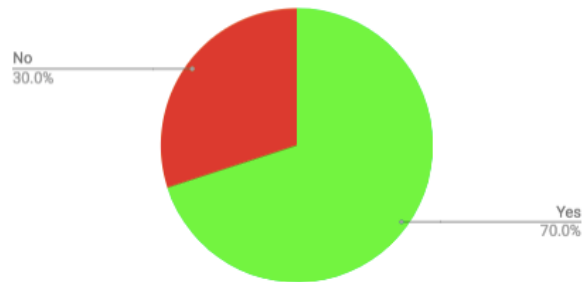
Word Problem Accuracy: Was the answer correct?

Intervention: Session 4



Word Problem Accuracy: Was the answer correct?

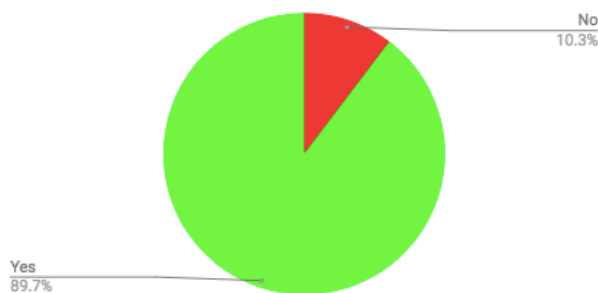
Intervention: Session 6



Last Sessions

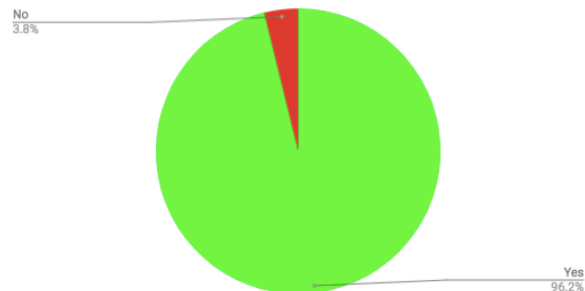
Word Problem Accuracy: Was the answer correct?

Intervention: Session 8



Word Problem Accuracy: Was the answer correct?

Intervention: Session 9



Three Reads and KWC Strategies and its Impact on Completion

One observation prior to the intervention was that some students were opting out of completing some word problems. When I inquired, and asked students many explained, "I didn't understand the problem," or "it was too hard and I didn't know where to start." I wanted to look at the data around completion to see if the percentage of students to complete and attempt the problems had changed over time. I chose to analyze completion over time to determine if there had been any changes with students completing and attempting the word problem. I looked at the first two sessions, two middle sessions, and two last sessions. I compared the percentage of students who

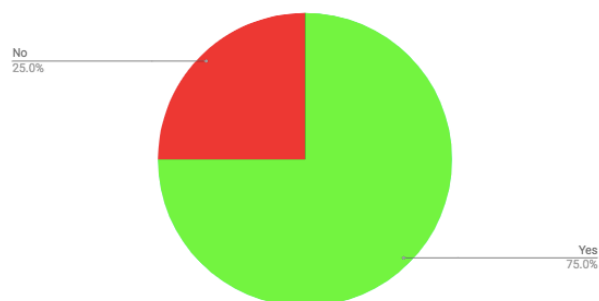
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completed the word problem and looked to see if the percentage of completion had changed over time.

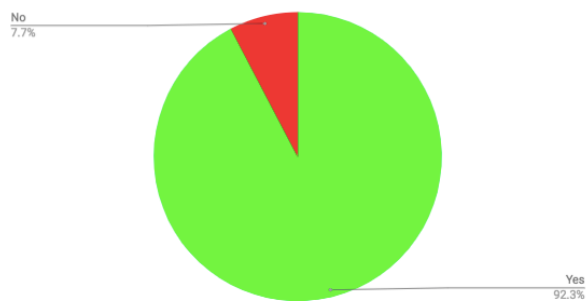
In sessions one and two, 75% and 92.3 % of students had completed their work and word problem respectively. In sessions four and six, 89.3% and 96.7% of students had completed their work and word problem respectively. In sessions eight and nine, 93.1% and 96.3% of students had completed their work and word problem respectively. The percentage of completion had improved over time of the intervention, and I attributed this shift in student's completion to understanding the word problem and feeling confident in attempting to solve and working through it with a partner.

Beginning Sessions

Word Problem Completion: Did students complete the problem?
Intervention: Session 1



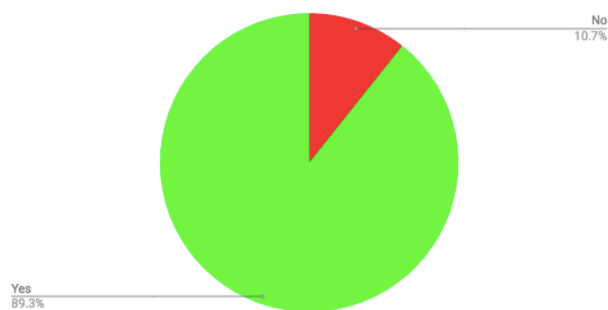
Word Problem Completion: Did students complete the problem?
Intervention: Session 2



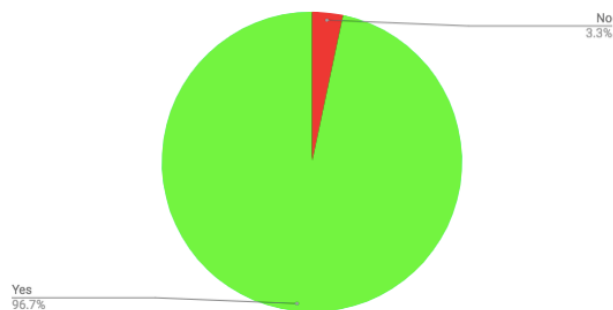
Middle Sessions

Mathematical Word Problem Comprehension

Word Problem Completion: Did students complete the problem?
Intervention: Session 4

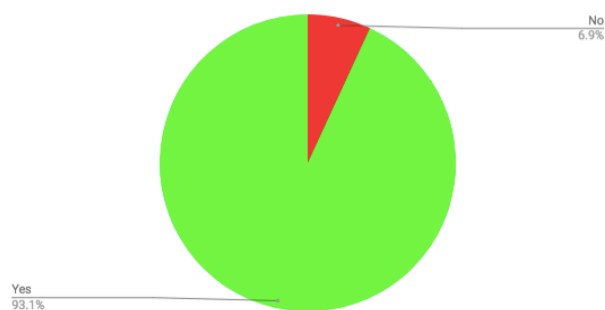


Word Problem Completion: Did students complete the problem?
Intervention: Session 6

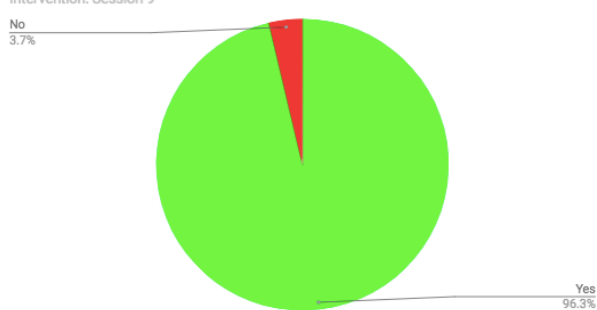


Last Sessions

Word Problem Completion: Did students complete the problem?
Intervention: Session



Word Problem Completion: Did students complete the problem?
Intervention: Session 9



Three Reads and KWC Strategies and its Impact on Identifying the Concept

Identifying the concept in a word problem can be challenging for students. This is important when solving a word problem because it helps lead students to strategies to use or attempt in order to solve the problem. According to research, in order to develop and deepen students' mathematical understanding, it is necessary to identify and support their conceptual development and underlying academic language in mathematics (Shockey 2015). I chose to analyze concept identification over time to determine if there had been any changes with students being able to identify the

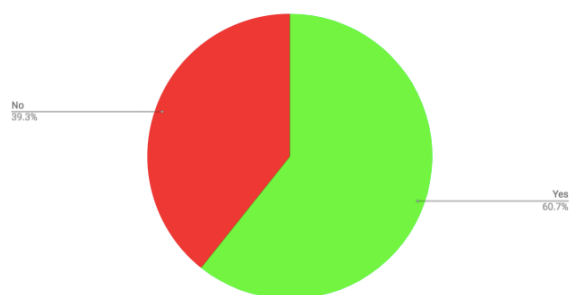
Mathematical Word Problem Comprehension

concept in the word problem. I looked at the first two sessions, two middle sessions, and two last sessions. I compared the percentage of students who identified the concept and looked to see if the percentage of concept identification had changed over time.

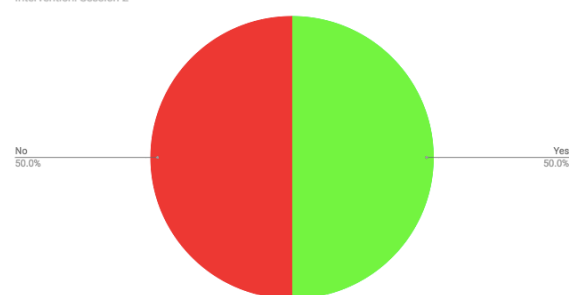
In sessions one and two, 60.7% and 50% of students were able to identify the concept respectively. In sessions four and six, 75% and 63.3% of students were able to identify the concept respectively. In sessions eight and nine, 79.3% and 92.3% of students were able to identify the concept respectively. The percentage of students being able to identify the concept in the word problem had improved over time. I attributed this shift in student's ability to identify the concept to understanding the word problem and really thinking about what is the problem asking of students and what concept is involved.

Beginning Sessions

Word Problem Conceptual Understanding: Did students identify the concept?
Intervention: Session 1



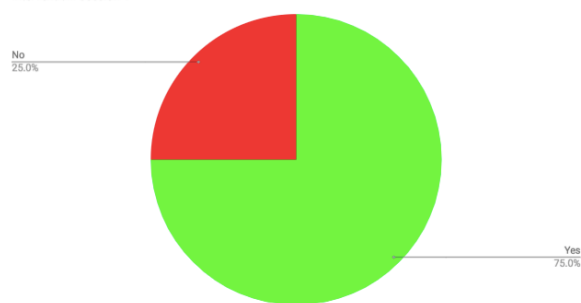
Word Problem Conceptual Understanding: Did students identify the concept?
Intervention: Session 2



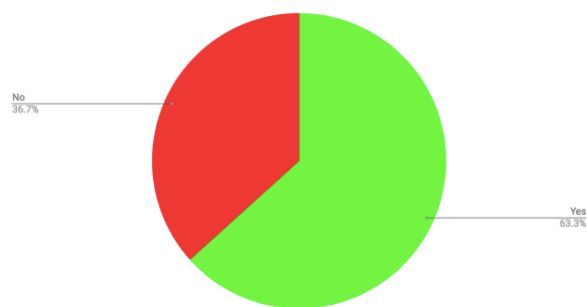
Middle Sessions

Mathematical Word Problem Comprehension

Word Problem Conceptual Understanding: Did students identify the concept?
Intervention: Session 4

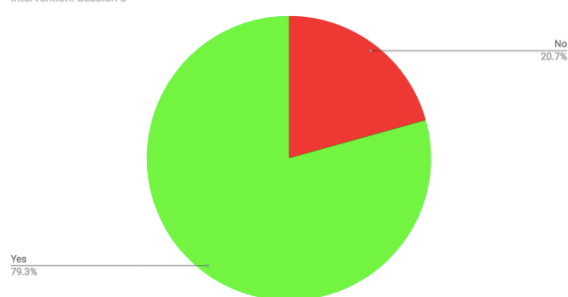


Word Problem Conceptual Understanding: Did students identify the concept?
Intervention: Session 6

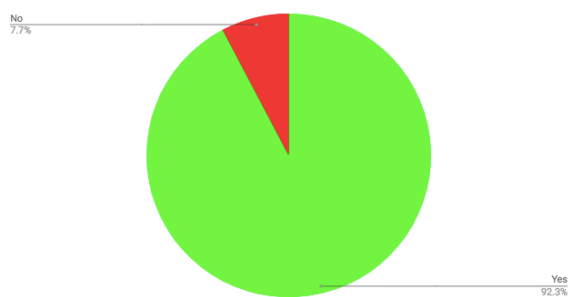


Last Sessions

Word Problem Conceptual Understanding: Did students identify the concept?
Intervention: Session 8



Word Problem Conceptual Understanding: Did students identify the concept?
Intervention: Session 9



Three Reads and KWC Strategies and its Impact on Visual Representations

Research suggest that effective problem solvers were able to translate a word problem into visual representations and use visual representations as a strategy to solve a mathematical word problem (Goldin, 2002). Visual representations help students make sense of problems and allow students the ability to explain the problem and communicate their thinking to others (NTCM, 2000). I chose to analyze visual representation over time to determine if there had been any changes with students being able to apply visually representations to the word problems. I looked at the first two sessions, two middle sessions, and two last sessions. I compared the percentage of

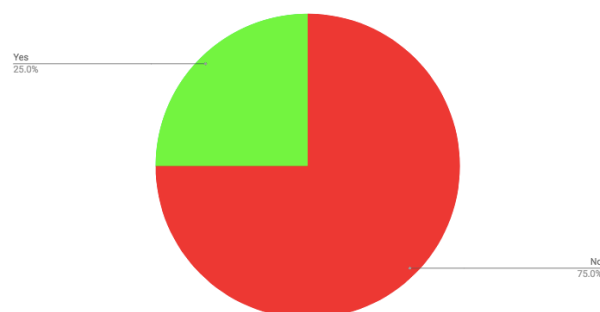
Mathematical Word Problem Comprehension

students who used a visual representation and looked to see if the percentage of visual representation had changed over time.

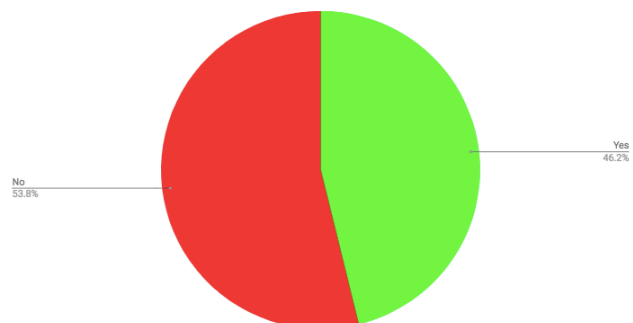
In sessions one and two, 25% and 46.2% of students used visual representations to help solve the word problem respectively. In sessions four and six, 67.9% and 86.7% of students used visual representations to help solve the word problem respectively. In sessions eight and nine, 96.6% and 95.8% of students used visual representations to help solve the word problem respectively. There had been a change over time in percentage of students using visual representations as a strategy to solve the word problems. When I asked students why they were using visual representations students explained, “it helps us solve the problem,” and “it (the problem) makes more sense” and “we can check our work with other groups.” I attributed the change in percentage to students feeling more confident in what the word problem was asking and being able to comprehend the word problem.

Beginning Sessions

Visual Representation: Did students use a visual representation to solve the problem?
Intervention: Session 1



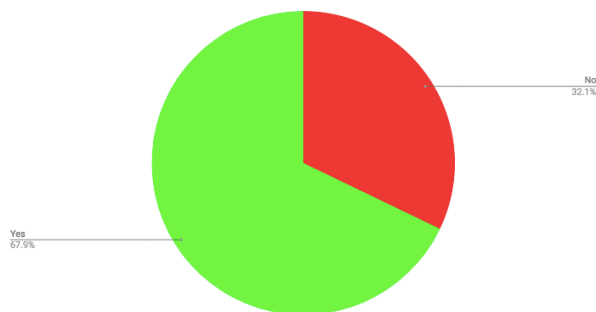
Visual Representation: Did students use a visual representation to solve the problem?
Intervention: Session 2



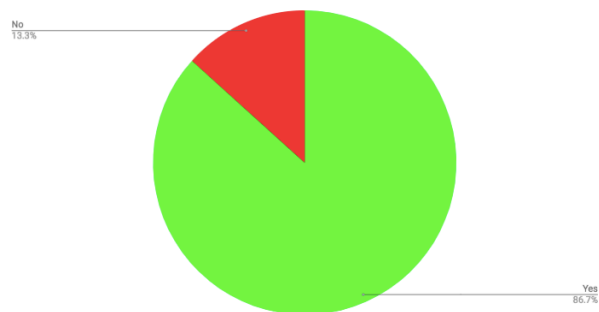
Middle Sessions

Mathematical Word Problem Comprehension

Visual Representation: Did students use a visual representation to solve the problem?
Intervention: Session 4

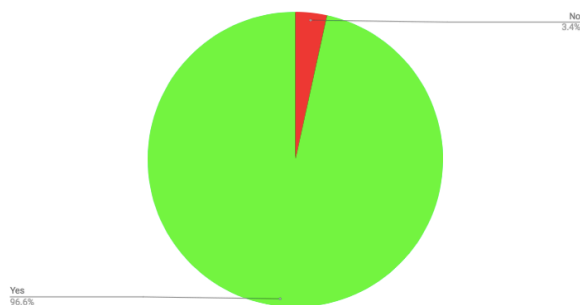


Visual Representation: Did students use a visual representation to solve the problem?
Intervention: Session 5

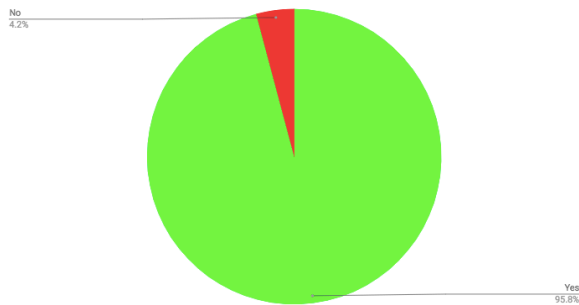


Last Sessions

Visual Representation: Did students use a visual representation to solve the problem?
Intervention: Session 8



Visual Representation: Did students use a visual representation to solve the problem?
Intervention: Session 9



Implementation of Action Research

To assess the effectiveness of the action research I used my observations from my research journal, student recordings, student work samples, and student pre- and post-intervention surveys. I was able to pick up on changes that happened for students over time based on their conversations and work samples. At the beginning of the intervention, students were most concerned about understanding what the problem was asking and getting the correct answer. I wanted to learn more by recording students

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while solving word problems and learning how they were working together and what they were doing while solving the word problems.

In the first session, the pair of students that I was observing and recording were using some strategies, but were not explicitly following along with the steps of the KWC or three reads strategies. I observed students reading the problem once, finding specific numbers and information they found important, and then jumping into trying to solve the problem. I observed students not asking each other questions or working together. It was very clear that there was one person in charge and leading the conversation, while the other person would follow along. I heard statements, from the leader of the pair like, “we need to divide 792 and 22 ,” but there was no explanation as to why or how they determined this step based on the word problem. In this pair, the partner would just say things like, “ok, sure.” There was not a discussion or dialogue happening between the partnerships or reasoning behind why they were doing what they were doing. In addition, there were long periods of time where this partnership would remain silent. I observed that this partnership was uncertain of what to do and was listening in on other student’s conversations. Instead of asking other groups or asking for help from the teacher, they would just sit there listening for an idea instead of engaging with the word problem and trying to find out what the question was asking. It became clear that students did not comprehend the word problem and were uncertain of what to do when they did not understand.

This first observation allowed me to modify and think about how can I be more explicit around the strategies and steps to take, as well as, how can I support more dialogue and teamwork within the partnerships. The following session, I did a direct

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model around working in a partnership and provided examples of questions students could ask their partner, such as:

- What strategy did you use?
- How did you get...?
- Why did you....?
- What key words helped you?
- How did you know what operation to use?
- Why do you disagree/agree with me?
- Can you explain how...?

I also, provided clear expectations and directions on reading every step of the worksheet I provided and did a direct model of the previous sessions word problem using the steps and worksheet to help solve. This way, students were provided with feedback on how to solve, what the correct answer was, and how to work in a partnership. I was prepared to take observation notes on how these behaviors changed in the following sessions.

In the following session of the intervention, I was recording and observing a partnership looking for changes in behaviors. I observed this partnership re-read the problem, find relevant numbers and information to help solve the problem. I observed students re-read the question the problem was asking. This was a slight improvement to the first session, where students read the word problem only once. I observed one of the students say, "I am doing to divide," but no explanation as to why there doing this operation. However, I did observe students explain to each other the arithmetic process of dividing. For example, students would explain, "I am bringing down 1450 and then

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subtracting five from 1700, what did you get?" There was limited dialogue and it was mostly around arithmetic process. This was a slight improvement from the first session, where students really struggled with articulating their thoughts, but it was still not engaging in the word problem or using evidence from the word problem. In this session, I would hear statements like, "I got 24, maybe subtract, maybe try that?" I observed students attempt and try many strategies, I observed students trying multiple attempts to solve the problem. This made me realize that students were uncertain of their answers, and were going back to see if another answer made more sense. The students were persistent and attempted different strategies, but were uncertain. I also observed students get frustrated and could physically see and hear them exhaling. During moments like these I observed students asking their neighbors, "what did you get?" The neighbors would respond, "I got 24," but would not provide an explanation as to how, nor would the student ask, "how did you get that?" The student would look at their answer and then talk to their partner and say, "we got that here, is that right?" Other neighbors would say, "I just guessed, I didn't know what to do either." Hearing these conversations, I realized that students were attempting to engage in more conversations with partners and neighbors, but were still struggling to truly comprehend the word problem.

This session allowed me to think about ways to explicitly show students how to engage with the word problem and look to the word problem for evidence. In the following session, I provided a direct model around picking up on key words, doing a deep dive of the word problem with the KWC and three reads strategy and using evidence from the word problem to explain to a partner why I was choosing a specific

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operation. I explained, that sometimes there might be a few operations to use and I encouraged students to write down all possible operations they thought this problem might use based on evidence from the problem or key words. In the following sessions, I encouraged students to try to explain to a partner why they were doing specific operations and to really use evidence from the word problem.

In session six of the intervention, I observed students re-reading the problem multiple times. I observed students finding appropriate numbers and information from the problem and following the KWC and three reads strategy much more closely. I observed students annotate the word problem, by underlining the question, key words, and key numbers. I observed students going back to the word problem and use evidence or phrases directly from the word problem to justify an operation. For example, a student would say to a partner, “we have to divide, because it says in the problem, “for every batch,” which means division, for every is a key word for ratio or division.” The partner would say, “you are right, I remember learning that, let’s try that.” I continued to observe students discuss the arithmetic process and ask their partner things like, “did you get the same answer as me?” I also observed students asking their partners more questions about how to do an operation like, “how do you divide fractions again? Can you show me?” or “do you flip the dividend or divisor?” or “how did you draw a tape diagram for this? Can you explain it to me?” I was noticing students were participating more in conversation and engaging more with the word problem. I was able to observe students being able to understand and comprehend the word problem more, by noticing more students being able to use a visual representation to help solve the word problem. As research stated, visual representations help students make sense of problems and

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allow students the ability to explain the problem and communicate their thinking to others (NTCM, 2000). This was evident in this session and made it more clear to me that students were in fact comprehending the word problems.

Based on this session, I decided to share with students what I was observing and noticing. I wanted to engage in a discussion with students on how they were feeling and what they were noticing. When I asked them, how are the KWC and three reads strategy supporting their comprehension, some students explained, “reading the problem three or more times helps me think about what the problem is asking.” Other students explained, “I like working with a partner, it helps me understand the problem better,” and “it made me realize that once I understand the word problem I know what to do to solve it.” It became clear that students were seeing the benefits of the strategies and how important it is to comprehend a word problem before jumping in and trying to solve it. I continued to encourage students to really try and explain their thinking to their partner by using evidence from the word problem.

In the eighth session, I observed students rereading the problem and finding relevant information to use to help solve the problem. Students were annotating the problem and working with a partner to go through the strategies more thoroughly. There was much more dialogue around the strategies and students felt more confident with the strategies without having to read the steps. I heard students say to each other, “let’s read it again,” and after the second read I would hear the other partner say, “now we have to read a third time,” after the third time, I heard the first partner explain, “I still do not understand, can we read it one more time?” After this partnership read this problem a fourth time they asked each other, “what is the problem about?” I observed this

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partnership going back and forth coming up with a sentence that they both created together. I observed this partnership wait for each other and make sure their papers were similar and observed them both participating equally. I observed this partnership going through all of the steps together and taking turns as well as having a dialogue with one another. I was impressed by the level of support and questions students were engaging in. I observed students really engaging in dialogue and relying on each other for support. For example, students said, "I have a question, how are we going to represent this problem using a diagram, do you have any ideas? What are your ideas?" their partner responded, "I think we should draw a tape diagram," and the dialogue went back and forth between this partnership around how to label and what goes in each unit. I was really impressed by the partnership and support these students were providing to one another. They were asking each other's opinion throughout their conversation and explaining their thoughts and process throughout the entire conversation. At the end this partnership explained, "let's write an answer statement to show our final answer," and they went back forth discussing how to write their answer statement.

It was clear to me at this point that students were really invested in the strategies and understood the steps on how to approach a word problem. Students were able to comprehend the word problem and engage in conversations with their partners and provide ideas on how to solve the problem. Taking observations from beginning to end I was able to see that these two strategies had had an impact on student's ability to comprehend a word problem and engage in meaningful discussions with their partners. I was able to see student's change in their confidence when faced with a word problem

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and their confidence in being able to solve the word problem. At the end of intervention students were explaining their desire to continue to use these strategies in the future, which suggested that students in fact found these strategies helpful and beneficial to their learning.

Implications and Conclusion

The results of this action research and intervention suggest promising results on literacy strategies, specifically, the three reads combined with the KWC being an effective tool to support student's comprehension of mathematical word problems. While it is challenging to correlate one factor to another, this intervention has proven to positively impact student's ability to comprehend a mathematical word problem. Through this intervention, students developed a deeper and more thorough understanding of mathematical word problem comprehension and how to solve them. In addition, through the partner work and partner practice, students were able to practice explaining their thinking and check their work with a peer and develop their mathematical practices. This intervention gave confidence in students and their ability to comprehend a word problem, as well as, provide tools to use when approaching a word problem. Students developed a deeper understanding of the importance of comprehending a word problem and strategies to use when solving a word problem in the future.

I feel strongly that the work of this study has made the argument that literacy strategies, specifically the three reads combined with the KWC, can be used as a tool for comprehending mathematical word problems. My next steps are to conduct further

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research on how to support students to check their answers and explain their thinking. In addition, I would like to implement this strategy for the entirety of the school year in all of my 6th grade cohorts and analyze the data over time, specifically involving word problem comprehension. I also have to consider that this strategy requires a deep dive of one word problem, which can take a lot of time. Therefore, I have to consider how to balance implementing this intervention with fidelity, but also maximize learning time for students.

It was evident that implementing reading comprehension strategies, specifically the three reads combined with the KWC strategy, supported student's ability to comprehend a mathematical word problem. The literacy strategies implemented into the mathematics classroom increased student's accuracy, completion, conceptual understanding, and visual representations over time. Implementing literacy strategies takes careful planning and requires a lot of instructional minutes, but can pay off with positively impacting student learning and growth. Implementing literacy strategies into the mathematics classroom has the potential to have dramatic results on student performance if implemented with fidelity.

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Appendix

Appendix A: Pre-intervention Survey Questions

1. What is your name?

2. Do you feel word problems are challenging?

Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3. How confident do you feel when solving a word problem?

Not confident at all	Not confident	neutral	Confident	Very Confident
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4. What do you find hardest about word problems?

- | | |
|--|--|
| <input type="radio"/> Understanding what the problem is asking | <input type="radio"/> Writing Equations |
| <input type="radio"/> Choosing Correct Operations | <input type="radio"/> Getting the Correct Answer |
| <input type="radio"/> Mathematical vocabulary | |
| <input type="radio"/> Other (please specify) | |

5. What Strategies do you use when solving a word problem?
(check all that apply)

- | | |
|---|---|
| <input type="checkbox"/> Underline the question | <input type="checkbox"/> Draw a Visual Representation |
| <input type="checkbox"/> Annotate the Problem | <input type="checkbox"/> Check My Answer |
| <input type="checkbox"/> Box Key Words | <input type="checkbox"/> Work with a Partner |
| <input type="checkbox"/> Circle the Numbers | <input type="checkbox"/> 3-Read Protocol |
| <input type="checkbox"/> Create a Plan | <input type="checkbox"/> KWC Strategy |
| <input type="checkbox"/> Other (please specify) | |

6. What Strategies do you know about but do not use?

- | | |
|---|---|
| <input type="checkbox"/> Underline the Question | <input type="checkbox"/> Draw a Visual Representation |
| <input type="checkbox"/> Annotate the Problem | <input type="checkbox"/> Check My Answer |
| <input type="checkbox"/> Box Key Words | <input type="checkbox"/> Work with a Partner |
| <input type="checkbox"/> Circle the Numbers | <input type="checkbox"/> 3 Read Protocol |
| <input type="checkbox"/> Create a Plan | <input type="checkbox"/> KWC Strategy |
| <input type="checkbox"/> Other (please specify) | |

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Appendix B: Post-Intervention Survey Questions

1. What is your name?

2. Do you feel word problems are challenging?

Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3. How confident do you feel when solving a word problem?

Not confident at all	Not confident	neutral	Confident	Very Confident
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4. What do you find hardest about word problems?

- ☐ Understanding what the problem is asking
- ☐ Writing Equations
- ☐ Choosing Correct Operations
- ☐ Getting the Correct Answer
- ☐ Mathematical vocabulary
- ☐ Other (please specify)

5. The 3 Reads Protocol is helpful when solving a word problem

Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6. The KWC Strategy is helpful when solving a word problem

Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7. What Strategies do you use when solving a word problem?
(check all that apply)

- | | |
|---|---|
| <input type="checkbox"/> Underline the question | <input type="checkbox"/> Draw a Visual Representation |
| <input type="checkbox"/> Annotate the Problem | <input type="checkbox"/> Check My Answer |
| <input type="checkbox"/> Box Key Words | <input type="checkbox"/> Work with a Partner |
| <input type="checkbox"/> Circle the Numbers | <input type="checkbox"/> 3-Read Protocol |
| <input type="checkbox"/> Create a Plan | <input type="checkbox"/> KWC Strategy |
| <input type="checkbox"/> Other (please specify) | |

8. What Strategies do you know about but do not use?

- | | |
|---|---|
| <input type="checkbox"/> Underline the Question | <input type="checkbox"/> Draw a Visual Representation |
| <input type="checkbox"/> Annotate the Problem | <input type="checkbox"/> Check My Answer |
| <input type="checkbox"/> Box Key Words | <input type="checkbox"/> Work with a Partner |
| <input type="checkbox"/> Circle the Numbers | <input type="checkbox"/> 3 Read Protocol |
| <input type="checkbox"/> Create a Plan | <input type="checkbox"/> KWC Strategy |
| <input type="checkbox"/> Other (please specify) | |

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Appendix C: Pre-Intervention Test Questions

1. What is your name?

2. Louise puts 11.7 gallons of gas in her car for a total of \$27. What did the gasoline cost per gallon? Round your answer to the nearest cent.

- ☐ \$0.23
- ☐ \$0.24
- ☐ \$2.31
- ☐ \$2.39

3. Caleb bought raisins in bulk at \$2.50 per pound. He spent a total of \$5.75. How many pounds of raisins did he buy?

- ☐ 2.03 pounds
- ☐ 2.04 pounds
- ☐ 2.3 pounds
- ☐ 2.4 pounds

4. Ms. Arciniega is giving school supplies to her students. She has 20 pencils and 24 pens. She wants to use all of the writing instruments to make identical supplies. What is the greatest number of identical supplies Ms. Arciniega can make and have no writing instruments left over?

- ☐ 2
- ☐ 4
- ☐ 6
- ☐ 8

5. What Strategies did you use when solving the word problem? (check all that apply)

- | | |
|---|---|
| <input type="checkbox"/> Underline the question | <input type="checkbox"/> Draw a Visual Representation |
| <input type="checkbox"/> Annotate the Problem | <input type="checkbox"/> Check My Answer |
| <input type="checkbox"/> Box Key Words | <input type="checkbox"/> Work with a Partner |
| <input type="checkbox"/> Circle the Numbers | <input type="checkbox"/> 3-Read Protocol |
| <input type="checkbox"/> Create a Plan | <input type="checkbox"/> KWC Strategy |
| <input type="checkbox"/> Other (please specify) | |

6. What Strategies did you **NOT** use? (check all that apply)

- | | |
|---|---|
| <input type="checkbox"/> Underline the question | <input type="checkbox"/> Draw a Visual Representation |
| <input type="checkbox"/> Annotate the Problem | <input type="checkbox"/> Check My Answer |
| <input type="checkbox"/> Box Key Words | <input type="checkbox"/> Work with a Partner |
| <input type="checkbox"/> Circle the Numbers | <input type="checkbox"/> 3-Read Protocol |
| <input type="checkbox"/> Create a Plan | <input type="checkbox"/> KWC Strategy |
| <input type="checkbox"/> Other (please specify) | |

7. How confident did you feel when solving these word problem?

Not Confident At All	Not Confident	Neutral	Confident	Very Confident
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

8. What did you find hardest about these word problems?

- | | |
|--|--|
| <input type="radio"/> Understanding what the problem is asking | <input type="radio"/> Writing Equations |
| <input type="radio"/> Choosing Correct Operations | <input type="radio"/> Getting the Correct Answer |
| <input type="radio"/> Mathematical vocabulary | |

Appendix D: Word Problem Questions

1. Cynthia worked 22 days this month. Her paycheck this month totaled \$792. If Cynthia was paid the same amount for each day, exactly how much did Cynthia earn per day?

Step 1: Read the problem out loud to a peer. Try to answer this question.

What is the problem about?

Step 2: Read the problem again. Talk to your partner about these questions:

What is the question in the problem?

What are you looking for? (Hint: Look at the end of the problem for the question.)

Step 3: Read the problem a third time. Talk to your partner about these questions.

- a. What information do you need to solve the problem? (What do you want to know)
- b. What information do you have? (What do you know?)
- c. What information are you missing? (What don't you know?)
- d. Draw a diagram of the problem and label the information you know.

Step 4: solve the problem

Mathematical Word Problem Comprehension

2. Gilberto's paycheck totaled \$174.00. If he was paid \$7.25 per hour, how many total hours did he work?

Step 1: Read the problem out loud to a peer. Try to answer this question.

What is the problem about?

Step 2: Read the problem again. Talk to your partner about these questions:

What is the question in the problem?

What are you looking for? (Hint: Look at the end of the problem for the question.)

Step 3: Read the problem a third time. Talk to your partner about these questions.

a. What overarching math skill are you doing?

b. What information do you have? (What do you know?)

c. What information are you missing? (What don't you know?)

d. Draw a diagram of the problem and label the information you know.

Step 4: solve the problem

Mathematical Word Problem Comprehension

3. Michelle is making fruit baskets to give her neighbors. She has 12 oranges and 16 lemons. She wants to use all of the fruit to make identical baskets. What is the greatest number of identical baskets Michelle can make and have no fruit left over?

Step 1: Read the problem out loud to a peer. Try to answer this question.

What is the problem about?

Step 2: Read the problem again. Talk to your partner about these questions:

What is the question in the problem?

What are you looking for? (Hint: Look at the end of the problem for the question.)

Step 3: Read the problem a third time. Talk to your partner about these questions.

- a. What information do you need to solve the problem? (What do you want to know)
- b. What information do you have? (What do you know?)
- c. What information are you missing? (What don't you know?)
- d. Draw a diagram of the problem and label the information you know.

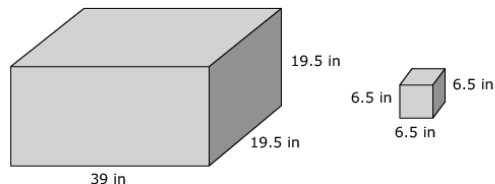
Step 4: solve the problem

Mathematical Word Problem Comprehension

4.

Cube-shaped boxes of tissue are shipped to stores in containers. The containers are rectangular prisms.

- The edges of each tissue box measure 6.5 inches.
- The dimensions of the shipping container are 19.5 inches by 39 inches by 19.5 inches.



What is the greatest number of tissue boxes that will fit into one shipping container?

Step 1: Read the problem out loud to a peer. Try to answer this question.

What is the problem about?

Step 2: Read the problem again. Talk to your partner about these questions:

What is the question in the problem?

What are you looking for? (Hint: Look at the end of the problem for the question.)

Step 3: Read the problem a third time. Talk to your partner about these questions.

e. What information do you need to solve the problem? (What do you want to know)

f. What information do you have? (What do you know?)

g. What information are you missing? (What don't you know?)

h. Draw a diagram of the problem and label the information you know.

Step 4: solve the problem

Mathematical Word Problem Comprehension

5. A factory makes 1,200 shirts every 6 hours. The factory makes shirts for 9 hours each workday.

What are the **fewest** number of workdays the factory will need to make 12,600 shirts.

Step 1: Read the problem out loud to a peer. Try to answer this question.

What is the problem about?

Step 2: Read the problem again. Talk to your partner about these questions:

What is the question in the problem?

What are you looking for? (Hint: Look at the end of the problem for the question.)

Step 3: Read the problem a third time. Talk to your partner about these questions.

- a. What information do you need to solve the problem? (What do you want to know)
- b. What information do you have? (What do you know?)
- c. What information are you missing? (What don't you know?)
- d. Draw a diagram of the problem and label the information you know.

Step 4: solve the problem

Mathematical Word Problem Comprehension

6. A recipe requires $\frac{1}{2}$ cup of flour for every batch of cookies. How many full batches of cookies can be made with $5\frac{1}{2}$ cups of flour?

Step 1: Read the problem out loud to a peer. Try to answer this question.

What is the problem about?

Step 2: Read the problem again. Talk to your partner about these questions:

What is the question in the problem?

What are you looking for? (Hint: Look at the end of the problem for the question.)

Step 3: Read the problem a third time. Talk to your partner about these questions.

e. What information do you need to solve the problem? (What do you want to know)

f. What information do you have? (What do you know?)

g. What information are you missing? (What don't you know?)

h. Draw a diagram of the problem and label the information you know.

Step 4: solve the problem

Mathematical Word Problem Comprehension

7. The table shows the relationship between the amounts of ginger ale and fruit juice needed to make punch.

Fill in the missing values to complete the table.

Ginger Ale (L)	Fruit Juice (oz)
	12
3	18
5	30
9	

Step 1: Read the problem out loud to a peer. Try to answer this question.

What is the problem about?

Step 2: Read the problem again. Talk to your partner about these questions:

What is the question in the problem?

What are you looking for? (Hint: Look at the end of the problem for the question.)

Step 3: Read the problem a third time. Talk to your partner about these questions.

- What information do you need to solve the problem? (What do you want to know)
- What information do you have? (What do you know?)
- What information are you missing? (What don't you know?)
- Draw a diagram of the problem and label the information you know.

Step 4: solve the problem

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Mathematical Word Problem Comprehension

8. Allison is saving to buy a \$500 bicycle by working during summer vacation.

- The job pays her \$8 for every 1 hour worked
- Allison works exactly 20 hours each week.

If she works for 4 weeks and buys the bicycle, how much money will she have left over?

Step 1: Read the problem out loud to a peer. Try to answer this question.

What is the problem about?

Step 2: Read the problem again. Talk to your partner about these questions:

What is the question in the problem?

What are you looking for? (Hint: Look at the end of the problem for the question.)

Step 3: Read the problem a third time. Talk to your partner about these questions.

- a. What information do you need to solve the problem? (What do you want to know)
- b. What information do you have? (What do you know?)
- c. What information are you missing? (What don't you know?)
- d. Draw a diagram of the problem and label the information you know.

Step 4: solve the problem

Mathematical Word Problem Comprehension

9. Sam and Alexa each build model cars. Altogether, Sam and Alexa have built 42 model cars. The ratio of cars Sam has built to the cars Alexa has built is represented by the tape diagram shown.

Sam

--	--	--

Alexa

--	--	--	--

How many cars are represented by each square in the tape diagram?

Step 1: Read the problem out loud to a peer. Try to answer this question.

What is the problem about?

Step 2: Read the problem again. Talk to your partner about these questions:

What is the question in the problem?

What are you looking for? (Hint: Look at the end of the problem for the question.)

Step 3: Read the problem a third time. Talk to your partner about these questions.

- a. What information do you need to solve the problem? (What do you want to know)
- b. What information do you have? (What do you know?)
- c. What information are you missing? (What don't you know?)
- d. Draw a diagram of the problem and label the information you know.

Step 4: solve the problem

Mathematical Word Problem Comprehension

Appendix E: Codes CATEGORIES

CATEGORIES	QUESTIONS	POSSIBLE CODES
SURVEY QUESTIONS (BASELINE AND POST)	<ul style="list-style-type: none"> • Do you feel word problems are challenging? • How confident do you feel when solving a word problem? • What do you find hardest about word problems? • What strategies do you use when solving a word problem? • What strategies do you know about but do not use? 	<ul style="list-style-type: none"> • MQ – Mindset Questions • MQ- Mindset Questions • CK – Content Knowledge • CK – Content Knowledge • CK – Content Knowledge
PRE AND POST TEST (BASELINE AND POST)	<ul style="list-style-type: none"> • Rates – Can students solve a single step word problem about rates? • Greatest Common Factor • Content Knowledge • Mindset 	<ul style="list-style-type: none"> • SSWP – Single Step Word Problems • MSWP – Multiple Step Word Problem • CK – Content Knowledge • MQ – Mindset
STUDENT WORK SAMPLES	<ul style="list-style-type: none"> • What are students doing when the solve a word problem? • What strategies do student do when working on a word problem? • Are they checking their work? • Are they reasoning and explaining their thinking? • Are they preserving and continuing to try new strategies to solve? Erase and resolve • Are students confident when solving word problems? • Are students using 3 reading strategies? • Are students using KWC Strategy? • What did students learn from the strategies 	<ul style="list-style-type: none"> • WSD – What students do • SSD- Strategies students do(Code individual strategies) • CW- checking work • RE- reasoning and explaining • PS- persevering solving • ES-Erase and solve again • MQ- Mindset Questions • IS- intervention strategy • IS- intervention strategy • ST-Student takeaways
AUDIO OBSERVATION OF PARTNER WORK	<ul style="list-style-type: none"> • What are students doing when the solve a word problem? • What are students saying to each other when working on a word problem? • What strategies do student do when working on a word problem? • Are they checking their work? • Are they reasoning and explaining their thinking? • Are they preserving and continuing to try new strategies to solve? • Are students confident when solving word problems? • Are students using 3 reading strategies? • Are students using KWC Strategy? • What did students learn from the strategies 	<ul style="list-style-type: none"> • WSD – What students do • WSS – What students say • SSD- Strategies students do • CW- checking work • RE- reasoning and explaining • PS- persevering solving • MQ- Mindset Questions • IS- intervention strategy • IS- intervention strategy • ST-Student takeaways