



Hot Summer, Cool Math & Science

An Inquiry Event brought to you by the MindBugs Team



"Hot Summer, Cool
Math and Science"

Content and Application

Grades: 3 - 5



Teacher Overview Contents

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MindBugs-in-Math and Science

The MindBug is a misconception in student thinking. Like a virus, MindBugs can spread through a student's number and conceptual systems. Avoid and debunk misconceptions through active, engaged learning and through reinforcing connections.

MindBugs Modules reach all learners through hands-on activities that engage the senses and by creating connections to math, history, art and the other sciences.

The Model

There has been a lot of discussion regarding how many E's are required for an effective learning model. In MindBugs workshops teachers have decided that the best model is actually $(4E)^2+E$, but because that isn't very memorable and this is primarily a science module, we'll use 5 E's.

1. **Engage** learners
2. **Explore** the topics actively
3. **Explain** what was explored
4. **Evaluate** to assess content knowledge
5. **Extend** the concepts and skills

The 5 E's is more accurately described as $(4E)^2+E$ because the process isn't linear for most learners. Students generally need to explore the concepts more than once and in more than one way before evaluations show they have mastered them to the appropriate level. The strides they can make with multiple explorations can have an exponential effect on discovery and performance.

Though only the first E encompasses the word, Engage, every day should be engaging. Keep students interested with hands-on activities and cross-curricular connections.

The Model Applied to MindBugs

Educators **Engage** students through attention-grabbing and imagination-tapping demonstrations. MindBugs demonstrations usually present a discrepant event; something students have seen before but haven't really noticed. Without paying real attention they've drawn incorrect conclusions. They've built mental bridges to nowhere and created their very own MindBugs. Following the demo, students jump right in to get their hands "dirty" with individual activities.

Students **Explore** the concepts through hands-on activities. Some activities are done individually and some in groups. Hands-on exploration helps all types of learners succeed.

Educators always **Explain** activities after students have completed them. Many learners make the critical connections only after experiencing the phenomenon first-hand. Lesson plans and a Power Point presentation are provided for each session in case projection technology is available in the classroom.

Evaluation can also be called Assessment (but that messes up the acronym). Whether the results are used to design future instruction or to rank students, it is important to gauge what they have learned and what they need to improve upon. As time allows, teachers are invited to teach concepts back to the class. this experience allows

them to pinpoint their own misconceptions and areas of weakness. Assessment questions based on the NAEP (National Assessment of Educational Progress) are provided for each module.

Students **Extend** the concepts and skills through...well, extensions. Math activities, historical references and stories as well as journal exercises are all effective.

My favorite part of the MindBugs workshops was that they got us engaged in the activities and THEN explained them. I liked that so I know my students will too.

*Debra Green
Science Teacher
Macon County Middle School (GA)*





Overview

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Overview

The language of science is mathematics. Mathematics is the study of patterns.

Hot Summer, Cool Math and Science is an integrated math and science experience. It helps teachers see the relevance of the math and science they are teaching while refreshing their content knowledge. The lessons are taught in the same manner that teachers might teach their own classes. Participants are engaged in scientific explorations from which the explanations are formulated. Math is used as an integral part of each lesson. Science and math should be the most exciting times of each school day.

When teachers are confident in their understanding of the subject matter, they enjoy the creative investigations that are possible in an elementary classroom. Ten80 STEM teams partner with teachers to offer support as they begin to tilt their own classrooms toward an inquiry based, student focused environment.

4 Day Agenda

Day 1: AM Session	Ten80 Tilt Toward Inquiry	Investigate forces and motion
PM Session	Forces and Motion	Use math and science to solve problems
Day 2: AM Session	Light and Sound	Waves and Vibrations
PM Session	Electricity and Magnetism	Forces, Waves and Vibrations
Day 3: AM Session	Astronomy and Biology	Telescopes and Microscopes and Scale
PM Session	Math MindBug Buster Break	Math is the Language of Science
Day 4: AM Session	The Nature of Matter	Earth Cycles, States of Matter
PM Session	Connections	Physical and Chemical Changes



Content & Process Standards

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SAMPLE:

MATH AND SCIENCE CONTENT STANDARDS WILL BE CUSTOMIZED FOR WEST VIRGINIA UPON FINALIZING THE AGENDA AND TIMES.

Ten80 & National Science Education Standards Addressed

Day 5:

Science as Inquiry

Develop students' abilities to do and understand scientific inquiry.

- Ask questions that can be answered through scientific investigation.
- Plan and conduct simple investigations to answer questions.
- Gather data using simple tools that help quantify observations.
- Use math and technology like calculators, hand-held devices and computers to organize and understand data.
- Use data and organized results to construct and check reasonable explanations.
- Communicate the questions, investigations and explanations.

Understanding Science, Technology and the History of Science

- Science and technology have been practiced by people for a long time as a way to answer questions and explain the natural world. Science is one way of answering questions and explaining the natural world. People have always had problems and invented tools and techniques (ways of doing something) to solve problems.
- Scientists and engineers often work in teams; their individual and team results contribute to human knowledge.

Tools help scientists make better observations and measurements for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do. [Unit 1: Cycles in Nature](#)

- Identify matter as liquids, solids, and gases.
- Understand the significance of the nitrogen, water, and carbon cycles in relation to animals, plants, and ecosystems. For example, carbon dioxide is taken up by plants to be converted into sugars through photosynthesis. Some animals eat the plants and use the sugar for energy.

Physical Changes and Separations

- Observe and record changes in the states of matter caused by the addition or reduction of heat;
- Conduct tests, compare data, and draw conclusions about physical properties of matter including states of matter, conduction, density, and buoyancy.
- Demonstrate that some mixtures maintain the physical properties of their ingredients

Chemical Changes

- In chemical changes new products are present. Their new products have different properties from the original reactants.
- Collect and analyze information using tools.



Professional Development Agenda

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An Inquiry Event

Math and Science teachers are invited to attend these sessions together. There is some flexibility in the particular stations to be used but each one has been chosen to demonstrate a particular concept. The conceptual understanding on the part of the teacher is more important in these workshops than the particular activity used for demonstration purposes.

Session 1 AM	Format	Title	Overview
One Hour ex. 9-10 AM Introduction to MindBugs and Set-up of LogBooks	Whole Group Experience 60min.	GETTING STARTED Pass out MB cards and other paperwork that must be completed.	Present a MindBug from each topic to be covered. Attendees discuss within their group and place a marker in a container for T or F. At end each group score is tallied by presenter in private and the Winning MindBug Buster Team is awarded a sticker for their nametags. They will help with the first demonstration. Make Journals for the workshop and to demo how the journals can work in their own classrooms.
Two Hours 10-12:00 AM The Ten80 Tilt Toward Inquiry Experience the different levels of inquiry and determine when each might be appropriate in a classroom setting.	Whole Group Experience 20 min.	ENGAGE: TEN80 TILT TOWARD INQUIRY! What science and math concepts explain how things move in a circle?	At each group set up a different spinning demo. Give groups 5 minutes to explore what is on their table and attempt an explanation for the class. Explanations must be 1 minute of less by the clock. Suggested demos: gyroscope, Euler's Disk, Tops, Bike Wheel on a Stool, Momentum Disk or water on a swing on a string, Spinning on a string (like Newton did).
	BREAK 10 Minutes		
	Whole Group Experience 60 min.	EXPLORE: 3 KINDS OF INQUIRY 1, 2, 3, GO!!!!	Groups cycle through 3 areas in which they experience a lesson on one topic using (1) a "cookbook" lesson or Level 1 Inquiry; (2) a challenge which gives more control to the learner; and (3) an open ended approach.
	Whole Group Experience 30 min.	EXPLAIN: 3 KINDS OF INQUIRY And the Science and Math behind things that spin.	Discuss each group's impressions of the kinds of experience presented to them at each station. Show the stages of Inquiry PPT. Discuss what kind of inquiry might be appropriate in various situations.
One Hour 12 - 1 PM	LUNCH BREAK		

**Professional Development Agenda (Session 1 PM)
Hot Summer, Cool Math and Science: Forces and Motion**

Session 1 PM	Format	Title	Overview
<p>Thirty Minutes ex. 1-1:30 PM</p> <p>What did we learn? What do we understand about things that spin?</p>	<p>Whole Group Experience 30 min.</p>	<p>EVALUATE:</p> <p>WHAT ENDURING UNDERSTANDING MIGHT COME WITH THESE EXPLORATIONS?</p>	<p>Have each group fill out a questionnaire about what they observed and using a whiteboard determine some basic relationships between the variables in the preceeding session.</p> <p>MATH IS THE LANGUAGE OF SCIENCE! How did math help us to define and understand these relationships?</p>
	<p>BREAK 10 Minutes</p>		
<p>APPLIED MATH AND SCIENCE Ninety Minutes ex. 1:30-3 PM</p> <p>Take a spin around a track!</p>	<p>Whole Group Experience 60 min.</p>	<p>EXTEND:</p> <p>SAME IDEAS IN A NEW PROBLEM!</p> <p>MOTION IN A STRAIGHT LINE</p> <p>Set up an Experiment</p> <p>Scale; Ratios, Measurement and Graphing</p>	<p>When teaching motion in a straight line, a drag strip is a great model. Use fractions, scale cars, a measured track, scales and timers to find the top speed of a math2go radio controlled car on a drag strip.</p> <p>You will use math2go radio controlled cars to investigate the elementary science of motion.</p>
	<p>Whole Group Experience 60 min.</p>	<p>TURNS! DRIVE DEEPER INTO THE SUBJECT!</p> <p>Set up an experiment to determine a relationship.</p> <p>Use what you know about the Science and Math behind things that spin.</p>	<p>Turn the drag strip into an oval (actually half an oval or a U-turn). You will be given a challenge. Your job is to move a large amount of weight around the track in the shortest time. This is a Goldilocks problem. Too much weight on the car at one time and you make fewer trips but they are very slow. Too little weight and the car moves really fast but you must make lots of trips. Some amount of weight is "just right" to get the highest score in this challenge.</p> <p>Math and science with a little data collection and graphing can show even a third grade student how to find the answer.</p> <p>It's fun and the problem solving tools you gain in this activity will work on lots of other problems as well..</p>

Professional Development Agenda (Session 2 AM)
Hot Summer, Cool Math and Science: Waves and Vibrations_Light and Sound

Session 2 AM	Format	Title	Overview
Ninety Minutes ex. 9-10:30 AM WAVES AND VIBRATIONS: INQUIRIES INTO THE NATURE OF LIGHT	Whole Group Experience 30 min.	ENGAGE: WAVES AND VIBRATIONS LIGHT AND THE ELECTROMAGNETIC SPECTRUM	Rainbows in a tin. Make a rainbow using simple materials (water, fingernail polish, paper) and produce your own spectrum paper.
	Whole Group Experience 60 min.	EXPLORE: 6 STATIONS	Using lenses, lasers, mirrors and other simple objects, explore six activities to learn about the nature of light. (1) lenses (2) mirrors (3) hidden penny and Standing on Your Head (4) hole in one (5) What's the angle? (6) Pinholes
	Whole Group Experience 30 min.	EXPLAIN: WHAT WAS HAPPENING? GEOMETRY provides answers.	Light travels in a straight line at a very high speed. How can math help you understand and explain what you just experienced. With a dramatic look at light beams using lasers, mirrors and a puff of powder, we can understand much of what was illustrated in the stations.
	BREAK 10 Minutes		
Ninety Minutes 10:30 - 12 PM WAVES AND VIBRATIONS: INQUIRIES INTO THE NATURE OF SOUND	Whole Group Experience 30 min.	ENGAGE: WAVES AND VIBRATIONS SOUND	Using simple materials make a stethoscope to experience how sound travels to your ear and how it travels differently through various materials.
	Whole Group Experience 60 min.	EXPLORE: 6 STATIONS	Using simple objects, explore six activities to learn about the nature of sound. (1) drums and "seeing" sounds (2) resonance chambers (3) Pitch it! (4) Tuning Fork Fun (5) Straw Oboes (6) Stick 'n Slip
	Whole Group Experience 30 min.	EXPLAIN: WHAT WAS HAPPENING? MEASUREMENT provides answers.	Sounds are created by vibrations. Sound waves are fundamentally different from light waves. They are however the same kind of wave that produces earthquake damage. Sounds travel differently through different materials, With springs and slinky's and ropes, plus a few other simple objects, demonstrate the fundamentals of waves and vibrations.
One Hour 12 - 1 PM	LUNCH BREAK		

Professional Development Agenda (Session 2 PM)

Hot Summer, Cool Math and Science: Waves and Vibrations _ Electromagnetic Forces

Session 2 AM	Format	Title	Overview
<p>Ninety Minutes ex. 1- 3:30 PM WAVES AND VIBRATIONS: INQUIRIES INTO THE NATURE OF ELECTROMAGNETIC FORCES</p>	Whole Group Experience 30 min.	ENGAGE: WAVES AND VIBRATIONS ELECTROMAGNETIC FORCES	Show loadstone. Create a compass. Show where the magnetic pole is with relation to the North Pole of the earth.
	Whole Group Experience 60 min.	EXPLORE: 6 STATIONS	Using simple objects, explore magnetism. (1) Rods and Bending Water (2) Magnetic Fields (3) Newton's Cradle with magnets (4) Levitating magnets (5) Magnetic Racing (6) Electromagnets
	Whole Group Experience 30 min.	EXPLAIN: EVALUATE WHAT WAS HAPPENING?	Have each group propose an explanation for one of the stations. Discuss the basics of magnetism in terms of the explorations. Introduce the relationship between electricity and magnetism. Using strong magnets, pipes and other simple materials, gain a basic understanding of how electricity and magnetism are together the electromagnetic force. What does this term mean with relation to the electromagnetic spectrum?
	BREAK 10 Minutes		
	Whole Group Experience 30 min.	EXTEND: SMALL GROUP ACTIVITIES	Challenge: Which group can pick up the most paper clips with their electromagnet? and WHY

Professional Development Agenda (Session 3 AM)

Hot Summer, Cool Math and Science: Astronomy and Scale_Telescopes and Microscopes

Session 2 AM	Format	Title	Overview
15 Minutes ex. 9 -9:15 AM Weight and Mass Astronomy	Whole Group Experience 15 min.	ENGAGE: MASS VS WEIGHT	Show a scale model of the planets by volume, distance What is the difference between weight and mass? What is meant by scale? Show balance scale and digital scale and explain the difference in mass and weight.
One Hour 9:15 -10:15 AM Weight and Mass Astronomy	Whole Group Experience 60 min.	EXPLORE: ASTRONOMY AND THE MASS OF PLANETS	Use play doh and scales to learn more about the solar system, its scale and arrangement. Create a scale model by mass of the planets.
30 Minutes 10:15 - 10:45 AM Scale Models	Whole Group Experience 30 min.	EXPLAIN: WHAT WAS HAPPENING? GEOMETRY provides answe.	Using web and PPT, show how telescopes work to help us see things too ar away to study with our naked eyes. What other scale models can be made by the numbers? What mindbugs are planted by the scale models we use in our classrooms?
	BREAK 15 Minutes		
Ninety Minutes 11- 11:30 PM Life on a Micro Scale	Whole Group Experience 30 min.	EXTEND: MICROBIAL ZOO	JUST AS TELESCOPES HELP US SEE THING THAT ARE REALLY LARGE AND FAR AWAY, MICROSCOPES HELP US SEE THINGS THAT ARE REALLY SMALL AND CLOSE TO HOME. Show slides and pictures of some VERY interesting microbial specimens. Discuss the scale of a plant cell. Discuss the microscope and telescope in terms of the light sessions and the lenses and mirrors included in them.
30 Minutes 11:30-12AM Adding and Multiplying Tens	Whole Group Experience 30 min.	EXTEND: MULTIPLYING BY TEN AND RATIOS	Counting by Tens, Powers of Ten and What it means to multiply by ten. The only way to appreciate the scale of biology and astronomy is to understand what it means to move a decimal one place in either direction.
One Hour 12 - 1 PM	LUNCH BREAK		

Professional Development Agenda (Session 3 PM)
Hot Summer, Cool Math and Science: Math MindBug Buster Break

Session 2 AM	Format	Title	Overview
2 Hours 1 - 3:00 Math MindBug Buster Break	Whole Group Experience 30 min.	NUMERACY	Without a solid foundation in math, students will not be competitive in any field of science. There is no subject more important than numeracy and place value. We are going to go over the basics in the next hour.
	Whole Group Experience 30 min.	ABACUS	Manipulatives that teach conceptual understanding should include this tool. You should think of the abacus as a place value board. Count with me and if you are interested in learning more we can do follow up lessons online.
	Whole Group Experience 30 min.	ADD MULTIPLY NUMBER LINES AND SLIDERS AND COUNTERS	Using simple objects, explore magnetism. (1) Rods and Bending Water (2) Magnetic Fields (3) Newton's Cradle with magnets (4) Levitating magnets (5) Magnetic Racing (6) Electromagnets
	Whole Group Experience 30 min.	SUBTRACT DIVIDE NUMBER LINES AND SLIDERS AND COUNTERS	Have each group propose an explanation for one of the stations. Discuss the basics of magnetism in terms of the explorations. Introduce the relationship between electricity and magnetism. Using strong magnets, pipes and other simple materials, gain a basic understanding of how electricity and magnetism are together the electromagnetic force. What does this term mean with relation to the electromagnetic spectrum?
	BREAK 10 Minutes		
30 Minutes 3 - 3:30 AM Making Connections	Whole Group Experience 30 min.	PATTERNS AND 99 CHARTS	Math is the study of patterns. What does that mean and what are some of the number patterns in our base ten system?

Professional Development Agenda (Session 4 AM)
Hot Summer, Cool Math and Science: Earth Science and The Nature of Matter

Session 2 AM	Format	Title	Overview
90 minutes Cycles in Nature 9-10:30 Our planet is constantly changing. Natural cycles balance and regulate Earth and its atmosphere. These cycles do not occur in isolation. In each one matter combines into mixtures and solutions, changes states and undergoes various physical and chemical changes.	Whole Group Experience 10 min.	ENGAGE DEMO: Cycles in Nature and Mobius Strip Models	Introduce vocabulary and session topic with strips of paper printed with steps of rock cycle on one side and the water cycle on the other. Making and cutting a Mobius strip demonstrates the interconnected nature of these cycles.
	set up for each of six groups. 30 minutes	EXPLORE: Water Cycle in a Beaker	How Clouds Are Formed: make rain in a clear glass or plastic container with 2" hot water in jar covered with an inverted cup with ice sitting on its top. Discuss the steps of the water cycle. As time permits, make a model of the water molecule. Show how the oxygen and hydrogen atom are positioned on the periodic table.
	whole group investigation. 30 minutes	EXPLORE Rocky Filters in the Rock Cycle Use paper doll models to show how sand, clay and loam compare as filters.	Place a cup of kool aid polluted water at each group: Place a second polluted cup at each table: Muddy water, vinegar water, soapy water, oily water, salt water, salt/flour/water solution. At each group place a funnel and collection cup made from 2 liter bottles. Add filter paper, and either sand, clay, or loam to the funnels and cover with a second filter. Set a timer at each station to time how long it takes to pour kool aid through the filters. While you wait, discuss the steps of the rock cycle.
	Whole group discussion 10 minutes	EXPLAIN: The Venn of Cycles	Use a venn diagram to show that cycles involve the same processes and the same changes in matter. focus on changes of state and matter combining in mixtures and solutions, sometimes undergoing chemical changes and sometimes physical ones.
	10 minute break	Set up stations and next experiments	Place ice and heat water during the break
10:30-12:00 AM Whole group discussion 10 minutes	Stations 90 minutes	EXPLORE STATIONS	Cycle through 6 stations to explore changes in state, mixtures, and solutions (1) Liquid or Solid: Plasticity (2) Frosty (3) Chromatography of Plant Pigments (4) Evaporation Separation and Winter Scenes (5) Silly States of Putty (6) Soapy Solution Separations
One Hour 12 - 1 PM	LUNCH BREAK		

Professional Development Agenda (Session 4 PM)
Hot Summer, Cool Math and Science: The Nature of Matter and Connections

Session 2 AM	Format	Title	Overview
90 minutes 1:00-2:30 Chemical Changes	Whole Group Experience 10 min.	Explain: What observations were made at the stations completed in the previous stations?	Emphasize Vocabulary!!!! What methods of separation were modeled in the stations? What is the difference in a liquid, solid, gas, and a substance exhibiting plasticity? (Glass, Mantle Rock)
Engage in a whole group investigation. Think about an area of curriculum taught in elementary school that offers an opportunity to use this kind of mixture or solution as a teaching tool.	Whole Group Experience 60 min.	ENGAGE DEMO: (note: we can choose from a number of activities for this station.) Chemical changes: New products and blowing up balloons EXPLAIN THE REACTIONS	Advanced extension: Make an atomic model of the reactants with beads. From the model predict the weight of the product of this reaction. Create a ratio to find the amount of carbon dioxide that will bubble away. (This sounds more complicated than it is. It is a simple percent problem...:) Set up an experiment. Add vinegar to a known mass of baking soda. Take the temperature and watch the digital scale. Place a lighted candle into the top of the container and observe what happens. How can the periodic table help you make sense of this experiment. Each group uses the same ratio of reactants, weigh the beginning reactants and the end ones. Light a candle to see if the gas bubbling off might be carbon dioxide. Level 2 inquiry: Set up two bottles with clear liquids and balloons covering them One blows up the balloon and one does not. How might you determine why the reactions were different?
	Whole Group Experience 20 min.	EVALUATE: The Journeys of an Oxygen Atom	THIS IS A GROUP EXERCISE: As the story reaches each table, your group should add another adventure in the tale of our little oxygen atom. Create a story and diarama, poster or travel brochure about the path of a single oxygen atom as it travels through more than one of nature's cycles. Share your stories and illustrate in your presentation a knowledge of cycles, mixtures, solutions and changes of state.
	BREAK 10 Minutes		
One Hour 2:30 - 3:30 AM Making Connections	Whole Group Experience 30 min.	CONNECTIONS	Evaluation and review How can you begin to tilt your classroom toward inquiry? Web resources introduction and practice with web-ex support system.