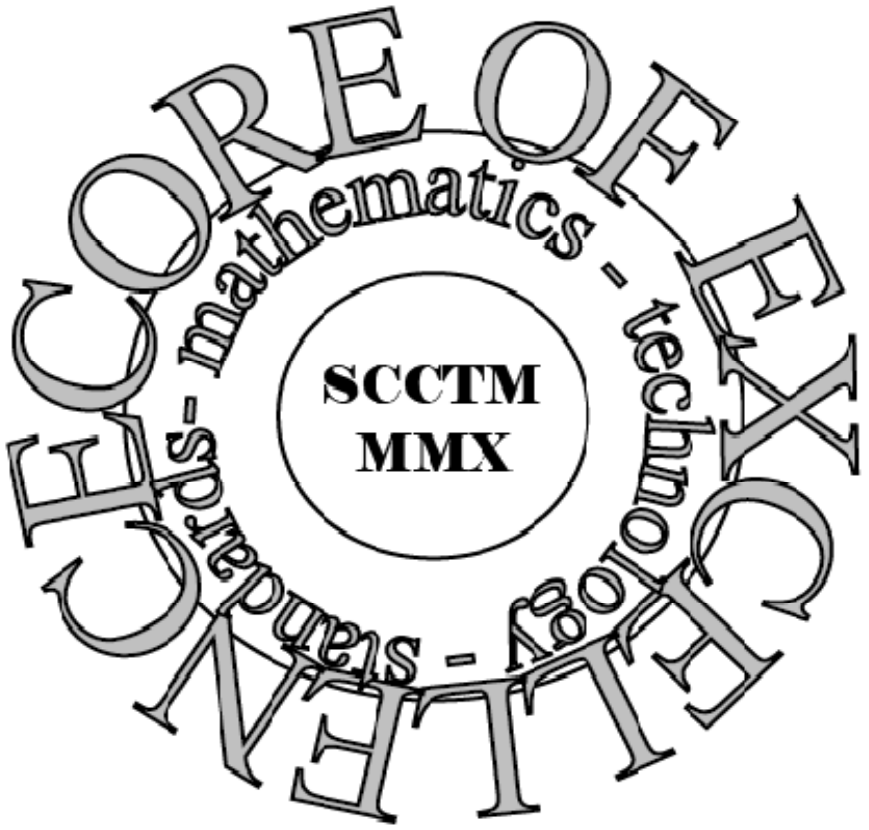
VOLUME 34 | NUMBER 1 | November 2010

The MathMate



The Official Journal of the
South Carolina Council of Teachers of Mathematics

Mission Statement: The mission of THE MATHMATE is to feature articles about innovative mathematical classroom practices, important and timely educational issues, pedagogical methods, theoretical findings, significant mathematical ideas, and hands-on classroom activities in order to disseminate this information to students, educators, and administrators.

THE MATHMATE, the official journal of the South Carolina Council of Teachers of Mathematics, is published online three times each year.

Submission Requirements: Submissions for THE MATHMATE should be no more than 15 pages in length not counting cover page, abstract, references, tables, and figures. Submissions of more than 15 pages will be reviewed at the discretion of the editorial board. Submissions should conform to the style specified in the *Publications Manual of the American Psychological Association* (5th ed.). All submissions are to be emailed to mathmate@winthrop.edu as attachments with a completed Submission Coversheet as page 1 and the article starting on page 2. Click here to download THE MATHMATE Submission Coversheet.

Submitted files must be saved as MSWord, RTF, or PDF files. Pictures and diagrams must be saved as separate files and appropriately labeled according to APA style. Copyright information will be sent once an article is reviewed, but authors should not submit the same article to another publication while it is in review for THE MATHMATE.

Submission Deadlines: Submissions received by October 1 will be considered for the Winter issue, February 1 for the Spring issue, and June 1 for the Fall issue.

South Carolina Recertification Credit: According to the SC Department of Education Renewal Credit matrix, *http://www.scteachers.org/cert/recert/pdf/matrix_dist_ent.pdf*, the primary author of a refereed journal article can earn 60 renewal credits.

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The MathMate

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Is Your School Involved in MATHCOUNTS???

MATHCOUNTS provides middle school-aged students with opportunities to be successful in math while making learning fun and challenging. MATHCOUNTS has two great programs that can be used to motivate and enhance the math instruction at your school. Please check out the two programs that are offered through MATHCOUNTS on the website https://mathcounts.org/ There is a competitive program and a club program. The club program has lots great resources that can enhance math instruction in the middle schools. The competitive program is a great opportunity for students to take their math skills to the next level. One of the programs offered by MATHCOUNTS is sure to be a great supplement to your math program.

We would like to thank all the coaches, students, and volunteers that participate in the program. South Carolina is extremely proud of the 2010 team that went to Florida during May to participate in the national competition for MATHCOUNTS. David Stoner (7th grade) from St. Mary's School in Aiken, Richard Chen (7th grade), Gregory Rassolov (8th grade) from Dent Middle School in Richland 2, and Kevin Zhao (7th grade) from Pleasant Hill Middle in Lexington 1 represented South Carolina at the National MATHCOUNTS competition in Orlando May 6-8. Coach Cathy Stinson (Dent Middle School) was the coach for the state team. Marguerite McClam is the state coordinator.

To see a video of the highlights of the competition go to https://mathcounts.org.

If you are a middle school teacher and your school does not participate in MATHCOUNTS, please consider starting a group at your school. Visit https://mathcounts.org/ to find out how to get involved.

MATHCOUNTS 2010-2011 Important Dates

By September 30, 2010
School kits distributed to all schools. If you did not receive a school kit, please contact your State or Chapter Coordinator. The State Coordinator is Marguerite McClam.

October through December
School competitions mailed to registered schools.

December 10, 2010
Registration deadline. Forms must be postmarked by the December 10 deadline. (Late registrations MAY be accepted at the discretion of MATHCOUNTS and the local coordinator.)

February 1-28, 2011
Chapter Competitions

March 1-27, 2011
State Competitions

May 5-8, 2011
The 2011 Raytheon MATHCOUNTS National Competition to be held in Washington, DC!

Making Mathematics Meaningful: Analyzing Data Across the Curriculum

Debi Mink
Diana Durbin
Winthrop University

Abstract

One challenge we face as teachers is finding ways to make skills that our students need to learn meaningful and connected to real-life experiences. Mathematics can be challenging to integrate into other discipline areas, leading to rote and disconnected memorization of content without authentic connections to a bigger picture. In this article we share research about mathematics learning, personal experiences with integrating mathematics using data analysis, and classroom activities connecting data analysis with other content areas. Five standards-based, classroom-tested activities that integrate history and geography with data analysis are discussed using an elementary lesson plan format with accompanying illustrations.

Mathematics Learning

Mathematics has drawn inspiration from business, religion, law, war, politics, ethics, gambling, metaphysics, mysticism, ritual, and even play (e.g., the mathematics in the children's game of hopscotch) (Davis & Hersch, 1986). When children build connections between mathematical ideas and other topics, mathematics becomes more meaningful and understanding is enhanced. For example, graphing and measurement are useful skills in science, while map skills are necessary for teaching and learning in social studies. Additionally, reading and writing are essential to the study of mathematics as students learn to communicate and connect their mathematics learning to relevant situations. A fundamental change is necessary in how students view mathematics – not as boring, sterile, and difficult, but as an exciting exploration with practical uses every day for everyone (Reys, Suydam, Linquist & Smith, 1998). This change can come about by integrating mathematics with other subjects.

One of the goals of the National Council of Teachers of Mathematics (NCTM) is for students to explore the relationships between mathematics and the other disciplines (NTCM, 1989b). Too often the meaning of integration seems to suggest that if the teacher throws any two subject areas together, something better will happen. With a little more purposeful thought, teachers can easily raise the interest, complexity, and success of some of their favorite activities. Effective teachers provide many opportunities for children to experience mathematics as found in other subjects such as: science, business, home economics, social studies, literature, art, music, and language arts/reading (specifically children's literature).

Using Thematic Units in Mathematics

Mathematics connections can also be highlighted through integration of thematic curricula. By combining subjects around themes, certain real-life connections can be made due to the fact that much of the repetitious material that occurs from subject to subject is eliminated. When subjects are connected, students begin to see more meaningful relationships because the subject matter serves as a vehicle for learning rather than as an end in itself (Ellis & Fouts, 1993).

Using a thematic approach is one way to provide integration because it addresses not only basic skills, but also more open-ended and higher-level objectives. Individual interests and differences may be more easily accommodated in a thematic unit. The cooperative learning approach lends itself to thematic units (Cathcart, Pothier, Vance, & Bezuk, 2000).

Even without a thematic approach, teachers encounter many opportunities to integrate mathematics with other subjects on a daily basis. However, connections are not automatic. Teachers must provide experiences in which the connections are "obvious." This will encourage children to look for other connections in other subjects (Cathcart, Pothier, Vance, & Bezuk, 2000).

Integrating Data Analysis and Elementary Social Studies

Sometimes statistics is synonymous with data. The definition of statistics is *the science of collecting, organizing, representing and interpreting data.* What are data? *Data are facts or information gathered for a*

purpose. *Data may be in the form of either words or number* (Monroe, 2006). Students learn to organize and present data in tables, charts, and graphs. The study of data gives teachers and students the perfect opportunity to integrate content areas into mathematics.

The following is Debi's story of a time when she realized the potential of data analysis for making learning meaningful for her unmotivated readers:

> The students in my fourth grade classes were for the most part struggling readers and were completely unmotivated to read. They also did not like to listen to books or stories. I began looking for low vocabulary and/or high interest books to read aloud to them with the hope that they would then want to read to themselves. In the early 1990s, besides being a publication, *The Guinness Book of World Records* was also a TV show that detailed amazing feats and oddities. To my excitement, I found that my students were fascinated by the television show. I bought one of the Guinness books and began reading it to them a little bit every day. Although not a low vocabulary text, the high interest in the content helped motivate students. The students began asking their parents to go to the library and bookstores looking for these books. I also observed that the unmotivated readers were often unmotivated in mathematics or were mathematics phobic. This is when I realized that I could teach Data Analysis and Probability by integrating other content areas based on *Guinness Book* trivia.
>
> I wanted the students to understand and become confident in the concepts of data analysis without them having to struggle with the basic arithmetic. Therefore, I taught the students how to use calculators. Even though students were not always allowed to use calculators on standardized tests, after completing the activities described later in this article, most understood the concepts and the procedures for finding the mean, median, mode, and range of a set of numbers and were more confident.

Other Data Analysis Activities for the Classroom

The progression of activities that lead to a conceptual and procedural understanding of the terms *mean*, *median*, *mode*, and *range* are explained in the following sections. This progression is classroom tested, and is an adaptation of the *Quick Questions* Activity in the original *Family Math* (Stenmark, Thompson, & Cossey, 1986) from the *Equals* series. These activities help students practice mathematics skills in a meaningful and interconnected way.

Integrating English/Language Arts into Mathematics

Activity 1: Teaching the vocabulary of data analysis

Teach the vocabulary associated with data analysis using concrete examples that are relevant to students. Then have students write a story about the vocabulary words in a way that makes the terms meaningful to them. The following is an example from 6th grade student, Gretel Mink, in her 6th grade general mathematics class. The assignment was to create a story using the terms *mean*, *median*, *mode*, and *range* so that the mathematical terms were connected with real life situations. The story is as follows:

> Mrs. *Mean* was the *average* teacher. She wasn't "cruel" mean because she never made us write out our times tables 50 times each or do 150 computation problems a night for homework, but she never did anything exciting or fun in mathematics class, either. This is why Mrs. **Mean** was the **Average** Mathematics teacher. (Students soon learned to connect the terms *mean* to *average*.)
>
> Mrs. *Mean* never deviated from the **middle** or **median** of the road. She was just the *average* mathematics teacher. She did the same thing every day in class. We did a page in the book and a page for homework. She never deviated. (Students now connect the word median to middle and realize that median is the middle number of a set.)
>
> The mode (most) favorite teacher of all the 6th graders was the social studies teacher. He was voted the favorite teacher because he did deviate from the median or middle of the road. When we studied a country, we ate the food from the country, we dressed in costumes from the country and

we learned some vocabulary from the language of the country. He also had an inflatable globe that we got to toss to each other and try to catch the globe on the country we were studying. This is why he was our mode favorite teacher. (Students connected Mode to Most or most frequent number in a set.)

My teachers ranged from my mode favorite (my social studies teacher) to my least favorite (my mathematics teacher). (Students connected the range as being the high minus the low.) This is how I remember the terms mean, median, mode, and range.

PS- Now that I think of it, Mrs. Mean was a little cruel, too, because she made us show HER step-by-step procedures when completing each problem.

Activity 2: Teaching Mathematical Procedures

After students learn the vocabulary and their association to data analysis, teach them the mathematical procedures for finding the *mean, median, mode* and *range* of a set of numbers. After trying many ways to teach these procedures, we found that once elementary students made the real life connections from their own story, the procedures were not as difficult to learn.

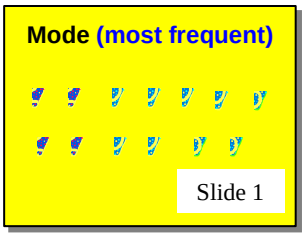
The key to the success of this activity is to allow students to use calculators to find the answers. Students need to feel successful learning the concepts and procedures. Allowing the use of calculators helps them to learn the concepts and procedures without having to worry about making errors in the computation. The use of the calculator also lets early readers understand basic concepts of data analysis.

The Procedures for the Vocabulary of Data Analysis

Mean/Average: Add all the numbers together and divide by the number of numbers.

Median/Middle: Order the numbers from smallest to largest. Put one finger on the minimum number, put the other finger on the maximum number. Slowly move fingers in toward the middle. The median is where the fingers meet. If fingers meet between two numbers, add the numbers together and divide by 2.

Mode/Most Frequent: Students are often confused by the concepts of 0 mode and *no mode*. Look at Slide 1. The sample on Slide 1 shows a mode of 0 because the most frequent number is 0. Sample 2 shows NO MODE because all of the numbers are represented one time.



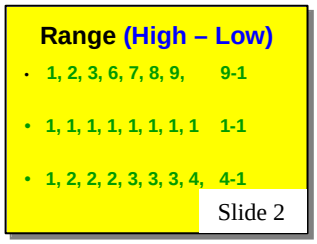
This is a trick question on some standardized tests. The question might look like this:

What is the mode of the following set of numbers?
0,0,0,1,1,1,5,5,5,8,8,8,9,9,9
A. 0 C. 5
B. 1 D. Not Here

Some students will answer A, when the correct answer should be D, Not Here. The correct answer is NO MODE, not 0.

An example of a 0 mode would be:
0,0,0,0, 1,1, 2, 5, 9

Range/Best to Worst: Range is defined as *the difference between the greatest number and least number in a set of data* (Monroe, 2006). If this is true, why are students confused by the previous examples? In Slide 1, there are 7 numbers, but the range is 8. In Slide 2, there are 8 numbers, but the range is 0. In sample 3, there are 8 numbers and the range is 3. In reality, the range of a set of numbers is the number of counting numbers between the high and the low. Procedurally, students are asked to subtract the low from the high.



Activity 3: Playing the Trivia Game

Objectives:

- Students will be able to calculate the mean, median, mode, and range of a given set of numbers.
- Students will demonstrate the understanding of the concepts of mean, median, mode, and range of a given set of numbers.
- Students will demonstrate understanding of the procedures to calculate mean, median, mode, and range of a given set of numbers using a calculator.

Materials:

1. One trivia necklace per student. To make a trivia necklace, two-hole punch 5 X 8 index cards and put them on yarn or string to go around the neck. Students will wear them like a backward necklace. (See Illustration 3.)
   - Make enough cards so that each student will have a card. We usually list 10 trivia questions so that if there are 30 students are in the class, 3 students will have the same question.
   - An easy way to make trivia card necklaces is to make the list of questions and enlarge the font to 36. This way, two questions will fit on each 8.5 X 11 sheet of paper. Cut in half, laminate, punch holes, and tie string to go around neck. (Yarn is very itchy, you may want to use cord or ribbon.)
2. One answer sheet per student (See Illustrations 1 and 2.)
3. One calculator per student
4. Pencil
5. Slides of the trivia games

Mathematics Vocabulary:
Mean, median, mode, range, average, estimate

(Primary Answer Sheet)

The answers I received from other people were:

1. _____
2. _____
3. _____
4. _____
5. _____

My guess _____

Mean (average)

Range From_____ to_____

Illustration 1

(Intermediate Answer Sheet)

The answers I received from other people were:

- 1._____
- 2._____
- 3._____
- 4._____
- My guess_____
- Range_____
- Mean _____
- Median _____
- Mode _____

Illustration 2

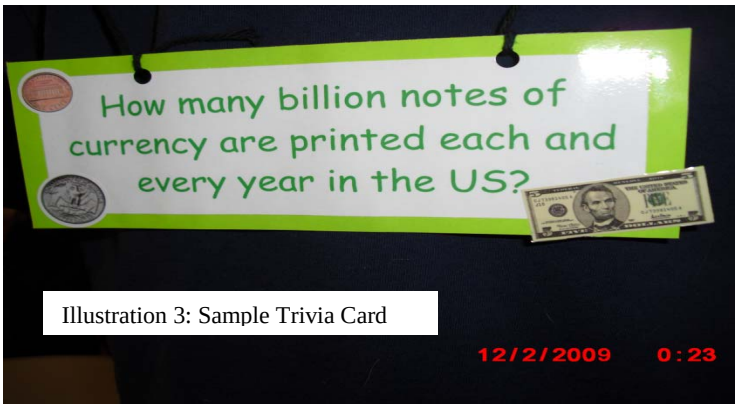


Illustration 3: Sample Trivia Card

Procedures:

1. Distribute answer sheets.
2. Place a trivia necklace around the neck of each person--*backward*. (Students should not be able to read their own question.) (See Illustrations 3 and 4.)
3. Explain to students that they are going to estimate the answers to questions on each others' backs.

Illustration 4: Fancy trivia cards


Illustration 5: Student reading trivia card

4. Each student will ask four other students to answer their question without reading it aloud. Students record the answers given to them on their answer sheet. (Some answers will be easy to estimate and others won't.) (See Illustration 5.)
5. After getting four answers, students take the necklace off, read the question to themselves and write their estimate under My Guess. (See Illustration 6.)
6. Using the calculator, students will find the mean of the set of five numbers. They will then find the mean, mode, and range.
7. Ask the students to circle the Mean.
8. Play Too High, Too Low, Just Right

Illustration 6: Should I make my guess now?

Directions for Too High, Too Low, Just Right:
Two to Three students may have the same question depending on the number of students.

1. Using the PowerPoint - ask students who has question number one?
2. Ask him/her to tell you the mean of the set of guesses.
3. Students will decide if the mean is "too high," "too low," or "just right."
4. The teacher will say, "Too high, Too low, Just right- one, two, three up!" On the word "up," students will indicate whether the estimate is "too high," "too low," or "just right." This will be done as follows:
   - If the student thinks the estimate is too high, he will show thumbs up. If he thinks the estimate is too low, he will indicate thumbs down. If the student thinks the estimate is just right, he will indicate by holding hand out straight.
5. The teacher will then give the right answer. This way the teacher can see who is estimating correctly.
   - Hint: If students are asked their opinion without the cue from the teacher, they will look around the room to see the other students' estimations. With the teacher's cue, they are more likely to think for themselves.
6. The teacher will then move on to the next question.
   - Teacher's Note: When designing trivia games, make sure that the questions are asked with a unit of measure. For example, the question, "How long is the world's longest sausage?" could be answered in inches, feet, yards, centimeter, meters, etc. The question should be asked, "How many <u>feet</u> is the world's longest sausage?" On some state tests, if the student answers without the unit of measure indicated, the answer will be counted wrong, even though the numeric part may be correct.

<u>Activity 4: Mapping the Answers</u>

After all of the correct answers are found, ask students to locate the city and/or state on a US or South Carolina map or place the dates on a timeline.

Activity 5 : Research Activity

Assign groups of students a topic to research and create their own trivia game. They will create and design a PowerPoint. They will also design and make the necklaces. This project takes approximately three weeks to create and complete.

Playing the Trivia Game

Two answer sheets are used in this activity (See Illustrations 1 and 2). The first sheet is for early readers through second grade. They will use a calculator to find the Mean and the Range of the set of six numbers.

The second answer sheet is used with students in third grade and above. The student will use a calculator to find the range, mean, median, and mode of a set of five numbers.

Trivia to Integrate Social Studies: South Carolina Trivia

1. South Carolina entered the Union on May 23, 1788. It became what number state to enter the Union? (8)
2. How many counties are in South Carolina? (46)
3. South Carolina's smallest county is McCormick. How many square miles? (360)
4. South Carolina's largest county is Horry. How many square miles is Horry County? (1134)
5. South Carolina's Grand Strand stretches from Little River to Georgetown, and is one of the most popular tourist destinations in the United States. How many miles does the Grand Strand stretch? (60 miles)
6. The Upper Whitewater Falls is the highest cascade in eastern America. How many feet is its descent? (411 feet)
7. How many U.S. Representatives does South Carolina have? (6)
8. How many square miles is the state of South Carolina? (31,055 sq. miles)
9. South Carolina entered the Union in May 1788. What date in May was this? (23)
10. Sweetgrass Basket making is a traditional art form that has been passed on from generation to generation. How many years has Sweetgrass basket making been a part of the Mount Pleasant, SC community? (300 years)

The places mentioned in the trivia game can be located on a map of South Carolina or placed on a timeline.

Trivia to Integrate Social Studies: United States Trivia

1. The woman with the longest finger nail lives in Salt Lake City, Utah. How many feet long is her fingernail? (21.7ft.)
2. Ray Macareg of San Jose, California blew the most bubbles with a tarantella in his mouth. How many bubbles did he blow? (99)
3. Rosalie Bradford of Perkasie, Pennsylvania recorded the greatest weight loss ever. How many pounds did she lose? (938 lbs.)
4. Walter Hudson of Hempstead, New York, had the biggest waist ever recorded. How many feet around was his waist? (9.9 ft.)
5. Cedar Point in Ohio has the most rides of any theme park. How many rides does it have? (67)
6. The world's largest strawberry shortcake was made in 1999 for the strawberry festival in Plant City, Florida. How many pounds of strawberries were used to make this dessert? (3995 lbs)
7. The largest head of broccoli was grown in Palmer, Alaska. How many pounds did it weigh? (35 lbs.)
8. Mary Norman of North Carolina had the oldest baby tooth to be extracted. How many years was the baby tooth? (83 years)
9. The oldest person to have an operation was from Houston, Texas. How many years old was he when he had his hip replaced? (111 years)
10. The world's largest pecan pie was made in Okmulgee, Oklahoma. How many feet was the diameter of the pie?

After finding the trivia answers, locate the states on a United States map.

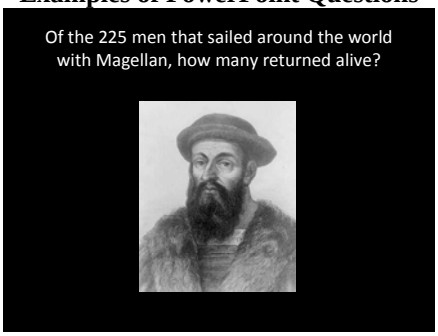
Trivia to Integrate Social Studies: World History Explorer Trivia

1. In kilometers, what was Columbus' estimation of the circumference of the earth? (25,255 km) The actual circumference is approximately 40,000 km.
2. How many ships sailed during Columbus' second voyage? (17 ships)
3. Out of an estimated 3,000,000 Native Americans living in Haiti when Columbus arrived, how many were left 25 years later? (12,000) This was a result of murder, kidnapping, enslavement, and diseases brought by the Spanish.

4. Of the 225 men who sailed around the world with Magellan, how many returned alive? (18) Magellan was not one of them.
5. When Magellan's expedition was over, how many days behind were the calendars of his ships' logs? (1) This oddity led to the establishment of the International Date Line.
6. How many women signed the Mayflower compact? None. (0)
7. How much money did Congress approve for the Lewis and Clark expedition? ($2500)
8. How many transcontinental expeditions were completed *before* Lewis and Clark's? (2).They were completed by Sir Alexander Mackenzie (1793) and Cabeza de Vaca (1536).
9. About how many hours did it take John Glenn to orbit the Earth three times in 1962? (5) Actual time was 4 hours, 55 minutes, and 23 seconds.
10. How many days after launch did Neil Armstrong set foot on the moon? (4)

This trivia game may be used as an assessment after the 5th grade explorer unit.

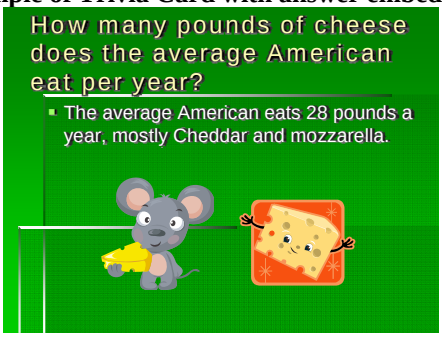
Examples of PowerPoint Questions



From Explorer Trivia

Sample Answer for PowerPoint

Sample of Trivia Card with answer embedded



Food Trivia

In Summary

In this article we shared research about mathematics learning, personal experiences with integrating mathematics using data analysis, and classroom activities connecting data analysis with other social studies. Five standards-based, classroom-tested activities and three trivia games that integrate history and geography with data analysis were discussed using an elementary lesson plan format with accompanying illustrations.

Acknowledgments

- Strategies for integrating these activities were presented at the 2010 SCCTM annual conference.
- Special thanks to Gretel Mink and the Winthrop University students in the course Teaching Mathematics in the Elementary School 2009 for their contributions to this article.
- Trivia is found in the Guinness Book of World Records 2009 and 2010, as well as in various social studies books and the South Carolina Academic Standards for Social Studies.

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Authors

Dr. Mink teaches elementary mathematics methods courses to undergraduate and graduates. She has 33 years of experience as a classroom teacher in Florida. Debi and her students presented these activities and strategies at the 2010 SCCTM Annual Conference in Greenville.

Dr. Durbin teaches Social Studies and reading to students in both the undergraduate and graduate programs at Winthrop University. Diana has six years of teaching experience in Georgia.

Pictured are Winthrop University students who contributed to and presented the activities in this article along with Dr. Mink at the SCCTM 2010 Conference in Greenville. Left to right: Meagan Love, Holly Taylor, Katherine Weikle, Kristen Hall, and Sharon Crocker.

Boys, Girls, Books, and Math: Ratio and Proportion

Heather Studer
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Newberry County School District

I received an SCCTM grant in the summer of 2009 to design engaging and meaningful math lessons with literature for gender-grouped seventh graders. I have two classes of boys and two classes of girls in "average level" pre-algebra classes in seventh grade. I wanted to get my students interested in and excited about math, and to be able to strengthen their skills in probability, ratio and proportion, and graphing/data analysis.

My first unit addressed ratio and proportion. We studied this unit in-depth for several weeks. It is very important to develop a deep understanding of ratios, rates, and proportions in order to move on with other topics such as interest, discount, tax, and tip.

I began by reading *If You Hopped Like a Frog* by David M. Schwartz. All of my classes, both boys and girls, loved this story with its reptiles, bugs, sports, and more. The book contains comparisons of animals and their abilities to what humans could do with the same talents. We used the facts in the index of the book to begin with our comparisons and setting up similar ratios.

My boy classes were more interested in the sports like the baseball and football examples given in the book. The boys researched their comparisons to include jumping and running, while my girl classes preferred anything with the animals in the book. They were especially intrigued by the pelican's sac holding three gallons of water! Either way, the comparisons were made to build interest in the topic and to make the math personal to each student. It worked very well!

The next book I used was Shel Silverstein's *Where the Sidewalk Ends.* I read "One Inch Tall" to all of my classes. We used string cut to each student's height to represent one inch as they compared the items in our classroom to their "new height." The boys absolutely loved seeing the comparison of the items to their newly shrunken one-inch height. This hands-on approach really impacted my boy classes. My girl classes were engaged, but not as much as the boys. Next time, I will try to interest the girls with their favorite personal items like lotions and lipsticks!

The final book I used for ratio and proportion was *Jim and the Beanstalk* by Raymond Briggs. This book was a hit for everyone. The giant in the story wants to eat three fried boys on a piece of toast. I had my classes use proportions to come up with the correct size of bread that would actually fit three people. It was so much fun watching the students lie on the floor and trace themselves, measure each other's lengths and widths, and compare it all to a real slice of bread that I supplied. The boys and girls both were really challenged by this activity, and they learned the true meaning of proportional relationships.

Working with children's literature has really made an impact on my students and their level of understanding in not just math, but also across the curriculum with reading and writing. Using these books has kept my students engaged and put the mathematical topics into a realistic application in which they were interested. I look forward to expanding my repertoire of literature and lessons with even more math standards, and sharing these and more ideas with my colleagues.

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A Fractions Intervention in High School

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> *Akesha, a 9th grade student with learning disabilities, enters an intervention class for extra help with mathematics. Mrs. Johnson, the special education teacher acting as the intervention teacher asks Akesha to open her textbook to what was covered that day in math. Mrs. Johnson reexplains the lesson and helps Akesha one on one with the rest of her homework. When Akesha goes to her math class the next day the teacher checks her homework quickly and starts the next lesson. Again, Akesha struggles in class, failing to understand what she has been asked to do and the reasoning behind the procedures taught by her math teacher. Also, she looses interest in the class, knowing that she will receive extra help on the subject in special education. Later that day, she enters her special education class where Mrs. Johnson again helps her complete her homework. When taking the next unit test, Akesha struggles again and does not attempt some of the question. However, she feels better when she takes the low score to Mrs. Johnson to help her complete corrections for extra credit.*

The cycle within this vignette occurs frequently in secondary schools. Students with learning disabilities struggle in math class and wait to receive help from a special education teacher. The next day, they repeat the same problem again. This cycle of frustration reoccurs because the student is unable to keep up with the instruction in the general education mathematics class due to previous misunderstandings about mathematics or gaps within their learning. This cycle is dangerous not only because the student is always a lesson behind the rest of her peers but also because it teaches the student that they cannot succeed in the general education class on her own. Even though the student eventually learned to complete each of the mathematics competencies she was taught, she was unable to learn at the level or the pace of her peers. This leads to failure in the classroom and on standardized assessments.

There are alternatives to this approach to math intervention. Take this vignette for example:

> *Akesha, a 9th grade student with learning disabilities, enters an intervention class for extra help with mathematics. Mrs. Johnson, the special education teacher trained in math intervention asks Akesha to open her intervention textbook to lesson 3 where Akesha and five other students make progress to become fluent in one of their weaker foundational skills. With 10 minutes left in the intervention class, Mrs. Johnson explains the lesson in their next grade level math class. When Akesha goes to her math class the next day the teacher checks her homework quickly and starts the next lesson. Akesha shows some interest in the lesson because of the familiarity to the information and the fact that she can now do some of the work required of the lesson. Later that day, she enters her intervention class where Mrs. Johnson teaches the group the next lesson of the intervention and preteaches the next lesson in the general education math class. When taking the next grade level unit test, Akesha struggles some but can get through most of the problems and attempts every question.*

This vignette shows a distinctly different approach to mathematics interventions. Here, the teacher serves as an interventionist who focuses on foundational skills that hinder performance in the general education curriculum. Additionally, the teacher infuses preteaching to prepare the student to learn in the general education classroom. This not only helps academically, but also behaviorally. Preparing the student to learn the content through strengthening foundational skills and setting an advance organizer helps deter the student from exhibiting learned helplessness. (For more information on learned helplessness see Jensen [1998].)

Teaching Math through Response to Intervention

This system of intervention fits within a Response to Intervention (RtI) framework. RtI is a process that incorporates evidenced-based instruction, assessment, and interventions through different levels of intensity depending on the need of each student. In mathematics, students who do not achieve in the general education setting alone after documented extra attempts by the teacher, that student may be placed in an additional math intervention class during the day to receive additional time for learning mathematics. During this intervention time, the focus of the instruction is on teaching students what they are lacking compared to their peers. If after the intervention the student still does not meet expectations on standardized tests, then that student should at least receive continued intervention. If scores continue to plummet compared to peers, then an alternate intervention or curriculum should be considered. RtI decision teams may make different recommendations based on their state's or district's model. What is important is that students receive help commensurate with their needs before special education is considered an option (Riccomini & Witzel, 2010).

Concrete-to-Representational-to-Abstract (CRA) Math Intervention

Within RtI, there are several intervention approaches that have a history of effectiveness. One is the concrete to representational to abstract sequence of instruction (Gersten et al, 2009). This approach starts students at a concrete level of understanding and teaches the procedural steps to solving a problem. Next, the student transition to a pictorial representational level of learning that again helps students learn the algorithm. Finally, students transfer their learning to the abstract level where students perform steps similarly to what is shown in most traditional textbooks. The benefit of this intervention approach is that it takes students at a level of learning they are comfortable and successful with and transitions it to what is expected in a standards-based general education setting.

The purpose of this intervention manuscript is to show how one classroom utilized a math intervention in a high school setting and tested the effectiveness of an intervention across two intervention classes. What is unique and appropriate about this project as action research is that very little math intervention research exists with high school setting students with disabilities. Thus, action research is an appropriate step to establishing possible means for interventions in mathematics. The students not only improved in the intervention but also improved their personal outlook on mathematics. For more information on action research see Mills, 2010..

Class Intervention Research Method

Mrs. T (co-author) is a high school special education teacher in a rural area in a state with a history of low math achievement. Her goal this year was to implement math interventions for her 10 students who scored below-basic on the previous year's statewide exam. The area of most concern for her students was fractions. Her concern isn't unique. The National Math Advisory Panel (2008) stated that "Understanding and manipulating fractions is crucial for further progress in mathematics and for tasks of everyday life" (p. 4-xv). However, students in the United States struggle significantly with learning rational numbers such as fractions (Gersten et al., 2009). Based on the low performance of her students, Mrs. T initiated an intervention in fractions that would benefit the students' in algebra.

Students

Two groups of five students each came to the teacher three times a week for academic support. She randomly assigned one group to receive a concrete-representational-abstract (CRA) treatment in fractions using Witzel and Riccomini's (2009) *Computation of Fractions* intervention. The other group would receive the same fractions work but through a series of repeated abstract (traditional, algorithmic) steps. Both groups received the same lesson plans, same number of days of intervention (30) and even the same lesson worksheets to ensure equal time spent and type of problems attempted in class. Equally, both groups were provided explicit instruction during the intervention to help teach what is happening and why. Such explicit instruction is highly important when providing interventions (Gersten, et al., 2009, NMP, 2008, Riccomini & Witzel, 2010). Both groups also received the same pre and post assessment to maintain consistency across each group. For a visual difference between C and R and A lessons, see Figure 1.

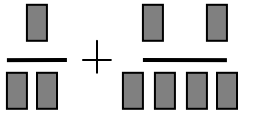
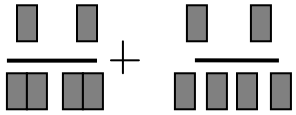
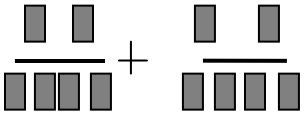
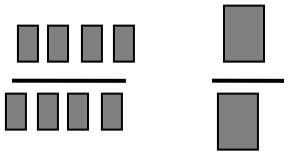
Concrete and Representational sample	Abstract sample
	1/2 + 2/4
	1(2) / 2(2) + 2/4
	2/4 + 2/4
	4/4 or 1

Figure 1. Visual Difference between C and R and A lessons

Results

The results according to number correct out of 20 on equivalent pretests and posttests showed a greater growth and a higher final posttest mean score for computation of fractions. Per student, the gains were consistently in favor of the CRA sequence of instruction. See Figure 2.

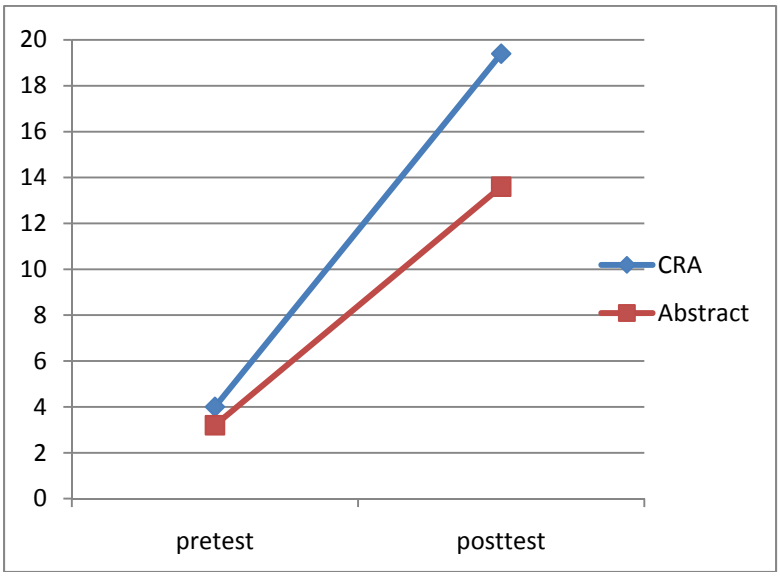


Figure 2: Mean Scores and Gains per Instructional Group

The highest gain in the CRA intervention group was 20 on a 20 point posttest. The lowest gain in the CRA intervention group was 9 which was achieved by two students who scored 10 out of 20 on the pretest and 19 out of 20 on the posttest. The highest gain in the Abstract intervention group was 12 which was achieved by two students

who scored 14 and 15, respectively, on the posttest. The lowest gain in the Abstract intervention group was 7 which was achieved by one student who scored 8 out of 20 on the pretest and 15 out of 20 on the posttest. It is important to note that three of the five CRA intervention students received the maximum score, 20, on the posttest while none of the Abstract intervention group received the maximum score. For student scores, see Table 1.

	CRA					Abstract				
Demo graphics	Female White F/R Age=15	Female White Age=16	Male White F/R Age=16	Female White F/R Age=15	Female White F/R Age=16	Female Afr-Am F/R Age=17	Male Afr-Am F/R Age=15	Male White Age=15	Female White F/R Age-16	Male White F/R Age=16
Pretest score	1	3	10	0	6	3	8	0	2	3
Posttest score	18	20*	19	20*	20*	13	15	11	14	15
Score increase	17	17	9	20	14	10	7	11	12	12

Note. * Denotes maximum score on the assessment; F/R= Free/Reduced Lunch

Table 1: Student Scores per Instructional Group

Along with improved scores on fractions computation, the general education math teacher reported that each of the students who received intervention using CRA improved their class performance in algebra. Thus, consistent with RtI principles by one teacher's account, conducting a fractions intervention helps support the learning of secondary areas of mathematics.

Discussion

First, it must be noted that since this project is a pre-experimental action research project comparing two conditions and not quasi-experimental with a larger N and integrity recordings, these findings must be replicated before specifics about the intervention approaches should be generalized. It is important to find that both groups improved their performance in fractions when provided explicit instruction in an intervention approach. With historically low fractions scores across the United States, knowing that interventions aimed at certain aspects of fractions can be improved rapidly when taught correctly is an important beginning to establishing secondary math intervention work.

Examining the scores of these students based on the treatment provided, provides further promise for the CRA approach to interventions. While there have been successful fractions interventions using CRA (see the work of Butler, Miller, Crehan, Babbit, & Pierce, 2003), this is one of few intervention attempts at CRA with high school level students. More action research and quasi and experimental research must be conducted on secondary approaches to math, and specifically fractions, interventions. Included with these studies should be more RtI related studies showing whether or not these increases in fractions understanding and computation translate into improved grade level math performance.

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Authors

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