Adapting the Horkan Model of Reading and Writing in the Math Classroom
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Abstract
My teaching has changed in many ways over the last couple of years. However, no single idea has changed my teaching style as much as a seminar by William Horkan, Jr. on incorporating reading in the math curriculum. Since this time I have not only implemented the basic aspects of Horkan’s model in my own classroom, I have extended also tried to extend his model in a variety of ways. This paper will briefly summarize my implementation of Horkan’s model as well as my own adaptations of these ideas and document some of the observed results in my classroom.

Background
Most schools around the United States are promoting cross-curricular planning and instruction. This is especially true when it comes to finding methods for incorporating reading and writing in all academic disciplines. These are noble ideals, but putting this into practice is often more difficult than it sounds. Class time is valuable, and often teachers see every minute spent reading and writing in their math class as one less minute focusing on the math material to be covered for that day.

Incorporating reading and writing into a math class is even more difficult when working in an Washington, D.C. Public School with a population for which English is not their first language. Bell Multicultural High School is a school in which approximately three-quarters of the students do not speak English in their homes. Most of the students were not born in the United States, with a large majority of the students arriving into this country in the last four years. Every class at Bell consists of a wide variety of students with varying degrees of English proficiency. This adds to the challenge of bringing reading and writing into the classroom but working with such a population makes it all that much more crucial that we do so, in order for these students to succeed in this country and hopefully continue on to college.

Bell Multicultural senses that need to keep promoting student reading, and has instituted programs such as the 25-Book Initiative (each student is to read 25 books over the course of a school year), and D.E.A.R. time (“Drop Everything And Read”—10 minutes of Silent Reading in every class, every day). However well intentioned, many of these programs are often ineffective; and in many cases actually distract from course content, taking away precious minutes from class instructional time—all with negligible benefits.
Approach

In the spring of 2001, Robert Horkan presented his approach to these issues in his work at a similar school in Fairfax County, VA. His approach was to use the first several minutes of each class period with the students reading the math text for the day, and answering non-mathematical questions based on that reading. Not only were his students reading text, but they were required to answer the daily questions in complete sentences with proper grammar, which promoted writing as well. His rational for this was to use the time reading and writing as a tool for introducing the mathematical concepts for that lesson. Horkan cited the additional bonus of engaging students who may be weaker in mathematics, but were able to gather introductory information and may then better approach the math work for the day once they have tasted success.¹

This may not sound like an extremely novel idea, and it isn’t. This method takes the school requirements of incorporating reading and writing into the curriculum, and creates a daily exercise, which at the very least, relates to the course content, and potentially adds to the understanding of the mathematical material. Too often good ideas (ie: incorporating reading and writing in a math class) become dogmatic policy (D.E.A.R time) which leads to ineffective practice (students pretending to read novels for ten minutes) that actually detracts from class (we now have less time to spend on math). By using mathematical content as the content for reading, it not only promotes reading, but also allows students to learn reading skills, as well as provides further exploration into the mathematical topics by being aligned with the lesson for that day.

I followed the basic pattern of reading sheets set up by Horkan in my Geometry classes. In addition to his method of reading from the text and writing short responses, I focused on skills for reading text² as well as adding additional readings related to the curriculum.³ The use of reading sheets also stimulated my creativity and affected all aspects of my teaching through my requirement that students explain their understanding of concepts, and requiring more writing throughout all of the curriculum.⁴

Probably the most significant adaptation I made was the use of a strategy called Read Aloud/Think Aloud. This is a strategy that was being promoted throughout Bell. The basic premise of this strategy is for the teacher to read the material, pausing throughout to interject his/her thoughts about the reading, comments related to the text, or ideas for how to gather information from the text.⁵

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² See Advantage #2: Reading for Understanding
³ See Advantage #4
⁴ For a few examples see Advantage #5
⁵ For further explanation and rational of the Read Aloud/Think Aloud method, contact Colin Hill, English Chair at Bell Multicultural High School.
Advantages and Disadvantages of Reading Sheets

Advantages

1.) Reading sheets create a routine.

Most educational trainings I have attended (especially those focusing on classroom management) stress the idea of classroom routine. I used to make excuses, arguing that I like to “mix it up” each day and I don’t want to get stuck in a rut or my students get bored if each class is always the same. However, the more I am in the classroom, the more I see the value of routines. There is still room for creativity within a classroom filled with routines—my classes actually became more creative. When the students know that the first thing they do is to pick up the warm-up sheet, sit down, find the page in the text and begin the reading, and that I expect them to be ready to begin before the bell rings, this not only settles the students because they fall into routine, but it allows me to take care of administrative things such as attendance. After several weeks, there are no questions about what is expected and students begin to begin each class on task.

I believe that I would continue using reading sheets as part of my daily classroom routines even if the only benefit were the calming effect of a consistent introductory activity. (If this were the only benefit, any number of activities could serve this same purpose, this one just happens to work for me).

2.) Reading sheets develop reading and writing skills.

Reading for Understanding

My experiences as a high school student required very little use of textbooks to acquire information. In most of my classes the teacher would teach a skill, and then we would do drill problems from the book. There were many pages between each problem set full of words, but they were rarely read.

Once at college, my professors expected me to read the text and learn much of the material from this reading. I was unprepared to read for understanding. How much more of a disadvantage are my English language learners for whom in many cases sounding out the words is a challenge, much less reading for understanding. With my students it would have been irresponsible to simply say, “Read these five pages and answer these questions.”

For many of my students to gather information from a page or half of a page that was read aloud by the teacher was a challenge. I wanted to make sure that my students began to gather the skills required to read a

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6 For a detailed explanation of routines and procedures, see Harry Wong’s First Days of School.
textbook. In my first year of teaching the classes I taught were similar to those I sat in on as a student. I dismissed all the pages of text in between the problems as too difficult for my English language learners. However, it is even more crucial for these students to have the opportunity to learn how to use this material than it is for someone for whom English comes more readily. Several of the questions in my reading sheets pushed students to use the margins, pictures, index, appendices, and other reading tools.

To reach the students where they were, I used the ideas described above in the Read Aloud/Think Aloud (see above). The Think Aloud comments not only focused on understanding the words on the page or the mathematical ideas, but also focused heavily on skills for reading a page in a textbook. Looking at pictures, reading captions, reading margin notes, looking for bold and italicized words were all skills we focused on to help the students identify important information. These are basic reading skills for any reader, but especially for a English language learner who needs additional shortcuts to help him/her find the needed information from text.

Writing to be Understood

Not only do reading sheets help students read for understanding, but they help students write to be understood. This includes spelling, grammar, correct capitalization and all other basic writing skills. Many educators argue that we should let students, especially those to whom the language is new, express themselves any way they can and then fix the grammatical details later. I believe this is a good practice—in certain instances. Journaling is a good example of a time when students should be liberated from the confines of grammar rules. However, if students are never required to write properly, they no longer attempt to write properly and often, unknowingly make the same mistakes over and over again.  

I chose to use this activity as one where I insisted on proper writing. This included all of the standard grammar ideas listed above, but also the basic idea of restating the question in the answer. As I would check student's writing I would not accept responses such as

"Because one is the whole circle and the other is half of the circle."

This statement does little to inform the reader of what the writer is trying to explain. I discouraged students from starting sentences with "Because" (not a hard and fast rule, but good practice for beginning writers), and restating part of the question in the answer so the reader has some context.

"The radius and diameter are different because the diameter is the measurement from one side to the other and the radius is the measure from the center to the outside."

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7 Insisting on proper writing was encouraged through conversations with Horkan.
This sentence is not perfect, but it is much improved, and the concept being explain is at least be understood. I found that as the students continued to practice writing correctly, they improved. In many cases it meant becoming less lazy and actually attempting to write correctly, but I also saw students begin to make repetitive mistakes less frequently. For English language learners, both reading and writing skills are crucial toward their educational improvement, and in many cases they do not improve unless the expectations require that they work on these skills.

3.) Reading sheets relate to course content and reach a different type of student (Multiple Intelligence Theory)

Reading sheets can serve as a method for addressing the above goals, but I do teach a math class, and if I spend all of my energy on routines and reading and writing, I run out of time for teaching math. That is, unless the routines and reading and writing incorporate the mathematical concepts as their focus. Although it is often underused, the text often explains the mathematical concepts in a slightly different manner than I may explain it in front of the class.

For many of my students, especially for lower-level English language learners, using the text is one of the most difficult methods for them to explore mathematical concepts. However, there are some students who even in their limited English proficiency, have a linguistic learning preference.⁸ Both Horkan and I observed students who were weak in mathematical skills and performed well in the reading sheets warm-up activities. For those students which this is one of their strengths, they should be given the opportunity to explore these ideas in a learning style which best suits them. Equally importantly, for those students not strong in a linguistic learning style, they should be provided opportunities to exercise this approach in order to improve one of their weaknesses.

4.) Reading sheets provide opportunities to explore related ideas.

As with any text, there were lessons that needed several days to focus on a single topic. In many cases I could divide the reading for that lesson into several smaller parts. However, there were days for which I needed to “stall” a bit to allow students enough time to master a concept. There were also lessons in the book for which I simply did not see the reading to be useful. In these times I supplemented the textbook readings with those I found on my own. This allowed me to explore mathematics from a slightly larger base.

I chose to focus on the history of mathematics. When we focused on a new math concept we would read a short historical passage I would find, edit and paraphrase from the Internet. The question format would

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remain the same, but now the students were given a more comprehensive explanation of the background of these ideas and their importance in history. When we began geometry we read about Euclid of Alexandria who wrote the first geometry book. When we used algebra to solve problems we read about Abu Ja’far Mohammad who first developed algebraic ideas. When we worked with circles, we talked about the history of Pi and some of the mathematicians who worked with Pi. We read about “crazy” Archimedes and his contributions to mathematics. And although it wasn’t reading and writing, we had a story time about Pythagoras stealing ideas from the Egyptians complete with Egyptian headdress and a rope with nine knots. By exploring the history of these ideas, I believe that it gives the students perspective and gives mathematics more meaning.

5.) Reading sheets stimulate a more well-rounded approach which open the door for more meaningful activities.

Once I spent the first month convincing students to read and write for their warm-ups, it not only enforced these skills for the students, but provided a culture within the classroom for which reading and writing were expected. This in turn stimulated my planning. Before using reading sheets, I did not look for ways to incorporate these skills into my classes. However, once I saw their writing improve and a classroom climate had developed which at least tolerated writing, I became bolder in asking them to write more. I was able to ask for more summary writing in the assigned projects. I no longer needed to prod the students to write their answers in complete sentences when working on word problems. It simply became expected that they were to write proper sentences when answering questions, and they knew how to do that after they had worked on these skills through the reading sheet warm-ups.

One of the most unexpected results of reading sheets was that it impacted a class which never saw a single reading sheet. Because I was now encouraged to look for ways to incorporate reading and writing into my math classes due to my success with reading sheets, I increased the reading and writing expected in a more advanced statistics course. In this class students had weekly selections to read out of a college-level text. Even though the material was above their reading level, they were asked to glean whatever information they could from the text and to take notes from the text. One of the most successful activities was writing end-of-chapter summaries as a review exercise before the test. The more they wrote, the more proficient they became, not only in their writing style, but in their ability to explain concepts. As they explained things, I believe their understanding reached a greater level. The more they improved, the more I could demand of them. Through my use of reading sheets, I changed from a teacher who taught skills, to a teacher who lead the students in pursuit of ideas.

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9 See Appendix B for the scaffolding of the end-of-chapter summary writing activity.
6.) Reading sheets satisfy school-wide policies to be implemented in my classroom.

As previously mentioned, there are several school-wide initiatives at Bell Multicultural that were created to promote reading and writing. Good intentions aside, many of these ideas are implemented in such a way that they detract from the daily lessons and even fall short of their goal of improving reading and writing. Using reading sheets satisfied my D.E.A.R. time, served as documentation for students reading 2 of their 25 required books, and we used Read Aloud/Think Aloud throughout this entire process. Not only did we combine three activities into one, but we did so without being distracted from our first goal of learning Geometry.

Disadvantages

1.) It still takes class time

Horkan claimed that he had his routine of reading sheets down to a five minute activity. I was not so fortunate. As the students were first learning the expectations, the morning warm-up often lasted nearly the entire period. I learned to shorten the reading, but continued to hold my expectations high. My efforts paid off and as the year progressed, students began to be more proficient and efficient in working with the reading sheets, without sacrificing quality. However, by using the Read Aloud/Think Aloud method, it often took 5-15 minutes to simply read the short amount of text. Then students had to read the questions and answer them. For many of my lowest-level English language learners even shortening the expectations to three questions still did not provide a setting in which they could succeed with limited time. Because of our longer, block scheduling I could afford some lengthening of the warm-up time, but even near the end of the year there were days when I needed to make decisions about how much time to allow students to complete their reading sheets.

2.) I didn’t grade every paper

It became quickly apparent that I could not grade every reading sheet every day. As an alternative, I had the students keep their reading sheets in their notebooks and would collect them at the end of each unit. As the students would write their answers I would wander around the room looking over students’ shoulders, giving comments and corrections where I could. Some students appreciated the one-on-one contact and would insist that I read their answers every day. Other’s would slip through the cracks, and would have incomplete papers. I would include their work in their participation grade for the course, but without my reading every word written by every student, I could not ensure a high quality of work from every student.

10 Horkan,
3.) It takes planning (if you miss a day the routine is damaged)

One of the largest drawbacks to reading sheets is the planning necessary to prepare the material. For every day of class I needed to select a text to read and create five questions regarding that text. For the historical readings I needed to do research and to write a historical summary that was at my student’s reading level. This was a lot of work.

There were days, for whatever reason, in which I did not provide a typical reading sheet warm-up. On these days the importance of consistent routines was especially evident. From a classroom management perspective, the students would be disoriented, even if I had a clear activity ready. This would lead to immediate behavior problems. Along with the initial confusion of the class, when we would attempt to return to the standard reading sheet warm-ups, there would be some resistance and it would take time to fall back into the routine. (This was especially true if several days elapsed since the last reading sheet warm-up activity.)

4.) It is tied to a specific book

This accompanies the planning as one of the largest drawbacks. Teachers hesitate to do a great deal of resource development tied to a specific text for fear that the district or school may change the required text, or that their teaching responsibilities may lead them away from a specific course. If this is the case, all that planning seems to be in vain.

I had the luxury of teaching the same course for two successive semesters. After working hard to prepare a reading sheet for every day of the course, I was able to reuse the material the second time around with only a few minor changes in specific lessons. All that planning seemed to pay off and make my teaching easier. I felt confident that I could continue using this material since it had only been one year since our district had adopted this text.

Unfortunately a change in courses was instituted within our school and Geometry no longer exists as an isolated class, but we have moved to a more integrated approach to teaching Algebra and Geometry. This change will remove the Geometry text from regular use, and I will not have the opportunity to reuse (and improve) all of the resources I have developed. I can use the historical articles, but unless I find a way to recreate a daily reading sheet warm-up activity in a course that lacks a primary text, the routine of the reading sheets is lost.

Conclusion

Overall I was extremely pleased with my experience with using reading sheets to incorporate reading and writing into my math classroom. Even though I will not be able to continue using much of the material I have developed, it has changed my overall approach toward my curriculum planning. I will continue to find ways to directly and indirectly implement these ideas in my classes, and would encourage others to do so as well.
References

Appendix A

The following are sample reading sheet activities. Most are from the text, *Geometry: Tools for a Changing World*. Prentice Hall, 2001
Do #1-3 for a √  Do #1-5 for a √+

1.) How are radius and diameter different?

2.) Look at the picture of the amusement ride. Answer question #1 on the bottom of page 96.

3.) Answer question #2 on the bottom of page 96.

4.) What is the formula they are using in example 1?

5.) Why are they using this formula when they are working with circles?

REMEMBER! Always write in complete sentences.
DO NOT READ THIS WHOLE SECTION! Spend a few minutes to *skim* (quickly look over) these pages, and then answer the questions below.

1.) What is the most useful thing you find in the beginning of this section? WHY?

2.) A coke can is an example of a *cylinder*. Where would you look at to help you find the *volume* of a coke can?

3.) Near the end of this section there is a group of pages with a purple boarder (p. xix-xxv). Why did the publisher include these pages? How are these pages helpful to you?

4.) Read p. xx. Use the space below to complete the three sentences in the green stripes.

5.) List one good thing about this purple section, and one thing that is confusing to you.
REMEMBER! Always write in complete sentences.
Archimedes: Mathematical Magician

**Born:** 287 BC in Syracuse, Sicily  
**Died:** 212 BC in Syracuse, Sicily

Archimedes was the son of an astronomer. He was from Syracuse, which is a city on the island of Sicily below mainland Italy. He was a mathematician, scientist, inventor, and some even considered him to be a magician or wizard because of the amazing things he did.

Archimedes was born just a few years after Euclid died, but it is believed that he studied with some of Euclid’s students in Alexandria, Egypt. In Egypt he also invented a type of water pump called an Archimedes Screw, which is still used, today on farms and in factories. He continued to write to his friends in Egypt even after he left. Many of his letters were about mathematical theorems. Some of his friends began taking credit for Archimedes’ work, so he also added theorems that were not true just to throw them off.

Many different people wrote about Archimedes. Except for his friends in Egypt, most people didn’t care about his mathematics. He was best known for his inventions and machines that were used in war. However, he thought these were just amusing games and he was more interested in true mathematics—especially geometry.

His amusing games of war were quite amazing. Some of the machines he made shot missiles and large rocks. Others lifted whole ships into the air, flipped them over or threw them into rocks. Many of his inventions involved large explosions that were loud and frightening. On another occasion he used pulleys in such a way so he could pull an entire ship loaded with many people without any help. Because of his incredible inventions many people were afraid of Archimedes and some considered him to be magical or to have wizard-like powers.

Even with all these amazing machines, Archimedes first love was mathematics. He was a very serious mathematician. Some of his best-known work is his discovery of the first 4 digits of \( \pi \) by drawing shapes with 96 sides! Hundreds of years later even Newton used Archimedes’ ideas to help him develop calculus. Sometimes he would get so wrapped up in his work that while he was taking a bath he would begin drawing geometric shapes with dirt on his naked body in order to help him solve a mathematical problem.

Archimedes even was even killed because of his love for math. Archimedes was working on a math problem while Syracuse was having a war with the Romans. When a Roman soldier entered his room, Archimedes refused to follow the soldier’s directions because he wanted to finish his work. The soldier didn’t like to be ignored, so he killed him with his sword.

For more information, see the article by: J J O’Connor and E F Robertson at  
http://www-groups.dcs.st-andrews.ac.uk/~history/Mathematicians/Archimedes.html
1.) Were Euclid and Archimedes friends? WHY OR WHY NOT? Who did Archimedes hang out with?

2.) Why did Archimedes send Theorems that were not true to his friends in Egypt?

3.) The king in Syracuse really liked Archimedes. Why do you think he liked him?

4.) In your opinion, what was one of the craziest things Archimedes did?

5.) From your reading on the back, which discovery do you think Archimedes should be most remembered by?
REMEMBER! Always write in complete sentences.
Appendix B

This activity served as an end-of-section review for a Statistics course. This class did not use Reading Sheets, but reading and writing were incorporated into the curriculum after my success with reading sheets in Geometry.

WARM-UP Statistics Date:_____________
pp. 1-55 Chapter One Review

During today’s period we are going to review the contents of Chapter One. To do this, please follow the steps below to help you outline the Chapter.

I expect complete sentences with correct grammar.

1.) **First**, starting from the beginning of the chapter, leaf through the book and list all of the important things we have talked about.

2.) **Second**, out of all of the things you listed, circle the 5 most important things. *[Let me see your 5 things before you go on.]*
   (These will be the topics of your paragraphs.)

3.) **Third**, write a very brief overview of the whole chapter. (This is your introductory paragraph.)

4.) **Fourth**, write a brief paragraph for each of the 5 topics. (Each sentence needs to be no more than 3 to 5 sentences.)

5.) **Fifth**, write a summary paragraph that wraps up your paper.

**Congratulations!**
When you finish, share your paper with a friend for them to edit it. Polish your paper and make it look neat. Not only will this be a good tool to study from, but it will also go in your book log and count toward your 25-books.