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Action Research TE 861C

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# Read Three: Comprehending Reading in Mathematics

*"The students know how to do the math, they just don't understand what the question is asking."*

In the five years that I have been teaching at my school I have been teaching the sixth grade "high fliers": that is, the honors students, and I have said some version of this quote a hundred times. These students were placed in sixth grade honors math because of their fifth grade End of Grade exam (EOG). On that EOG they placed in the top twenty percentile in mathematics and in the top ten percentile for reading, for the state of North Carolina. My school is a magnet school whereby students from fifty-two area elementary schools are eligible to attend via lottery. Most students were the top students at their respective elementary schools and unfortunately have not had to work very hard to be the top math students. They believe that math is easy and can be done quickly.

In my math class I have always focused on the story problem. In real-life, no one stops you on the street and asks, "Quick, is 654,321 divisible by three?" Nor do they ask you, "What is the absolute value of these 25 numbers?" My focus on the math problems with real world context and the level of effort that my students now have to put into math problems is a rude awakening for many of them. For the first time in their lives, they are getting these problems wrong.

They are getting the problems wrong not because they are not capable of doing the math or because they are not strong readers. They are getting them wrong because they do not know how to read the math problem. They do not know how to attack the problem. In the past, in an attempt to address this problem, I have tried to fool them as my strategy. I have given my "Stanley Test". This is an adaptation of the problem where I give the students a set of directions. The first step tells the students to read all of the directions completely before starting any work.

They very last direction informs the student that it was all a trick and that he or she should not do any work at all. Since students do not read carefully, they miss the trick and end up doing work that they did not have to do. In my version of the test, I have them do a few silly math problems then draw a cow and name him "Stanley" before the last step reveals that they should have read the directions all the way through. I post some of the better drawings of "Stanley" around my room as a reminder to slow down and read. This method draws some attention to the problem but it obviously is not the total solution.

I have also used the S.O.L.V.E (Appendix A) method to address the reading problem. The S.O.L.V.E method has my students: Study, Organize, List each step, Verify, and Examine. Each step has two to three sub-steps. The challenge with this method, however, is that despite its raising my students' scores, it takes too long. My students end up taking about 15 minutes per problem using the S.O.L.V.E. method. Additionally, the students have stated some dissatisfaction with being made to solve the problem a set way, not giving them freedom to use their own strategies.

In my years as a teacher I have fielded questions from students where it was clear to me that they never fully read the problem. At the start of last year I assigned one of my favorite problems, the locker problem. This problem describes 1000 students opening and closing 1000 lockers that are multiples of their number in line (person three opens or closes lockers 3,6,9, and so on). This year, I put the students in pairs and gave little direction except: "read the problem and answer the question." I was extremely disappointed with the results. The problem only explains what the first four students do and then asks: "what lockers are left open after <u>all</u> the students have gone by". Most of my students only solved the problem for the first four students, showing me that they did not read.

If I had a nickel for every time one of my students told me that they do not understand the problem I would not need to teach anymore. When I ask what part of the problem they do not understand they claim: "all of it." The students seem to know there are words on the page, but they have no idea what those words mean or where to start. I understand that math has its own language, and students can get lost in the double meaning of the words. I do not believe that not understanding the words is the case with my students. My students all read at an advanced level and are very familiar with words that have multiple meanings. If my students were more familiar with the structure of the story problem, they would understand more.

I believe that if I get my students to slow down, they will actually think about the math they are doing and notice the mistakes that they are making and be able to correct them. It never fails that four of the first five papers turned in will have some silly mistake. I have never heard it said but my students act like there is some prize for being the first one to finish. I guess there is a prize: a few regrettable mistakes. In the past, in an attempt to slow my students down and reflect, I have required that all work be written in complete sentences, but this only works if they actually take the time to read the sentences that they write.

I have a few sayings in an attempt to highlight this issue: If your answer does not make sense, it is wrong. Check your units, a 200 meter door is a little too tall, could it be 200 of something else? Remember Stanley. Even with all of these sage words, I still have students answering a problem that asks: "What percent was the discount?" with an answer like, $1.50. I want a way to reinforce ". . . the idea that a piece of mathematics text needs to make sense (and that it can make sense) is exceedingly important." (Metsisto, 2005).

Throughout the 2013- 2014 school year I plan on exploring the issues stated above. Through this study I will explore the research question "What happens to my students' academic performance when I incorporate reading strategy *Read Three*?

## Research

I understand what the research says about the difficulty students have in comprehending mathematics text. First, the format of a math problem is difficult. The "main ideas in mathematics and science texts do not necessarily appear in the expected places. In language arts, students have learned that an author's main idea typically appears in a passage's introduction or a paragraph's first sentence. In mathematics, however, the main idea may not appear at the beginning of a word problem but at the end." (Barton, 2002) Second, "mathematics vocabulary can be especially deceptive because many key mathematics terms are used in more common ways in general conversation." (Buehl, 2011) Finally, the style of the text book is unlike other subjects' text books that are heavy with extended prose.

> The math text book is "written in a very compact style; each sentence contains a lot of information, with little redundancy. The text can contain words as well as numeric and non-numeric symbols to decode. In addition, a page may be laid out in such a way that the eye must travel in a different pattern than the traditional left-to-right one of most reading. There may also be graphics that must be understood for the text to make sense; these may sometimes include information that is intended to add to the comprehension of a problem but instead may be distracting. Finally, many texts are written above the grade level for which they are intended." (Metsisto, 2005)

The struggles in comprehending math text books have been well documented, and much research has been done to try to solve these problems. I have found that there are three main methods to attack the lack of comprehension of mathematical text: 1.) have the students read with a purpose, 2.) teach them to focus on their reading, and 3.) have them write about what they have read.

First, reading with a purpose has been well documented. "Students must understand why they should read the information and the degree to which they will be held accountable for knowing it." (Brunner, 2010) The purpose of reading can take many forms. In Renee Goularte's action research, she found positive results when asking her students to create drawings of equations. "Primary students solve … story problems using drawings, equations, and written responses, helping them understand the links between the language of story problems and the numerical representations." (Goularte, 2003)

In the 2012 article *Improving Reading Improving Math* Arthur Glenberg had success with having his research subjects "literally manipulat[ing] pictures on a computer screen to simulate sentence content; next, for additional texts the children imagined the manipulation of the pictures." (Glenberg, 2012) This simple use of props saw an improvement - "a 35% reduction in the use of irrelevant numerical information in solution attempts" (Glenberg, 2012)

Finally, "give students a specific purpose for reading the assignment. It will not be enough to say, 'Read this so that we can discuss it later.' Be more specific. Give them a list of questions to guide their reading. This will not only increase their comprehension of the text related to those specific questions but will also help students answer other questions as well". (Brunner, 2010)

In terms of focus, the style and format of mathematical text demands that the reader need to have a different process while reading the text. "Clearly, readers must read mathematical sentences differently and more intensely than they read sentences, and indeed paragraphs, in most other disciplines. For a majority of readers, one trip through [a math text] will not result in satisfactory comprehension." (Buehl, 2011) In Shanahan and Shanahan's 2008 article in the Harvard Educational Review they reference that rereading is crucial to understand math text.

"Students often attempt to read mathematical texts for the gist. . . but this kind of text cannot be appropriately understood without close reading" (Shanahan, 2008).

Throughout the research I found that having students write is a way to have them reinforce recently acquired information and is a way to promote a deep comprehension of the story problem. This could be as simple as having them explain why they think their answers are correct. Buehl argues in Developing Readers in the Academic Disciplines that "explaining why is an essential component of comprehension" (Buehl, 2011). He goes on to say that it gets the reader to think about the logic of the math that he or she is doing and to stop thinking about the procedure. Through an understanding of the logic, the readers will truly understand. "Writing helps students think about the content, reflect on their knowledge of the content, and share their thoughts with the teacher." (Douglas Fisher, 2002) In a study in Pennsylvania through the *Math Proficiency for All* project researchers found that having their students write their answers to story problems, "[they] began incorporating more appropriate mathematics vocabulary into their writing and demonstrating competency in deciding what each problem was asking" (Parker & Breyfogle, 2011) "When students summarize or interact with the text in written format, they build their comprehension". (Brunner, 2010)

In 2000 the Nation Council of Mathematic Teachers (NCTM) released the *Principles and Standards for School Mathematics* and made writing (communication) one of their standards. They stated that "through communication, ideas become objects of reflection, refinement, discussion, and amendment. The communication process also helps build meaning and permanence for ideas and makes them public. When students are challenged to think and reason about mathematics and to communicate the results of their thinking to others orally or in writing, they learn to be clear and convincing" (NCTM, 2000)

These three main methods: read, focus, and write, is the backbones of reading strategies. The most prolific reading comprehension strategy is SQ3R (Survey, Question, Read, Recite, and Review). This strategy has been around since it was first introduced by Francis Pleasant Robinson in his 1946 book Effective Study. SQ3R gives the reader a plan or a purpose while reading, has them focus on the text and then review their final answer. This is like many other strategies, which get documented in R. J. Draper's paper, *School Mathematics Reform, constructivism and literacy: A case for literacy instruction in the reform-oriented math classroom.* "These activities (SQ3R) and others like them provide students with practice as they develop strategic reading skills and the tools they need to become independent learners" (Draper, 2002). Draper recognizes the historical significance of SQ3R and then points out the similarities between it and others like it; K-W-L (what I know-what I want to know- what I learned), DR-TA (directed reading- thinking activity), and REAP (read, encode, annotate, and ponder activity). She states that all of these "comprehension strategies designed to foster strategic reading (learning) in general can be adapted to assist students into developing strategic reading skills for studying mathematics" (Draper, 2002)

Draper does not think that these strategies will solve all comprehension problems but "[they] provide a starting point for math teachers who wish to make mathematics text more accessible to their students." (Draper, 2002)

Taking into consideration the works and strategies stated above, they have brought me to a strategy that is described in a Miller and Koesling article *Mathematics Teaching for Understanding: Reasoning, Reading, and Formative Assessment*. Miller and Koesling suggest: that the teacher should "break the [reading] process into small pieces that the student is able to successfully negotiate. First read. Reading for understanding: What is the real-world setting of

the problem? Second read. Identifying a problem-solving process. Third read. Solving the problem and checking for reasonableness". (Miller, 2009) With this in mind, I created the new template entitled, "Read Three." I wanted something shorter than S.O.L.V.E. and more open-ended because I believe that "students using their own strategies to solve problems and justifying these strategies also contributes to a positive disposition toward learning mathematics." (Wisconsin Center for Education Research, 2007) I wanted a template having fewer steps than SQ3R while still having students focus their reading. In Miller and Koesling's article, *Teaching for Understanding*, I found their practice of having their students read the question three times to be a good fit.

In the Read Three template, I follow Miller and Koesling's suggestion, explained above, with two additions of my own. I added guiding questions to the template because "asking students questions about the text structure can help them to focus on the idea that texts have an underlying organization." (Metsisto, 2005) I continued with Metsisto's suggestions. "Also significant are questions about the meaning of the problem, such as, 'Can I paraphrase the problem?' 'Does the problem make sense to me?' or 'Does my understanding incorporate everything I've read?'" (Metsisto, 2005) Finally, between the second and third read I have my students apply a mathematical strategy of their choosing to aid in solving of the problem. "Students have to visualize the problem's context and then apply strategies that they think will lead to a solution, using the appropriate data from the problem statement." (Metsisto, 2005)

My new template follows these simple steps with its guide questions: *<u>First Read</u>: What is the story? <u>Second Read:</u> What is the question? Apply a Strategy: <u>Third Read</u>: How do you know your answer makes sense?* "When math teachers link classroom instruction to students'

intuitive knowledge, students can take classroom instruction a lot farther." (Wisconsin Center for Education Research, 2007)

The research will be conducted in 6th grade classrooms at Piedmont IB Middle School (Piedmont) in Charlotte, North Carolina. Piedmont is a half district magnet school which receives students from over 50 elementary schools from half of Charlotte Mecklenburg School District (CMS). To be accepted into Piedmont, a 5th grader has to have scored at grade level on both the 5th grade Math and Language Arts End of Grade (EOG) exams and be selected from CMS's magnet school lottery. The magnet school lottery puts preference on students whose "home school" is a Title One school. Currently there are no direct feeds into Piedmont. There are twelve 6th grade classrooms ranging from twenty-three to thirty-three students each. All students in the class are in 6th grade for the first time; there are no students repeating the grade. All students are either ten or eleven years of age.

I will be collecting my data from the work done in my classroom. I will administer a pre and post-test with formal assessments between the two.

Piedmont's 6th grade math classes follow the Common Core State Standards (CCSS) for 6th grade mathematics. Class periods are fifty-five minutes in length, and meet every school day. The twelve sixth grade classes are separated into three different types. One type of class is Honors/Honors. These students must have placed above the eightieth percentile on the fifth grade math EOG and above the ninety-fifth percentile on the fifth grade Language Arts EOG. The second type of class is Honors/Standard; these students placed above the eightieth percentile on the fifth grade math EOG and below the ninety-fifth percentile on the fifth grade Language Arts EOG. The third type of class is Standard/Standard; these students placed below the eightieth

percentile on the fifth grade math EOG and below the ninety-fifth percentile on the fifth grade Language Arts EOG. The third group has the widest range of ability. There are students who placed from the thirty-fifth percentile to the seventy-ninth percentile on the Fifth Grade Math EOG. There is only one teacher in each of these math classrooms except for the one inclusion class which will have an additional teacher to work with the students who have special needs.

I will use the lowest of my four classes (standard/standard) and I will directly instruct these students. This class will give the most variance of math and reading abilities. The students from this class will be selected for this research by virtue of the fact that they were placed in my standard/standard class. I will be their sole math teacher for the 2013-2014 school year.

I will get consent from the parent/guardian of my students and assent from my students. At the start of the year I will pass out and collect consent (Appendix B) and assent (Appendix C) forms following the example found in Mertler's Action Research Improving Schools and Empowering Educators. I will also offer two parent nights where parents are invited to meet with me before and after the research has taken place to make sure they are comfortable with the research. The Action Research proposal will be made available on my wiki page for parents to read. All interaction with my students will happen inside my classroom in a group setting to insure that no student will be exposed to any risk.

I am performing a pre-test-post-test control group design. I understand that there are limitations to this method including the difficulty of creating a random assignment of participants in each group. The scheduling of the classes I teach allows me to have the same level of achievement in each of my classes. The teaming model my school uses for 6$^{th}$ graders

allows for flexibility in my students' schedules, so I will be able to create an experimental and a control group.

I will be focusing on my two standard/standard math classes. These are students who scored below an eighty percentile on the previous year's End of Grade Exam. I will not be working with my honors groups out of fear that there will not be enough room for growth between the pre-test and post-test.

As stated above, my students have difficultly reading story problems no matter which topic in math I am teaching. I will focus my research on the following topics: Least Common Multiple/Greatest Common Factor (LCM/GCF), Percent Problems, Fraction Operations, Coordinate Plane Geometry, and Volume. To explain the methodology I will use in teaching each of these five topics, I will explain in detail the process I will use on LCM/GCF. For each topic I will follow a same format.

I understand that all of my students come into class with a different amount of knowledge in math and with different abilities in reading. To normalize both classes I will teach them from the Connect Mathematics Project 2 (CMP2) Investigation 3 Common Multiple and Common Factors. This is a unit that is covered during the first few weeks of school, and historically my students have a hard time seeing the difference between the two types of problems. Investigation 3 will take three class periods to teach the material. After finishing the investigation I will give a test (Appendix D) that I will use as a pre-test. With the scores from the pre-test, each participant will be matched with another student who has a relatively similar pre-test score. I will create an experimental group and a control group by putting each person in the pair into the separate groups. The control group will be re-taught LCM/GCF using the Additional Practice from the

CMP2 book, while the experimental group will be taught the Read Three strategy along with the Additional Practice. During the regrouping of my students, I will give daily formative assessments (Appendix E) to both groups to see if the experimental group is adopting the treatment and to collect data on my students' growth. This data from the formative assessments that will let me track on my student's daily growth. This grouping will last for three days, closing with a post-test (Appendix F).

I have selected this approach because I feel it is the best way to study the effects of an introduction of a reading strategy in math class. It is the closest thing I can create to mimic a true experiment. The pre- and post-test will be used to compare the growth of both the control and experimental groups and to compare the score from each group to the other. I feel this data and the observation from the formative assessment from the period when my students were regrouped will give me insight into the effectiveness of the Read Three strategy. I expect to see growth from both groups, experimental and the control, because they will both have three more days than usual of instruction on the topic. If the Read Three strategy is proven effective, I will see larger growth from the experimental group.

Being that all my data is descriptive; my plan for the data analysis is to conduct a repeat measure t test. I will use this comparison from the data that I will collect form the pre and post-test. Again I have my students in two different groups using the pre-test post-test control group design which will lend itself well to the repeat measure t test. I will also be able to use this comparison on the formative assessments that I will be giving out daily during the regrouping periods. This will not be my only way to analysis my data, being that I have a control and experimental group I will be able to implement the independent-measure t test. After a short

normalizing period I will have two different groups of students; one receiving the treatment and the other as the control. I will be able to take the data from the posttest to use as a comparison.

First for data analysis I plan on creating to table for both groups to showcase the individual growth for each student. I also will find the mean of each formative assessments and posttest per group. With these means I will graph them on that double line plot to show the change in each group's performances and the difference between each group. If the difference between the two groups is significant it would prove my research that the Read Three did effect my students in a positive way. Once he process is completed, I will also find the mean absolute deviation (MAD) of each event in each group because I will be interested in seeing if the treatment works for all students the same amount.

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**Appendix A**

Example of S.O.L.V.E template

Paul was given 40 small tiles from his art teacher to create a wall hanging. How many different rectangle arrangements could he create?

**Study** the Problem:

- Underline or highlight the question.
- Re-write the question in your own words:

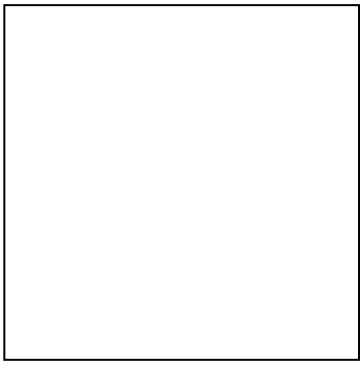
_____

_____

**Organize** the Facts:

- Circle the facts
- Make a list of the facts
- Cross out any unnecessary facts

Draw a Picture!



**List your steps**:

- Write down the steps to your plan:

**Verify** Your Plan with Action**:**

- Work through the plan you created. Show your work.

**Examine** the Results**:**

- Check your work.
- Does the answer make sense?
- Write the answer in a complete sentence:

_____

# Appendix B

September 1, 2013

Dear Parents:

As you may know I am working on my Master's Degree in Middle School Education through Michigan State University. With this program I will be conducting a search study on the effectiveness of reading strategies in middle school math classes. If you would like to read the proposal I have posted it on my wiki page. http://pauljosephbooth.cmswiki.wikispaces.net/

I plan to run this research over a few topics thought out the school year. I will introduce topics and test like I normally but after a few test this year I will break the students in your child's class, for only a few days, and introduce the reading strategy to one of the two groups. My hope is that I can come up with data that will prove this strategy is beneficial in math and can start promoting it throughout Piedmont and the district. The only data that I will collect are test and quiz scores. The score from these test and quizzes with not affect your student's grade, and will not be put on Parent Assist.

If you or your child chooses not to participate, there will be no penalty. It will not affect your child's grade, treatment, or status in my class. Your child's participation is voluntary and she/he is free to withdraw from participation at any time without suffering any ramifications. The results of this research may be published but your child's name will not be used. Data collection will be confidential and will not be shared with anyone else.

If you have any questions or concerns please do not hesitate to email or call me at school Paul.booth@cms.k12.nc.us or 980-343-5435.

I will have a meeting on Tuesday the **10th of September at 6pm** for anyone that would like to come and talk to me about this project, please feel free to bring your student

Sincerely,

Paul Booth

Please sign below, I give consent for my child to participate in the above- referenced study.

Parent's name: _____ Child's Name_____

Parent's Signature_____

# Appendix C

September 1, 2013

Dear Class,

As you may know I am working on my Master's Degree in Middle School Education through Michigan State University. With this program I will be conducting a search study on the effectiveness of reading strategies in middle school math classes. If you would like to read the proposal I have posted it on my wiki page. http://pauljosephbooth.cmswiki.wikispaces.net/

I plan to run this research over a few topics thought out the school year. I will introduce topics and test like I normally but after a few test this year I will break you guys in to two different classes, for only a few days, and introduce the reading strategy to one of the two groups. My hope is that I can come up with data that will prove this strategy is beneficial in math and can start promoting it throughout Piedmont and the district. The only data that I will collect are test and quiz scores. Your name will never be used

I am asking a favor from you, I need your help for me to finish my schooling. If you do not to participate, it is no big deal it will not affect your grade, or anything. Your participation is voluntary and you can get out anytime you want without any problem. The results of this research may be print in a journal but again your name will not be used. Data collection will be confidential and I will only share your scores with you, they will not affect you grade.

If you have any questions or concerns please do not hesitate to email or you know where I work

I will have a meeting on Tuesday the **10th of September at 6pm** for anyone that would like to come and talk to me about this project, please feel free to bring your parents

Sincerely,

Paul Booth

Please sign below, I give consent to participate in the above- referenced study.

Student's Name_____

Student's Signature_____

# Appendix D

## Pre-Test
## Least Common Multiple/ Greatest Common Factor

1. Two radio stations are playing the #1 hit song "2 Nice to be True" by Anita and the Goody-2-Shoes. WMTH plays the song every 15 minutes. WMSU plays the song every 25 minutes. Both stations play the song at 3:00PM. When is the next time the stations will play the song at the same time?

2. Judy is planning a party for her younger brother. She has 45 prizes and 60 balloons. How many children can she have at the party so that each child gets an equal number of prizes and an equal number of balloons? Explain your answer.

3. Carlos is packing sacks for treats at Halloween. Each sack has to have exactly the same stuff in it or the neighborhood kids complain. He has on hand 96 small candy bars and 64 small popcorn balls

4. “Sam” and “Martha” are the local names for two lighthouses that guard a particularly dangerous part of the coast. Sam blinks every 12 seconds and Martha blinks every 8 seconds. They blink together at midnight. How many seconds will pass before they blink together again?

## Appendix E

Formative Assessment (Experimental)

Ishaan and Tiffany are in different chemistry classes at Almond. Ishaan's teacher always gives exams with 30 questions on them while Tiffany's teacher gives more frequent exams with only 21 questions. Tiffany's teacher also assigns 6 projects per year. Even though the two classes have to take a different number of exams, their teachers have told them that both classes will get the same total number of exam questions each year. What is the minimum number of exam questions Ishaan's or Tiffany's class can expect to get in a year?

*First Read: What is the story?*

*Second Read: What is the question?*

*Apply a Strategy:*

*Third Read: How do you know your answer makes sense?*

Formative Assessment (Control)

Ishaan and Tiffany are in different chemistry classes at Almond. Ishaan's teacher always gives exams with 30 questions on them while Tiffany's teacher gives more frequent exams with only 21 questions. Tiffany's teacher also assigns 6 projects per year. Even though the two classes have to take a different number of exams, their teachers have told them that both classes will get the same total number of exam questions each year. What is the minimum number of exam questions Ishaan's or Tiffany's class can expect to get in a year?

## Appendix F

Post Test
Least Common Multiple/Greatest Common Factor

1. Joanne is campaigning for class president and plans to distribute some campaign materials: 24 flyers and 80 buttons. She wants each classroom to receive an identical set of campaign materials, without having any materials left over. What is the greatest number of classrooms Joanne can distribute materials to? How many buttons and fliers would she leave in each room?

2. Matthew goes hiking every 16 days and swimming every 6 days. He did both kinds of exercise today. How many days from now will he go both hiking and swimming again?

3. Omar just bought 1 package of 20 markers. He also bought 1 package of 28 glue sticks. He wants to use all of the markers and glue sticks to create identical sets of office supplies for his coworkers. What is the most amount of coworkers that could receive a set?

4. On Saturday, Nadia is having a party and she's planning to play her 25 favorite songs. She also wants to get some hot dogs for the party. When she goes to the store, she finds that hot dogs come in packages of 8 and buns come in packages of 10. If Nadia wants to have the same number of hot dogs and buns, what is the minimum number of hot dogs she will have to buy?