

**Math and Literature:
Blue Balliett's Art Mystery Books**

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Overview

The days of distinct, isolated school subjects are gone. In today's world, there has to be a partnership between teachers of all subjects so that we can build upon and enrich each others' subject matter and increase comprehension and engagement for our students. In schools across the country, students are making graphs in social studies class, or writing a paper about rock formations in science class, or reading about the Great Depression in communications class.

Math and communications are the major focus in almost all schools across America, definitely here in Pittsburgh, and a student needs to do well in both areas in order to succeed in the future. Writing in the math classroom has been going on for some time. In my class, the students write in journals, they write math reflections, and they must always explain how they got an answer to a problem. But besides reading the introduction to a problem or the problem itself, there has been very little other reading in math. We need to work hard to improve our students' reading skills, so poems and stories and novels can no longer be something kids see only in communications class.

Rationale

Here's a disturbing fact: two-thirds of those students who cannot read proficiently by the end of the fourth grade will end up on welfare or in jail. There are even more troubling statistics. A quick search online produced this information: over 70% of the inmates in America's prisons can not read above a fourth grade level. The Justice Department has said "the link between academic failure and

delinquency, violence, and crime is welded to reading failure.” Nearly half of those Americans with low literacy skills live in poverty. The most shocking statistic of all? One child in four grows up not knowing how to read.

On April 14, 2009, Pittsburgh Public Schools Superintendent Mark Roosevelt presented a powerpoint report to the board of education, outlining his plans for the use of the district’s stimulus funds. These funds are part of the American Recovery and Reinvestment Act (ARRA), \$2.6 billion of which have been earmarked for K-12 and higher education in Pennsylvania. The largest chunk of that money, \$16.1 million, must be used to improve math and reading instruction for children in poverty (Title I). Mr. Roosevelt’s report stated that he planned to use the largest part of the stimulus funds to “maximize achievement and engagement”, and that he would focus on literacy and focus on middle school. Why focus on the middle school years? Because we have already put considerable effort into the K-5 years, and the test results have shown an overall improvement (over 31% increase in proficient readers in just three years). But when struggling readers get into their middle school years, they have a tendency to fall even farther behind. Mr. Roosevelt says that according to *Reading Next 2006*, there is a strong correlation between dropout rates and reading skills. Low-level readers in ninth grade are twenty times more likely to drop out of school than their higher-level peers.

Our job as middle school teachers is to send our students to high school with the reading skills necessary to succeed. The middle grades literacy focus will include intense literary intervention for struggling readers, every day.

What does all this have to do with my seventh grade Connected Math 2 (CMP2) classroom? It is math time, after all, and shouldn’t we be concentrating on math? And math skills improvement *is* part of the stimulus package. So why bring reading into the math classroom?

More and more over the past few years, there has been a real push to encourage reading and writing in the math classroom. My school has made literacy a priority in all subjects, and we often have staff meetings and professional development to help us incorporate reading and writing into our classes. Math class has undergone a big change since the district adopted the Connected Mathematics program. Students must now explain their reasoning and strategies for every math problem they do. While I push my students every day to write about their work, it is still a struggle to make it a natural part of their problem solving. Perhaps it has become a tedious chore for them, and they don’t see the point of explaining their thinking in a mathematical setting. If they had a chance to read some fun novels that had math as a major component of the plot, they

might become more interested in the math, reading, and writing connections.

On the website *LiteracyMatters.org*, the strong connection between math and literacy is explained:

Math is highly conceptual and process-oriented, requiring that students are able to do more than copy and memorize facts. The goal is to construct meaning by applying skills such as questioning, predicting, examining, discussing, describing, and rationalizing. Reading and writing play a critical role in these processes.

I can already hear my seventh graders' response when I tell them that we will be reading novels in math class: "WHAT? This is math class, not Communications! I HATE reading. Nope, not doing it." How many of your students hate to read? Probably more than you think. Something happens between early childhood and adolescence that turns many kids off. Think about a classroom of kindergartners hanging on every word as the teacher reads If You Give a Mouse a Cookie, then come and visit my seventh grade homeroom during DEAR time (Drop Everything And Read). Two students are deeply engrossed in books they have brought from home, and the other 23 are either holding a torn-up paperback from my classroom library and pretending to read, or have stopped even trying to pretend ("Go ahead, give me a lunch detention. Reading is BORING").

For a true blue bookworm like me (I read Gone With the Wind in 18 straight hours without stopping when I was thirteen, pausing only for very brief bathroom breaks and sustenance delivered by younger siblings), this breaks my heart, because the non-reading kids will never experience how a book can take you away to another world and open up the entire universe. If I can find interesting stories that engage my students and help them understand math better, maybe they'll discover that reading isn't so bad after all.

A student's understanding of math concepts can be strengthened through the use of literature chosen specifically for its strong mathematical content. If you search online, you will find dozens of lists of books that have strong math connections. Finding a book is the easy part; the difficulty lies in seamlessly integrating that book into your curriculum, and finding the time to read and discuss the book when the curriculum demands that you keep up with the district's pacing guide.

I hadn't even heard of Blue Balliett's books until last summer, and since then I have been completely hooked. *Newsweek* called Chasing Vermeer "a Da Vinci

Code for ‘tweens.’”

There are three novels in the series: Chasing Vermeer, The Wright 3, and The Calder Game. The characters are Calder Pillay and his friends Petra Andalee and Tommy Segovia. As the first book starts, Calder and Petra are sixth grade students at the University School in Chicago. Tommy, Calder’s best friend, has moved (against his will) to New York.

In Chasing Vermeer, Calder and Petra get involved in an international art scandal when a famous painting by Vermeer disappears.

In The Wright 3, Calder and Petra are joined by Calder’s old friend Tommy, and the three are caught up in another art mystery, this one involving Frank Lloyd Wright’s Robie House in Chicago.

The final book in the series, The Calder Game, puts Calder in a small English village, where he promptly disappears. Of course, Petra and Tommy must fly over to England to help find him, and more mystery and intrigue ensues.

The best thing about this series is that the books are so rich with original ideas and connections to math (in fact, all school subjects can be incorporated), so I will only give you a small sampling of ideas and activities. If you go online and search for Blue Balliett or any of the three books, you will be inundated with websites, ideas and suggestions for incorporating the books into your curriculum. The vast amount of ways to use these books necessitated a more focused approach. I decided to try to align a unit with the CMP2 curriculum I teach, as well as the math standards for seventh grade.

According to the 2008-2009 Seventh Grade Roadmap, there are 7 units that must be covered during the schoolyear (the 2009-2010 Roadmap isn’t out yet, but I don’t expect it to be too much different). The units for seventh grade are:

I. Introducing Algebra: How can we use mathematics to describe change?

CMP2 unit: *Variables and Patterns*

II. Similarity Transformations: When shapes shrink or grow, what changes and what stays the same?

CMP2 unit: *Stretching and Shrinking*

III. Ratios, Proportions, and Percent: How can we use the relationship between numbers to find missing values?

CMP2 unit: *Comparing and Scaling*

IV. Reasoning With Uncertainty: What do you believe will happen in the long run?

CMP2 unit: *What do You Expect?*

V. Extending the Number Line To the Left : What lies on the other side?

CMP2 unit: *Accentuate the Negative*

VI. Linear Functions: How do we use mathematics to describe constant change?

CMP2 unit: *Moving Straight Ahead*

VII. The Third Dimension, Measurement and Geometry: How do we measure space?

CMP2 unit: *Filling and Wrapping*

This is a lot of material to cover in one school year, even with double periods every day, but it has to be done. How can I fit three novels and the accompanying activities into all this? I have tried to build this unit around our CMP2 curriculum, attempting to come up with activities that are relevant to what we are doing in class at the time. Of course, this can't work out every time. Even if a lesson or activity isn't exactly aligned with whatever unit we're on at the time, it will still be relevant to what students have learned in the past or will learn in the future.

Using the seventh grade curriculum roadmap and the Pennsylvania state mathematics standards as a guide, I have created a unit that blends math and literature, while at the same time fitting easily into the seventh grade math curriculum.

Objectives

In the seventh grade curriculum, the four mathematical strands that CMP2 develops are Number and Operation, Geometry and Measurement, Data Analysis and Probability, and Algebra. All of these strands will be covered in the curriculum unit.

CMP2 is closely aligned with the NCTM *Principles and Standards 2000*. The recommended scope and sequence of the CMP2 units stresses building a deep understanding of required content topics, with an emphasis on problem solving.

Students can make sense of mathematics if the concepts and skills are embedded within a problem. If time is spent exploring interesting mathematical situations and reflecting on the solutions, students are much more likely to develop a robust understanding of mathematical concepts (CMP2 Implementing and Teaching Guide, p.6).

My objective for this unit is to use literature as an enhancement to my regular curriculum, increasing my students' interest and understanding of mathematical concepts.

Strategies

As previously mentioned, my plan is to spread this unit out over the school year, in an effort to align the novels and some of their lessons and activities with where we are in our curriculum.

Chasing Vermeer is the first book, and it would coincide with Units I and II. The Wright 3 would go along with Units III, IV, and V, and then The Calder Game would finish out the school year with Units VI and VII.

There are several options for getting your students to read each book. I have found that most of my students enjoy it when I read to them, so this might be a nice way to launch each new book; take some time to read the first couple chapters aloud to the entire class, and then have a brief discussion afterwards about what they think will happen in the book. You could continue reading the book aloud to them, especially if you are not able to get enough books for the entire class. Then again, we want our students to become better independent readers. Giving your students goals and deadlines (i.e., read up to chapter 9 by Thursday) will make them responsible for the material without just giving them the vague directions to "Read the book" (because we all know how well seventh graders would do with *those* instructions).

I plan to use my daily warm-up time as reading time (about 10 minutes at the beginning of the class), and give students the option of reading if they finish their

classwork or tests early. Giving reading assignments as homework can be futile, but if your students are pretty good about doing homework, then this could be an option if you're short on class time.

Classroom Activities

If you go online and check out any of these three books, or go on Blue Balliett's website, you will find links to countless lessons and activities. Additionally, at the end of each book there are suggestions for activities. I have chosen just a couple for each book, ones that I believe will keep the students engaged, as well as reinforce content from the curriculum.

Chasing Vermeer

Unit I: finding patterns, using mathematics to describe change; tables, graphs, and equations, *Variables and Patterns*

Unit II: similarity and scale factor, ratios and proportions, *Stretching and Shrinking*

Pentominoes

Pentominoes are geometric shapes formed by putting together five congruent square tiles with one another edge to edge. There are twelve unique ways the tiles can be arranged, and each pentomino is named after a letter of the alphabet (see Appendix B). According to the author Blue Balliett, pentominoes are used by mathematicians to explore ideas about geometry and numbers.

Calder walks around with a set of pentominoes in his pocket, and he even dresses up as F for Halloween. Pentominoes play a big part throughout the book, and provide clues to help solve the mystery.

This activity should be started before your students have the book in their hands, so that they don't see the twelve pentomino arrangements. For this activity, you will need:

- 1-inch square tiles (at least five for each student)
- 1-inch grid paper
- Scissors

- Pentomino sets (I have plastic sets that I got from a school supply place, but you can make them out of heavy cardstock. The plastic ones are really nice, though, and the kids love playing with them)
- Optional: glue, large pieces of colored construction paper

Start by asking the students what a domino is. Ask a student to come up and make a domino out of the square tiles (this should be done on the overhead projector, or the Elmo® if you have one). Ask the class how many different ways the two tiles of the domino could be arranged (1; make sure your students understand that rotations and reflections don't count as different arrangements). Continue the classroom discussion:

How many ways could you arrange three tiles? (2)

How many ways could you arrange four tiles? (5)

What about five tiles? What would you predict?

Let your students make guesses about the number of arrangements, then challenge them to find all the different ways. I have my students seated in groups of four, so I make it a contest to see which group can find all the different arrangements first. Let them use the square tiles if they want to, and then transfer them onto the 1-inch grid paper. I usually have my students work for awhile before telling them that there are twelve different ways to arrange the tiles (they always seem to think that they are finished after seven).

After the groups have cut out their arrangements and glued them onto construction paper, I tell them that these are called pentominoes (*penta* means five), and we look at all the different arrangements and their letter names (see Appendix B). Give each student a sheet with the twelve pentominoes for future reference. Now would be a good time to hand out the books and read the first few chapters out loud to the class.

The next class period, give each student his/her own set of plastic pentominoes and let them try to solve the puzzles: a standard pentomino puzzle is to tile a rectangular box with the pentominoes (cover it without overlap and without gaps). Each of the 12 pentominoes has an area of 5 unit squares, so the box must have an area of 60 units. Possible sizes are 6x10, 5x12, 4x15 and 3x20. I usually start my students off with smaller rectangles like a 5x6 or a 5x8, and if they solve those, then they can move on to the bigger puzzles.

There are 2339 solutions to the 6x10 puzzle, 1010 solutions to the 5x12, 368

solutions to the 4x15, and just two solutions to the 3x20. They could also try an 8x8 rectangle with a 2x2 hole in the middle.

This is a fun activity for students; it is very tactile and sharpens their spatial reasoning and problem solving skills.

Another activity is a review of the sixth grade unit *Covering and Surrounding* (two-dimensional area and perimeter). The area of each pentomino is five square units, but do they all have the same perimeter? Have your students make a table of the different pentominoes and their perimeters, in order from least to greatest.

The pentominoes activities fit into the Geometry and Measurement strand, and address Mathematics Standards 2.3, 2.5, and 2.9 (see Appendix A).

Other activity ideas

- Calder and Tommy made up a secret pentomino code and used it to send messages to one another. Have your students create their own codes and write secret messages (Unit I, finding patterns, standards 2.4, 2.5, 2.8)

The Wright 3

Unit III: ratios, proportions, percents, *Comparing and Scaling*

Unit IV: probability, *What Do You Expect?*

Unit V: integers, absolute value, order of operations, *Accentuate the Negative*

Calder, who thinks in numbers, is beginning to see patterns all around him. His mom explains Fibonacci and his numbers to Calder.

The **Fibonacci sequence** is a series of numbers in which each number is the sum of the two preceding numbers:

1 1 2 3 5 8 13 21

The Fibonacci sequence shows up in nature and in manmade creations. In his book Mathematics: A Human Endeavor, Harold Jacobs says that the Fibonacci sequence has been found in pine cones, Roman poetry, sunflowers, and the reproduction of bees (to name just a few).

Put the first eight terms of the Fibonacci sequence up on the overhead, and

challenge the students to try to find the pattern. Ask them to continue the pattern, up to at least the 15th term. Jacobs suggests some other questions to ask (p.101):

The terms of the sequence that are even numbers form a pattern. The pattern has to do with their position in the sequence. What is the pattern? (they are every third term)

The terms that are divisible by 5 form a similar pattern. What is it? (every fifth term)

There are only two numbers in the Fibonacci sequence that are squares. One of the numbers is 1. What is the other number? (144)

This activity can be expanded way beyond these relatively simple questions (see Jacobs' chapter 2 on number sequences), and you can include ratios, percents, and predictions in your lessons (Units III and IV, standards 2.4, 2.7, 2.8).

Other ideas

- Give your students a copy of the floor plan for Frank Lloyd Wright's Robie House (Appendix C). Have them find the scale factor from the plan to the actual house. They could explore the connection between scale factor and area. Have them make a scale drawing of their own dream house (Unit II and III, standards 2.1, 2.3, 2.9).

The Calder Game

Unit VI: writing linear equations, *Moving Straight Ahead*

Unit VII: volume and surface area, *Filling and Wrapping*

A great activity for the end of the school year is to have your students make mobiles like the fascinating Alexander Calder mobiles featured in this last book. This will take planning and collaboration on the part of the students; they will have to decide what the theme of their mobile will be (characters in the books, pentominoes, etc.) and they will have to figure out how to balance their mobiles. Have the students make their suspended pieces 3-D, and ask them to find the volume and surface area of each piece. What is the scale factor from their mobile to a similar mobile hanging in a museum? What happens to the volume and surface area when the mobile is enlarged? (Units II, III, and VII, standards 2.1, 2.3, 2.9)

Bibliography

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Lappan, Fey, Fitzgerald, Friel, Phillips. CMP2 Implementing and Teaching Guide. Pearson Prentice Hall, 2006.

National Council of Teachers of Mathematics. Principles and Standards for School Mathematics. Reston, VA: NCTM, Inc., 2000.

Roosevelt, Mark. *Progress on Planning for Use of Stimulus Funds*. Powerpoint presentation to Pittsburgh Board of Education, April 14, 2009.

Websites

www.adifferentplace.com/vermeer

An absolute treasure trove of links and activities related to Chasing Vermeer.

www.architectstudio3d.org

Gives students the opportunity to design a house with Frank Lloyd Wright as their guide.

www.gowright.org

This website gives you a peek into Frank Lloyd Wright's Robie House in Chicago, as well as providing some great ideas for activities to go along with The Wright 3.

www.literacymatters.org

A professional development site that focuses on “what matters most” in adolescent literacy development.

www.scholastic.com/blueballiett

Play pentominoes online, crack the pentomino code, or try other games related to Chasing Vermeer.

Appendix A

Pennsylvania Department of Education **Academic Standards for Mathematics**

Numbers, Number Systems and Number Relationships...2.1.

Types of numbers (e.g., whole, prime, irrational, complex)

Equivalent forms (e.g., fractions, decimals, percents)

Computation and Estimation... ..2.2.

Basic functions (+, -, ×, ÷)

Reasonableness of answers

Calculators

Measurement and Estimation... ..2.3.

Types of measurement (e.g., length, time)

Units and tools of measurement

Computing and comparing measurements

Mathematical Reasoning and Connections... ..2.4.

Using inductive and deductive reasoning

Validating arguments (e.g., if...then statements, proofs)

Mathematical Problem Solving and Communication... ..2.5.

Problem solving strategies

Representing problems in various ways

Interpreting results

Statistics and Data Analysis... ..2.6.

Collecting and reporting data (e.g., charts, graphs)
Analyzing data

Probability and Predictions... .. .2.7.

Validity of data
Calculating probability to make predictions

Algebra and Functions... .. .2.8.

Equations
Patterns and functions

Geometry... .. .2.9.

Shapes and their properties
Using geometric principles to solve problems

Trigonometry... .. .2.10.

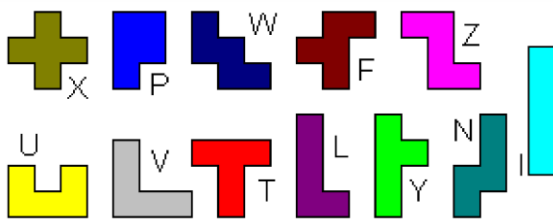
Right angles
Measuring and computing with triangles
Using graphing calculators

Concepts of Calculus... .. .2.11.

Comparing quantities and values
Graphing rates of change
Continuing patterns infinitely

Appendix B

Pentominoes



You call the 12 figures, which you can make of five squares, pentominoes. You must arrange the squares, so that they must have in common at least one side. The shapes are similar to capital letters, so they have letters as names.

Appendix C

Floor plan of Frank Lloyd Wright's Robie House in Chicago, IL

