BEST PRACTICES (adjusted for math, links with examples and/or hand outs are on the Best Practices link on GHS's site.

- **Fast Five:** Ask five short questions at the beginning or end of class. These can be done daily and used to review past skills, math terms, equations, and check for understanding of new ones. The teacher could even throw in a question about a new skill or standard to check for prior knowledge. Students hand these in, and the teacher can quickly assess what needs to be done in the classroom.
- **The Simple Stuff**: Display student work, decorate your room and make it easy to move around in, write what the student will learn on the board in a style they will understand, use a variety of materials, focus on real-world applications, no down time, use a variety of teaching strategies, post the expectations for class behavior
- **Students are Thieves:** They should preview the text selection by looking at the Title, Headings, Introduction, Every sentence, Visuals and Vocabulary, End of chapter questions, and Summary.
- **Pick One:** Ask students which assignment out of a selection of assignments they want the teacher to grade. For instance, pick which one of their homework assignments, one of their written math explanations, or which question or questions on their homework, or...
- **Exit Tickets:** Students write on a post-it note what they still feel they need more work on and/or what they feel they mastered that day.
- **CLOZE:** Works on reading comprehension by omitting words from a passage. A word bank can be provided. Once students have read a passage, make a paragraph highlighting the important concepts. Leave words out that require students to focus on what they've read. Leave out words form directions on solving math equations.

Compounds and Elements

Work Bank

be one Iron at heart has shockwave heavier heavier the stable our Without then but into Atoms, as Nuclear Stars such all Elements a

Now that the Universe had _____ _____ mainly in the form of Hydrogen, which even today still represents 90% of all Energy/Mass/Matter we see, Energy/Mass/Matter could start to clump together to form Stars. _____ _____ there would be no abundance of all the Elements we have in _____ Periodic Table because it is in the burning _____ of Stars where Radioactive Fusion reactions occur which create all the familiar Atoms such _____ Oxygen, Chromium, Bromine, Zirconium, Samarium and Selenium. However Stars have to _____ more massive than our Sun to create the _____ _____ as only inside their cores can the temperature and pressure get so high as to cause _____ Fusion of the lighter Elements. The story doesn't stop there, because once a highly massive Star _____ turned _____ its fuel _____ _____ it begins to contract and loses energy _____ a prodigious rate _____ there is still _____ final twist in this tale. If other matter crashes into _____ Iron core the result is _____ cataclysmic explosion called a SuperNova. This scatters all the Elements which the Star had accumulated and also as the temperature and pressure, again, is higher than ever before in the Star's life, yet more _____ Elements are created in the tremendous _____ of the SuperNova. Even unstable Radioactive Elements _____ as Uranium, Polonium and Francium can be made and are _____ thrown out into the depths of Space by the continuing explosion.

- **Homework Checkers:** Place students in groups (according to which assignment they had if differentiated instruction is used). *Students* discuss the answers and come to an agreement on which ones are correct and why. Teacher walks around and moderates, breaks ties, adds explanations... Students staple all of their work with the final correct version on top. The teacher can collect the groups' stapled work to quickly see who did the homework and if any skills need more focus or if any student(s) need more help.

- **Centers:** Have students work through different skill centers and check their groups' or the individual's work with a key. There is a folder with the assignment and handouts for each center. There is a folder with the key for each center. If the group or a student does not make a certain % or misses more than a certain number of questions, they must meet with the teacher to discuss why they missed it and receive reteaching. Some great discussion occurs within the group or between individual students and the teacher.
- **Even Dozen**: Used to summarize, synthesize, or review in small groups. You can also use fewer boxes. Another way this can be used is for the teacher to fill out the boxes with problems or math terms. Each student can pick a box, then solve and explain how the problem is solved.

Jan Rozelle and Carol Scearse: *Power Tools for Literacy and Learning, 2007*

After reading a passage, article, book, or viewing a movie or presentation, group students and have each group draw 12 boxes (large enough to write in) on a sheet of paper. Students then think about the main concepts and ideas, writing one in each of the 12 boxes. Now it gets fun. One student chooses a box and tells about its contents then writes 1 in the box. Going in one direction, the next student picks a box, writes a 2 in it, tells what he or she knows about its concepts, and then must relate box 2 to box 1. The next student chooses a box, writes 3, explains what's in the box, and then connects it to box 2 and box 1. With each box chosen, it gets more challenging for the student. Any student can get help from another or from his or her notes or text.

- **Paperless Classroom:** If you've got dry erase markers and desks or windows, let the students write on them. They love the change, checking their progress is easy, and cleanup is a breeze. Just use paper towels and some spray if necessary. A word of warning, red doesn't erase easily off of desks. You can always purchase shower board at 8 to 12 dollars a sheet and easily cut at least ten large mini dry erase boards for the students. They also love using these, wipe clean with a paper towel, and all students have to do is hold up their board, so you can check their answers. Hint: Give them two minutes to draw a picture and have the class vote on the best. That will get the urge to get off task out of the way.
- **ChaCha Cheaters:** Got a tough math assignment? Let the students call ChaCha for one answer. It can be a group's lifeline. Text 242242 or call 800-224-2242
- **Hot Seat**: Using post-it notes, write questions and stick them underneath the students' desks or chairs. Great for a review or check for understanding.
- **InterWrite Board:** Bought for math department. Gets the student's involved! See Richard Tipton
- **PQR2ST+:** Format for students to read, take notes, and study.

PQR2ST+ WHAT IS THIS???

PQR2ST+ is a note-taking and study method that can be used by the individual student when learning new information.

DIRECTIONS:

PREVIEW

Title, introduction, subtitles, pictures, charts, maps, graphs, bold print & italics, summary, end questions

QUESTION

Write a subtitle-related question on left side of 2-column notes.

READ

Read silently from the subsection, thinking about how you will summarize the passage in your own words

REMEMBER

Summarize into 2-column notes in your own words ***with book closed***

SCAN

Rapidly go over the same subsection of text, looking for missed details or errors in your first summarization

TOUCH-UP

Add any important details to your notes, like the answers to your questions.

+ Go back and study your notes within the SAME day, the NEXT day, and again the day BEFORE the test or quiz

- **ABC Review:** From a container, students draw tiles with letters on them. Then students need to make a statement about the topic beginning with the letter. For example, A - area = B- brackets are used to show….. C - cosine…..
- **Wake Up!**: Susan McNabb has some tried and true ways of pumping O_2 into students' brains.
  - Over the previous weekend I (Susan) was thinking how my 1st period class seemed to be "tired," and I needed something to "pick them up" right before we took a quiz. I found this activity in Spencer Kagan's book "Silly Sports and Goofy Games." This activity takes 10-15 minutes if the balloons are already inflated.
  - I inflated 6 balloons (each one a different color). My class is already formed in teams, so I took the teams into the hallway and had them form circles by holding hands (or hold wrists). Players bounced a balloon in the air without letting go of their hands. They used hands, heads, elbows, feet, or any body part to keep the balloon afloat. If they broke the circle or allowed the balloon to touch the ground, they were "out."
  - Something else I've done from this book that is a good 1/2 through the period breaker. This is a Pair Balance. Shoulder partners face each other with their arms fully extended forward. They place the palms of their hands against the palms of their partner's hands, leaning forward, supporting each other. They must lean forward from their toes, with their entire body straight, not bending at the waist. Each player in turn slowly takes a baby step backward, taking care to continue supporting their partner. They continue taking turns making tiny steps backward until they are both leaning at a considerable angle, supporting each other. Very slowly, the players let go of one hand, supporting themselves with the other pair of hands. With their free hands they "wave to the crowd." Finally the pair reconnects their free hands to wave to the real or imaginary crowd on the other side.
  - This activity can also be done with partners touching their toes and leaning out with a straight body to then "wave at the crowd."
- **Cooperative Learning**: Numerous ways for students to talk AND learn.
- **Jigsaw** - Groups with five students are set up. Each group member is assigned some unique material to learn and then to teach to his group members. To help in the learning students across the class working on the same sub-section get together to decide what is important and how to teach it. After practice in these "expert" groups the original group reform and students teach each other. (Wood, p. 17) Tests or assessment follows. Differentiate the groups by assigning a more difficult selection or math process to teach.
- **Think-Pair-Share** - Involves a three step cooperative structure. During the first step individuals think silently about a question posed by the instructor. Individuals pair up during the second step and exchange thoughts. In the third step, the pairs share their responses with other pairs, other teams, or the entire group.
- **Three-Step Interview** (Kagan) **-** Each member of a team chooses another member to be a partner. During the first step individuals interview their partners by asking clarifying questions about problem solving, terms. During the second step partners reverse the roles. For the final step, members share their partner's response with the team.
- **Three-minute review** - Teachers stop any time during a lecture or discussion and give teams three minutes to review what has been said, ask clarifying questions or answer questions.
- **Numbered Heads Together** (Kagan) - A team of four is established. Each member is given numbers of 1, 2, 3, 4. Questions are asked of the group. Groups work together to answer the question so that all can verbally answer the question. Teacher calls out a number (two) and each two is asked to give the answer.
- **Circle the Sage** (Kagan)- First the teacher polls the class to see which students have a special knowledge to share. For example the teacher may ask who in the class was able to solve a difficult math homework question, who figured out the word problem…Those students (the sages) stand and spread out in the room. The teacher then has the rest of the classmates each surround a sage, with no two members of the same team going to the same sage. The sage explains what they know while the classmates listen, ask questions, and take notes. All students then return to their teams. Each in turn, explains what they learned. Because each one has gone to a different sage, they compare notes. If there is disagreement, they stand up as a team. Finally, the disagreements are aired and resolved.
- **Partners** (Kagan) - The class is divided into teams of four. Partners move to one side of the room. Half of each team is given an assignment to master to be able to teach the other half. Partners work to learn and can consult with other partners working on the same material. Teams go back together with each set of partners teaching the other set. Partners quiz and tutor teammates. Team reviews how well they learned and taught and how they might improve the process.

- **Anticipation Guides**: Great for making sure students get exactly what you want them to get out of reading nonfiction text. Great for introducing new concepts and strategies in math. All you have to do is come up with statements, for example,

Title: _____ *Anticipation Guide*

Directions:

Before reading: Place a check by the statements you agree with or think are true. Leave the others blank.

During reading: Add new check marks or cross out those that you've discovered are wrong. You then must PROVE your answer for ***each*** of the statements whether they are checked or not. To do this, simply write down the words and page number(s) or the paragraph number(s) and page number(s) underneath each statement.

After reading: Discuss your answers with others until a consensus can be reached. Use your proof to persuade.

_____1. Function establishes a relationship between two quantities.

_____2. A linear equation is one that, when solved, you can graph a straight line.

_____3. The x-axis and the y-axis divide coordinate planes into two quadrants.

_____4. To analyze the relationship between 2 quantities, you can use a scatter plot.

_____5. A variable is a letter that represents one or more numbers.

_____6. Three steps to solving simple equations with variables are write the expression, substitute numbers for the variables, and then simplify the numerical answer.

_____7. 4^6 is called a power. The exponent 4 represents the number of time s the base 6 is used as a factor.

_____8. If a pitcher throws a baseball at 90 miles per hour across the 60.5 it takes to reach home plate, it would take the ball about .46 sec.

- **Questions Only**: Used for nonfiction and literary texts, students respond to text in a unique way. Students use post-it notes to ask questions in their text as the read a selection or a new concept. The questions can then be answered in groups or in a whole class setting.
- **Timeline Makers for Students**: Free online timelines students can make and print.
- **Thinking Maps Online:** The thinking maps in word documents.

Writing in Math?!?!

Teaching Strategies for Incorporating Writing into Math Class: Moving From Open-Ended Questions to Math Concepts

Starting Out Gently with Affective, Open-Ended Prompts

Writing about thinking is challenging. For this reason, it's best not to start out having students write about unfamiliar mathematical ideas. First get them used to writing in a math class:

Begin with affective, open-ended questions about students' feelings.

> Sample Direction #1: Reflect on your participation in class today and complete the following statements:
>
> I learned that I...
> I was surprised that I...
> I noticed that I...
> I discovered that I...
> I was pleased that I...
>
> Sample Direction #2: Describe how you feel about solving _____ problem.

- Have students write a "mathography"-a paragraph or so in which they describe their feelings about and experiences in math, both in and out of school. (This is a good tool to get to know students early in the year, and to make comparisons later when looking for signs of progress.) (see **Mathography Prompts**)
- Find ways to keep students writing for the allotted time:

Encourage students to keep their pencils moving.
Try requiring 20 words per answer, even if they have to copy the same words again to reach 20.
Use a timer. Ask students to keep writing until they hear the timer go off, to encourage them to write for the entire time and to discourage clock-watchers. Start by giving them two minutes to write, and work up to five or ten minutes at a time.

Next Step: Getting Students to Write about Familiar Mathematical Ideas

1. Once your students have become accustomed to writing about their attitudes and feelings toward mathematics in their journals, they are ready to write about simple, familiar math concepts. It is important not to make the writing too difficult by asking them to write about unfamiliar math ideas. Using writing to review familiar math ideas will increase confidence and skill in writing as well as revisit important math concepts.

> Sample Directions:
>
> Explain in your own words what subtraction means.
> Explain what is most important to understand about fractions.

2. Use student writing samples to help them refine their writing. (Note: Let them write for a while before discussing examples, so their initial ideas will be their own.)

3. Introduce the term metacognition to help students understand the reason and audience for their writing.

Moving On: Writing about More Advanced Math Concepts

When you feel your students are ready, ask them to write about more complex mathematical ideas, including concepts being taught at their current grade level. To help you move your students into this more advanced level of writing about their thinking. Here are some other suggestions to help you:

1. Encourage your students to use drawings and graphs to explain their thinking.

- Research shows that using simple visual aids (diagrams, graphs, etc.) improves mathematical problem-solving ability, especially in female students.

2. As student writing progresses, ask students to write about their small group work.

- Ask the group to write a summary of how they reached a solution, including any "false starts" or "dead ends."
- Ask each individual to write an explanation of the group's work on a problem. Have the small groups discuss the individual explanations.
- After a small group assignment, have students "explain and illustrate two different approaches to solving a problem."

Writing *Opportunities* in Math Class

How and When to Use Journal Writing

1. When new material has been introduced.
Ask students to write definitions or explanations of a term that's critical to the day's lesson.

> Sample Direction: "Explain in your own words the meaning of the term _____."

2. When the class looks disengaged or confused.
Ask students to write an explanation of something you were doing or a term you used. Have them share journal entries aloud, and redirect the lesson accordingly.

> Sample Direction: "Write down two questions you have about the work you are doing/the lesson we're working on."

3. When collaboration with fellow students is appropriate.

Have students form small groups and work together to solve a problem on paper. This will get them to talk to each other-to ask questions and give explanations-all with the common goal of solving the problem.

4. When teaching the value of revising their work.

Occasionally ask students to pick a journal entry and revise it. This helps emphasize that journal writing is an initial effort that can be rethought and improved upon-the end product is less important than the process.

> Sample Direction: "Review the last three entries in your journal. Select one to revise." Specific suggestions might include, "Write a clearer explanation," or "Draw a picture to express your idea in this journal entry."

Sample Journal Questions/Writing Prompts

Writing prompts can take many different forms. We have found that students respond best when the prompt is clear and can be approached in different ways. We recommend prompts that do the following:

1. Pinpoint a confusing or easily misunderstood mathematical idea

> For Example: "Do 0.2 and 0.020 equal the same fraction? Explain your answer."

Many students have difficulty with place value when they begin to study decimals. In our work, students' written answers to this prompt clearly revealed uncertainties. As one student responded: "The zeroes don't matter, so .2 equals .2." This student does not appear to have a good understanding of place value, having over generalized the "hint" to ignore certain zeroes. Another student drew two grids in response to this prompt. In one grid she colored in two rows of tenths and in the other grid she colored in two hundredths. She concluded that 0.2 was "way more" than 0.020. Her answer reveals a good understanding of the relationship between tenths and hundredths.

2. Can be solved using different strategies

> For Example: "Allison's team won 8 out of 10 games. Jennifer's team won 15 out of 18 games. Whose team won a greater fraction of its games? Explain your answer."

Students used different strategies to approach this problem . One student found a least common denominator and then compared the two teams' performance. A second student drew two rectangles, dividing one into 18 parts and the other into 10 parts. He then colored in 15 and 8 parts, respectively, of each rectangle. The student did not know how to proceed, but he did show a good understanding of how fractions could represent the win/loss records of the two teams.

3. Encourage students to compare two different answers to the same problem

> For Example:
>
> "Who is correct? The problem: Which fraction is biggest? 1/3 or 2/5?"
>
> Jamar's solution: 2/5 is bigger because 15 is the LCD and 1/3 equals 5/15.

2/5 equals 6/15. So 2/5 is biggest.

Bill's solution: I used the calculator. I made them decimals and then compared the decimals. For 1.3, I divided 1 into 3 and got 3.0. Then I divided 2 into 5 to get 2.2. 3.0 is bigger than 2.2, so 1/3 is biggest.

This prompt encourages students to consider two very different approaches to the same problem: the least common denominator (LCD) method taught in the text and a calculator. The two offered solutions also model fairly clear explanations. In this case a correct and an incorrect solution are offered. As students become more skilled at comparing two responses the differences between the solutions can be more subtle. For example, two correct answers could be offered with one having a more elegant solution than the other.

Managing Math Journals: Helpful Tips

1. Provide students with thin, inexpensive journals. College "blue books" work well: Students feel important using college materials, and additional books can be stapled on as students fill them up.

2. Keep journals in class. Collect math journals each day so as not to lose them.

3. Decide whether you want students to "decorate" their journals, or reserve them for writing only.

4. Decide on a system for identifying journal entries. Rather than having students take time to copy the writing prompt, have them number or date the entries.

5. Develop system for distributing and collecting journals each day. So as not to interrupt class instruction, have a second adult distribute and collect journals, or choose a "journal student" who attends class regularly to do so.

6. Use a timer for some journal assignments. This will help keep students writing. Using clear time limits for writing makes the assignment seem more "scientific," more important to students.

Encouraging Students as They Write

1. Be patient. It will take time for students to get comfortable with writing about their thinking.

2. Tell students you understand how new and different this is for them. Remind them that there are no "wrong" answers in writing about thinking.

3. If students indicate they have no more to say:

- Read over what they've written. Ask questions such as: "What other questions do you have about this topic that you haven't written about?" or "What's another way this could have been said?"
- Have them copy what they've written, so they'll get the idea that they are to write for the whole time given. (Often, they'll get bored with copying and begin writing something new.)

4. Ask students to choose a journal entry to revise.

- Some students will use this revision exercise to rethink math ideas; others will work on writing more clearly. Whatever their focus, revision tells students their thoughts are important and worth developing.

5. Provide feedback.

- Let students know you took time to read their journals.
- You won't have time for in-depth comments on each journal for every assignment, so try other kinds of feedback, too: Yes, even high schoolers like these.
  Stars Stickers Smiley Faces
- Put stars by sentences that helped you see their thinking.

6. Clearly communicate to students the purpose of writing in math class.

- Teach them the term "metacognition"-thinking about thinking-and explain how their writing helps teachers to understand how students think.
- Other purposes of writing: Writing is a concrete way to show students' thinking that they can look at and think about. Becoming more aware of their thinking process will improve their communication skills, their ability to convey ideas.

7. Use students' writing samples to help them refine their writing.

- Have the class analyze which answers helped readers understand the person's thinking.

Mathography Prompts: Here are some ideas for prompts to get students to write a "mathography"-a sort of autobiography of their history with mathematics:

1. Write down some of the early math accomplishments that you remember from when you were little. For instance, when and how did you learn to count? How old were you when you could first count to one hundred? Who taught you? How did they teach you? Did you "show off" this new talent to others?
2. When you were in first, second, or third grade what did you like about math? What didn't you like about math at that time?
3. What do you remember about learning to add and to subtract? Which did you think was more fun? Why did you like that one better?
4. What was your teacher's name in first, second, or third grade? _____ What kind of teacher was he or she in regard to teaching mathematics?
5. Did you have any "tricks" you used to remember adding or subtracting?
6. In what ways is adding and subtracting important?
7. Was math ever your favorite subject? _____ If so, when was it? What about math made it your favorite? If math has never been your favorite subject, what about it do you not like?
8. From your experience, do you think boys or girls tend to like math better? What makes you think this?
9. Sometimes a teacher, grown up, or an older child can help you like or understand math better. Did that ever happen to you? If so, tell about it. If not, tell about how that would have made a difference for you.
10. Sometimes people can recognize a time when their opinion of math dramatically changed either for the better or the worse. If such a time happened for you or for a friend of yours, tell about it. If you did not experience such a thing, tell about your steady feelings about mathematics.

11. Lots of times students think what they learn in math is only for the classroom and is really not of much use outside math class. Think about times you have used something you learned in math in your life outside math class. List some of those times when you used math outside of school.
12. What year in school was math the best for you? _____ What made it a good year in terms of math?
13. What year in school was math one of the worst for you? _____ What made it a bad year in terms of math?
14. If you were in a lengthy conversation about math or math class with friends of yours, what would be some of the things you would say? What would be some of the things they would say?
15. Draw a picture of you and the idea of mathematics.
16. Draw a picture of all you know about mathematics.

Best Practices Specific to Math

Math in the Real World: Students use algebra to analyze variable pricing of local cell phone plans. All students either have or want a cell phones, so this topic is a natural. Advertisements from cell phone companies typically emphasize low monthly rates, but additional charges --

such as for texting -- can push actual costs higher. Ask students to look at all of the details of a phone plan to create an equation that will reflect the real cost, and then please tell me because I think cell phone plans are the most complicated things in the world. Students can make graphs, evaluate their cell phone use, present the results, vote on the best plan.

A Hands-on Approach to Slope by Connie Rose, South Louisiana Community College

Slope is a rate of change, not a formula to be memorized. This concept can be understood by kinesthetic and visual learners using a concrete model, a set of stairs, to illustrate steepness. To climb stairs, one steps up before stepping forward. Since slope is a rate or ratio usually written in fractional form, the numerator (vertical change - stepping up) is written first followed by the denominator (horizontal change - stepping forward). By color-coordinating the links used to build the stairs, students can easily count the blocks rising and the blocks across. To reinforce the concept, students make their own set of stairs given a certain slope.

Rulers are used as ramps to demonstrate the steepness of each set of stairs. The sets of stairs are arranged in order according to steepness of the ramp. The numerical slope values are written on the board in corresponding order. Students observe that the slopes are ordered from largest to smallest and make the connection that the la rger the slope, the steeper the ramp.

The approach then moves to graphs on the coordinate plane and an input-output table. On the graphs, slope is determined by counting vertical spaces compared to horizontal spaces moving from one point to another on a line.

The idea of counting is carried from the concrete model of stairs to the picture of the line. Points on the line are matched to data entries in the table. Slope is then calculated by finding the change in output as compared to the change in input.

Algebra Activities for Kinesthetic Learners by Anita Hughes, Big Bend Community College

A group of 20 of the worst math students was assembled and efforts were made to find effective methods of teaching them algebra. The following are some examples of activities found to be successful with these students.

To simplify a square root, the instructor began with a collection of objects, some of which were alike, in a plastic zip bag. The bag represented the radical itself, which can be seen as a container. If the bag had two identical objects, the pair was taken out putting one object on one piece of paper and the other on another piece of paper.

Everything left in the bag stayed under the radical sign.

To distinguish factors and terms, the instructor gave students scissors and strips of paper with polynomials typed on them. The students were asked to cut each strip into pieces containing only one term, p lacing positive terms on a piece of black paper and negative terms on red paper. Students then cut terms apart into separate factors.

Like terms were modeled using red and white pipe cleaners with colored beads . Red pipe cleaners represented positive terms while white represented negative terms. One kind of bead was x, another was y. Students modeled terms such as $xyyxyyxx$, then discussed the purpose of exponents. Many other such activities were also used.

A Discovery and Calculator Exercise for Rules of Exponents by Roberta Lacefield, Waycross College

The exercise below can be used as an in-class activity or can be assigned for homework. It can be performed individually, in small groups, or with an entire class. Each approach has its advantages and disadvantage s. The exercise itself is designed for the following purposes:
1) to give students experience in using t he calculator to calculate roots and powers by requiring the use of
a. appropriate grouping symbols for bases and exponents
b. root keys
c. power keys
d. calculator conversion to a fraction
e. interpreting error messages
2) to lead students to disco very of the following rules o f exponents
a. $x1/2$ = and $x1/3$ =
b. $x!2$ and $!x2$ are additive inverses, but $x2$ and $x!2$ are multiplicative inverses
c. $x0 = 1$ for $x . 0$
d. $x1 = x$
e. when the base/radicand is negative , $x1/2$ and are nonreal
3) to help students understand that rules in mathematics are concise descriptions of patterns and that exceptions to the argument/domain reflect deviations from the pattern.
Students fill in the table below one row at a time. Once the table has been completed, they are asked to describe the patterns they see. As rules are described, they are written and kept a s a class reference. If a pattern has an entry that is an anomaly or contains an error message, the class discusses whether it was an error in the calculator entry or a restriction on the domain.
The exercise challenges students of all levels. When asked to identify patterns, most students can find something. Some patterns are relatively simple, while others are complicated and lead to opportunities for exploration. The students are often surprised at the number of patterns and that the patterns reflect rules learned. The c hart helps them move from concrete to the abstract.
Directions: Use your calculator to find the values. Write the result in the appropriate box. If your calculator displays an error message, write in the type of error. If your answer is a decimal, convert it to a fraction. If it is irrational, round to the thousandths place.

x	x^1	x^0	x^2	x^{-2}	$-x^2$	$x^{1/2}$	$\sqrt{x}$	$x^{1/3}$	$\sqrt[3]{x}$
0									
1/4									
1/8									
1/64									
1									
2									
4									
27									
-1/4									
-1/8									
-1									
-4									

Bouncing Ball Experiment by Roberta Lacefield, Waycross College

The exercise below is a data collection and analysis activity. It can be used to explore concepts related to graphing linear relationships. The objectives are gathering and organizing data, determining independent and dependent variables, and determining rate of change.

Initial height	Rebound	Rebound	Rebound	Average Rebound	(x,y)	Rebound rate $\Delta x/\Delta y$
0	0	0	0	0	(0,0)	

Part 1: Collecting the Data

1. Use a yardstick to pre-measure and mark a height from which you will drop a ball. Record the height in the first column of the table. This is called the *initial height* because it is your starting point.
2. Ask one person to drop the ball from that height while all other group members visually identify the maximum height of the first bounce (the rebound height). Measure and record this height in the second column of the table.
3. Drop the ball two more times from that same height. Record the rebound heights in the third and fourth columns.
4. Pre-measure and mark a new initial height that is not close to the previous one. Repeat the steps above.
5. Continue until you have at least four different heights.

6. Use your calculator to calculate the average rebound. Fill in the fifth column with your averages . Discussion: Why do we repeat the rebound experiment instead of just taking the first result? Should the average be rounded?

Part 2: Graphing the Data by Hand

1. The pairs of data to be graphed are the *initial height* and the *average rebound*. The two parts of a pair of data are the independent (x) and dependent (y) variables. Since the _____ depends on the _____, we will call _____ _____ __ the x values and _____ _____ the y values.
2. Determine the scale for each set of data. Discussion: Will negative numbers be included? Will all quadrants be needed? Is there enough space to use consecutive integers or will the scale need to be changed? What is the largest number to be included? Why is the point (0,0) already included on the table?
3. For each independent variable, determine the value of its corresponding dependent variable and fill in column six of the table. Locate these ordered pairs on the graph and plot the points.
4. Draw the line of best fit, that is, a straight line which is as close as possible to *all* the data points. It may miss some points, but all points should be close. Estimate the slope of this line, m = _____.
5. Fill in the last column of the table. Convert each rate into a unit rate. Discussion: Describe what the rebound rates mean. Compare the unit rebound rates to the slope of the line. Is there a pattern?

Part 3: Graphing the Data Using a Calculator

1. Using the <ST AT> feature, enter the information to be graphed. Put the information from column 1 into the tab le under L1. Put the information from column 5 into the table under L2.
2. Turn on the STAT PLOTS 1.
3. Use the <WINDOW> feature to set up the x and y scales. Type in the same values as used when graphing by hand.
4. Use the <GRAP H> feature to draw the graph. Does it look like the one you did by hand?
5. Follow your teacher's instructions to have the calculator draw the line of best fit and determine the equation of the line.

Author!!! Author!!! Author!!! by Josette Ahlering, Central Missouri State University

Teaching students to solve word problems is not easy. Just the mention of word problems sends students running. One of the reasons students do not do well with these types of problems is their weak reading skills. Their knowledge of words and mathematical nuances is poor. However, it is possible to increase students' awareness of words and their meanings by having them write their own problems. Tell them this is their chance to get even for all the boring unimaginative word problems they have had to solve.

While this provides an opportunity for students to be creative, they should adhere to the styles used in class. Each student should not only write a problem, but also solve and check it as well. For added motivation, tell the class that one or two of the best problems will be included on the next test. Students usually take one of two approaches to this assignment. The first is to write an equation and then make up a story line to fit the equation. The second involves writing a story and then developing an equation to fit the story. Both methods require students to make sure the words they use properly define the situation. The second approach is usually harder. Students frequently discover the numbers used in their stories are more challenging than those used in the text. Many will then attempt to change the numbers to make the calculations easier. They soon discover this can be harder than they realized. After grading the problems, use some class time to discuss the types of mistakes that occurred, verbally, logically, and

mathematically. Also, give students an opportunity to share their problems with each other. Since one or two will show up on the test, this can be a lively activity.

Radicals and Noah's Ark by Jacqueline Bakal, Felician College
Simplifying radicals is a difficult topic for developmental mathematics students. Some years ago, the Broadway play "Two By Two" showed how Noah only took animals onto the Ark in pairs. Using this metaphor can help students understand the simplification of radicals by explaining that all pairs under a radical must come out, while single factors must remain under the radical. For example:
$x2 \square x$ because one pair comes out,
$x3\square \quad x2\cdot \quad x\square x\, x$ because one pair comes out and one single factor stays in,
$x4\square \quad x2\cdot \quad x2\square x2$ because two pairs come out,
$18\square \quad 32\cdot \quad 2\square 3\ 2$ because one pair of 3's comes out and the 2 stays behind.
In addition to helping students comprehend the concept, the metaphor also helps them remember the method because of the unique way it is explained.

Assessments for Learning:

Accuracy & Reasonableness (AR) "Defending/Connecting it"

A. Calculations/diagrams are

5 COMPLETELY accurate.

4 BASICALLY accurate.

3 PARTIALLY accurate.

2 ATTEMPTED, but incorrect.

1 Missing.

B. Solution is

5 Justified, verified, AND extended.

4 Justified, verified, OR extended.

3 PARTIALLY justified, verified, or extended.

2 UNSUCCESSFULLY justified or verified.

C. Connections are

5 Made between solution and general situations.

4 BASICALLY made.

3 PARTIALLY made.

2 ARE ATTEMPTED.

1 Not made.

D. Work is

5 Checked a DIFFERENT way.

4 Checked same way as originally.

3 Checked SOMEWHAT.

2 Checked with INAPPROPRIATE method(s).

1 Not checked. 1 Missing or there is only an answer.

Communication of Reasoning (CR) = "Explain it"

A. Math terms are

5 ALL used correctly.

4 MOSTLY used correctly.

3 PARTIALLY used correctly.

2 Used INCORRECTLY.

1 Not used.

B. Thinking is

5 THOROUGHLY explained.

4 BASICALLY explained.

3 PARTIALLY explained.

2 ATTEMPTED to be explained.

1 Not explained.

C. Solution explanation is

5 COMPLETELY understandable.

4 BASICALLY understandable.

3 PARTIALLY understandable.

2 CONFUSING.

1 Not given.

D. Work is/has

5 Clearly presented and VERY logical.

4 CLEARLY presented with some logic.

3 SOME logic.

2 WITHOUT logic.

1 Not (or little) given.

Conceptual Understanding (CU) "'What' of it"

A. Understanding of problem is

5 THOROUGHLY demonstrated.

4 BASICALLY demonstrated.

3 PARTIALLY demonstrated

2 INCORRECTLY demonstrated.

1 Not demonstrated.

B. Problem information/data are

5 Used CLEARLY & WELL.

4 Used ENOUGH.

3 MOSTLY used.

2 Used INCORRECTLY.

1 Not used.

Checklist: Solving Mathematics Problems

My work will be more successful when I . . .

1. Problem solve correctly. That means I . . .

_____Made a plan and used it to solve the problem.

_____Verified or checked my solution.

2. Use mathematical language correctly. That means I . . .

_____Used correct math terms.

_____Used mathematical language that is clear and appropriate so that my solution is meaningful.

3. Communicate clearly. That means I . . .

_____Used a diagram, chart, table, graph, and/or word picture to help solve the problem.

_____Made the representations in my solution clear to read when they are read by others.

4. Make connections. That means I . . .

_____Know of other ways to get the answer.

_____Extended the solution to the general case.

_____Showed how this problem related to other problems, mathematical ideas, or applications.

5. Make a quality presentation. That means I . . .

_____Showed the steps to getting the solution.

_____Had a solution that was clear for others to follow and understand.

Student Self-Assessment

Name _____

Class period_____

Skills assessed:

1.

2.

3.

Item #	Right	Wrong	Careless mistake?	Skill (s) See above	Don't understand (Explain)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Math Websites for Teachers (and students)
Links on the Instructional Technology page

STEM: Assessment Collection and Activities! Lesson and Unit Builders http://www.stemresources.com/index.php?option=com_content&view=section&id=5&Itemid=55
Cut the Knot: Interactive mathematics collection and puzzles for " engaging mathematics" http://www.cut-the-knot.org/
National Council for Teachers of Mathematics (NCTM),: great interactive content for students. real-world applications, excellent place for students to find inspiration for projects. http://illuminations.nctm.org/
Math is Fun: Illustrated math dictionary, lessons for algebra, measurement, geometry, graphics are a bit young http://www.mathsisfun.com/definitions/index.html
Jefferson County Math Sites List: tons of sites! http://jc-schools.net/tutorials/tools/math-hs.html
Finance Freak: recommended site that teaches about stocks, banking, retirement, etc. has a very busy background and an annoying mouse effect http://www.financefreak.com/
Math.com: The usual good stuff like lessons, resources, professional development, games, work sheets http://math.com/teachers.html
Mathworld.com : The information is through, demonstrative, and accurate. It also includes extensive resources on mathematics history. http://mathworld.wolfram.com/
The Math Website: resources for teachers, students, as well as parents, lessons, puzzles, activities, and games that can be used in all levels of mathematics, 'math gadgets' to customize your own website with puzzles, humor, and riddles." http://www.themathwebsite.com/ListOfTopics.php
Texas Instruments: Lessons and activities to use with your TI calculator, weekly lessons and activities can be emailed. http://education.ti.com/educationportal/sites/US/sectionHome/gs_main_hs_math.html
Internet4classrooms: 103 math activities, sites, online quizzes and tests, and/or lessons for high school math subjects http://www.internet4classrooms.com/math_sec.htm
Nrich: Specialists in rich mathematics, great resources to use in the classroom http://nrich.maths.org/forteachers
Numb3rs : math activities using the TV show http://www.math.cornell.edu/~numb3rs/
Math10 Online: Math Forum Math Books Algebra Problems Geometry Math Tests College Mathematics Math History Games http://www.math10.com/
teAchology - Worksheets and activities for math
PICK ME!: Tons of resources. http://score.kings.k12.ca.us/r.9.12.html
Best Practices/Technology in Math: http://www.remc11.k12.mi.us/bstpract/bstpractNew/MathamaticsHS.html
More great resources ready to use: http://jc-schools.net/tutorials/pre-algebra/
And even more: http://jc-schools.net/tutorials/tools/math-hs.html

Math Academic Vocabulary Terms

http://jc-schools.net/tutorials/vocab/ for flashcards and games

Algebra II	**Geometry / Technical Geometry**
Cartesian plane	adjacent
completing the square	altitude
complex numbers	angle of depression
conic sections	angle of elevation
conjugate (complex)	bisect
correlation	central angle
Cramer's rule	chord
delta Δ	complementary (expressed algebraically)
dependent/ independent	congruence
events	conjecture
factorial	corresponding parts
functions (exponential, polynomial, logarithmic, etc.)	deductive reasoning
	geometric mean
inverse function	inductive reasoning
logarithm	inscribed
matrices	median of a triangle
mutually exclusive	parallel
normal distribution curve	perpendicular
parent function	pi
Pascal's triangle	proof (formal, paragraph,
probability (theoretical, experimental)	flow, coordinate)
radical equation	reflexive, symmetric, and transitive properties
range (function)	secant line
rational expression	similarity
sampling	supplementary (expressed algebraically)
scalar (multiplication)	surface area (lateral/ total)
sigma Σ	tangent line
synthetic division	theorem
three-dimensional coordinate	transversal
transformation (algebraic)	

Integrated Mathematics I	**Integrated Mathematics II**
bar graphs	absolute value
central tendency	bisect
circle graphs	Cartesian plane
distance formula	chord
domain & range	complex numbers
expression	congruence
Fibonacci sequence	deductive reasoning
function (exponential, polynomial)	geometric mean
inequalities	inductive reasoning
inverse operations (algebraic)	inscribed
irregular geometric figures	irrational
line of best fit	mutually exclusive
measure of dispersion	networks
non linear graph	parallel
Pascal's triangle	perpendicular
permutations	polynomial
pi	probability
Pythagorean theorem (area model)	ratio/ proportion (scale factors)
quadratic equation	rationalize
real numbers	secant line
relationship	similarity
slope	supplementary (expressed algebraically)
solve system of equations	surface area (lateral/ total)
	system of linear equations tangent line validity