Math History-Mystery Puzzles

Warm-up Activities for Middle School

by

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Our Mission

We at ActiveMath share your passion for creating an environment in your math classroom that fosters excitement and engagement in learning — while making mathematical connections to the real world. We especially recognize that not all math content is easily connected with real-world scenarios — which further hinders students from visualizing the usefulness of math in their own lives.

We began our venture to write complimentary daily “warm-ups” to provide support for teachers and students during the pandemic crisis. During the spring of 2020, more than 1,000 teachers from around the globe subscribed to receive them. Teachers referred to them as “do-nows,” “bell work,” “entry tasks,” and “problems of the day” to constructively make every moment in class count — without “teaching towards the test.”

Based on the positive response, we decided to continue writing these mathematical “sparks” to provide teachers with engaging material to hook students’ attention and engage them in the learning ahead — in a fun and “unsuspecting” rigorous format.

With each Math History-Mystery Puzzle, we have carefully considered and applied an \( R^3 \) approach in our own planning: \textit{Rigor, Relevance, and Relationship}.

- \textbf{Rigor} (in access, multiple pathways, multiple representations, presentation, and questioning/scaffolding)
- \textbf{Relevance} (real-world applications connected to \textit{Common Core State Standards for Mathematical Standards})
- \textbf{Relationship} (opportunities for collaboration, critique, discussion, analyzing, sharing, reasoning, strategizing, and making sense — keeping in mind the \textit{Common Core State Standards for Mathematical Practice})

The Structure of the Puzzles

The warm-ups are based on a spiral review of skills. During the early months of the school year, they provide important math review skills drawn from Grades 5 and 6. As the year progresses, the skills advance to those of Grades 6 and 7 — with an abundance of real-world connections related to the contexts of the events. Towards the end of the school year, math skills from Grade 8 will be included that can also be handled intuitively by students in earlier grades. It should be noted that many \textit{high-school teachers} are using the puzzles with success in providing students with important skills review in context.

Students focus on a number of different math skills and concepts in the same warm-up. The spiral review is intended to help students keep their skills sharp. Also, the clues are intended to provide day-to-day mathematical variety. So, while students may be in a unit, on, say, percent, they may be solving clues that review fractions or measurement.

Each puzzle begins with historical information about a particular person or event. The topics selected reflect the diverse nature of our society. Students use the clues that follow
to determine the *Mystery Year* when the event occurred. In some cases, data needed to solve a clue is contained within the historical information. This reinforces what students experience in the real world: The data needed to solve a problem may not all appear in the same place. Note that in addition to using math to solve the clues, it is fair game for students to consider the historical context of the situation as well.

Each clue produces a digit of the *Mystery Year*. As the clue is solved, students record the digit in the place-value chart for the *Mystery Year* at the bottom of the page. The final clue provides a “check” for determining the correct *Mystery Year*.

Provided with each puzzle are extensive Sample Solution Strategies that include valuable teacher information that address the following:

- A list of specific **Common Core State Standards for Mathematical Content** that are addressed in the clues. When a clue employs skills that are not directly addressed by a Standard for Mathematical Content, one or more Standards for Mathematical Practice are cited.
- Step-by-step solutions designed so thoroughly that parents working with students at home are equipped to help their child.
- **Alternative solution strategies** are detailed to illustrate various paths to the solution.
- **Math Notes** that provide additional mathematical background for the teacher. This includes an analysis of related **common student misconceptions** and ideas, problems, and activities for extension.
- **Historical Notes** that provide further context for the theme of the puzzle. This includes uplifting quotes related to the theme of the puzzle.

**Student Expectations**

We are well aware that students can simply go online to find out a particular history-mystery date. Our intention, however, is process-oriented, NOT answer-oriented. So, critical to the use of the puzzles is the expectation that students be prepared to explain their reasoning for arriving at each digit for each clue. Key questions to ask during these discussions are the following: *Did anyone solve this clue in a different way? If so, what was your strategy?*

**Prepare/Plan Ahead**

In bridging from our planning to your implementation, we offer the following suggestions:

- **How and when do you plan to use the puzzles?**
- **How much time should you devote to the puzzles?**
- **Do you plan to use these as a lesson opener or warm-up? As a lesson closer? For review?** (See suggestions on pages 4–5 under Present.)
- **Do you plan to scaffold to address the needs of all students?** (See suggestions on pages 5–6 under Scaffolding Suggestions: Levels 1, 2, 3, and 4.)

Regarding your time allocation for their implementation, there are many variables to consider. The puzzles are intended to be short “learning bursts” (such as “sponge” activities), taking around 5 to 10 minutes — in the beginning or end of class. They are intended to pique or hook students’ interest and engage them in the process of thinking and problem solving, setting the stage, if you will, for the learning ahead. If used at the end of class, these could be used as a short review, spiraling back to prior important skills, or assigned as homework. This is where your professional
judgement has to be exercised, in planning ahead and determining the best fit for your classes and readiness of your students for the skills captured in the puzzles.

In an ideal scenario, these could be presented in their entirety, students allowed time to think, process, work, and share. This process takes time, and perhaps more time than expected, simply due to students’ varying routes of solution. In fact, an entire class period could be devoted to a puzzle — but we recognize they are only intended as a supplemental enhancement to your curriculum.

**With the above in mind, here are some ways you can successfully implement the puzzles in 5 to 10 minutes:**

- Look ahead at the upcoming week’s puzzles. Be selective in your choices based on the needs of your classes, relevance, and interest. *Don't feel as though you have to complete one each day.*

- You might want to start off the year by doing one puzzle at the beginning of the week. You could present the information first and then take on one clue a day until each clue is completed and the puzzle is solved. By having this “less is more” approach, it gives you and your class more time to get comfortable with the process. You can focus on listening to your students, scaffolding with purposeful questioning, and affording them the time they need to fully digest both the content and process. You will probably see student perseverance improve with time to where they are ready to take on two clues each day, eventually solving an entire puzzle within a 5- to 10-minute time period.

- As stated above in *The Structure of the Puzzles*, we designed these to progress through the year in a natural, coherent manner, with grades 5 and 6 skills starting the year, evolving into grades 6 and 7, and so on. However, you may find that within a puzzle the clues are too advanced for your students. By planning ahead, you can customize the clues, modifying them with a more appropriate question that has the desired digit resulting for the *Mystery Year*.

- These puzzles can also be used as a “filler” assignment for those shortened schedule days or pre-holiday days, where you may not have time (or energy) to complete a planned lesson.

  - **Work clues out in advance so that you can anticipate potential stumbling blocks and misconceptions your students may have.**
    This will also afford you an opportunity to think about multiple solution strategies.
    The accompanying **Solutions** often include alternative solution strategies. This will help you consider purposeful questioning that you can employ to scaffold the clues and probe student thinking without reducing the rigor.

  - **Adapt clues/problems to fit the varying needs and levels in your classes.**
    If you feel some clues are too challenging or too simplistic, or not hitting certain standards you’d like, transform them to meet your needs. Most of the mathematics applied in the clues is at the middle-school level. But in many cases, based on how the mathematics is approached, students at different grade levels may successfully apply what they know to solve the clue. For example, some students may solve a clue by using reasoning, while other students may solve the clue algebraically.
Present

- **Suggested Uses**
  - **Review**
    - “pull” work, to check/reinforce prior learning and vocabulary
      Note: Important formulas and definitions are often provided within a clue.
  - **Extension/Enrichment**
    - “push” work, to challenge and motivate
  - **Interdisciplinary**
    - to connect to other content areas and careers
      Note: The puzzles are not only designed to provide springboards for mathematical discussion, but also for discussion in other disciplines — especially social studies and related social justice issues.
  - **Homework**
    - If assigned via distance learning, you may ask students to complete the puzzle on their own first, and then to **Ask 2**: Ask an older sibling or parent(s) for input. You could then use the puzzle as a class opener on the following day, for sharing/discussion. Maybe students would screen share their work and have them explain their thinking to one another.
    - If teaching in-person, these puzzles provide an excellent medium to promote rich student discourse and collaboration, supporting and strengthening the Mathematical Practices.

- **Suggested Routines/Strategies for Implementation**
  - Once a puzzle is presented, provide individual think time for students to digest the text information about the particular event and the clues. Then allow for partner/team time (to share thinking, allowing teachers time to listen in and provide purposeful questioning to promote perseverance vs. telling/giving too much information). Then promote whole-class sharing (with teams providing their solutions/solution paths). If presented “live,” this could be done as a team-share, gallery walk, or “stand-up, pair-up, share.”
    - If presented via distance learning, consider revealing the intro section first to the entire group and then assign students to breakout rooms to work with a team before calling them back as a whole group to share. This strategic use of wait time puts less emphasis on “quickness” and more emphasis on “access.” It also models the value of think time.
  - Another mode of delivery is to present the bio/intro section first, without the clues. Then allow students time to read and digest the information, and ask students questions such as: **What do you notice? What do you wonder? What questions COULD be asked?** Then, reveal the clues.
  - Another mode of delivery is in the “3-Reads” protocol, whereby you present the puzzle, ask students to read the introduction and clues to themselves first (to gather context) — then a second reading (to gather important facts and vocabulary), and finally a whole class reading. This strategy might work best with perhaps the most challenging clue in the warm-up, rather than all clues, given the time this may take. Yet, even with one clue, it will model the importance of reading for accuracy and comprehension/understanding (important literacy skills) before diving into the actual mathematics.
Extensions/Closures to facilitate students demonstrating understanding

- Ask students to do the following: Share one thing you learned from this puzzle with your partner/team, then share something with the whole group that you heard mentioned by someone else! This could be verbal or in the form of a “Quick Write” (akin to a journal entry) prior to verbal sharing.
- Suggest to students that You’re the Author! Have them create their own problem and solution related to the information given in the Warm-Up. This could be exchanged with a partner/team or presented to the whole class.

Suggestions for Scaffolding: Levels 1, 2, 3, and 4

For students who need support in working through the puzzles, we provide four levels of scaffolding, from Level 1 (that provides the most scaffolding) to Level 4 (that provides the least scaffolding).

- **Level 1: Provide access for all students and value all voices.**
  - Read the introduction text to the class. Do not show the clues. (See example below about Beyoncé’s birthday.)
  - Provide the Mystery Year to students (in this case 1981), and ask students to generate clues that yield each of digit in the Mystery Year.
  - Students can work in small groups or in teams to share and compare.
  - Allow students to present their clues and have the class solve them.

**September 4: Beyoncé’s Birthday**

September 4 of the Mystery Year is the birthday of Beyoncé Giselle Knowles-Carter, formerly lead singer of the group, Destiny’s Child. She rose to fame in the late 90’s to become a multi-talented mega-star. In addition to her singing and dancing, she is also an accomplished producer, song-writer, entrepreneur, philanthropist, and activist. Influenced by the musical talents of such artists as Michael Jackson and Etta James, Beyoncé considers her singing style to be a mix of soul, funk, R & B, pop, and hip-hop.

Queen Bey (Beyoncé’s nickname) is an advocate for civil rights and feminism. She was awarded the 2020 BET Humanitarian Award by Michelle Obama.

- **Level 2: Generate interest, promote greater collaboration, and support the process of research.**
  - Present just the introduction text, and have students read it to themselves. Ask: What kinds of math questions could be asked related to this text?
  - Provide following instructions: You will have about 5 minutes to do a quick search online to find out all “mathematical” facts about Beyoncé that you can, including her birth year. (You can direct them to Wikipedia if need be.)
  - Based on your research, write math problems that would lead to the digits in her birth year (1981), the Mystery Year. If you are engaged in synchronous instruction, four small groups would be ideal for this; you can assign one of the digits to each group to select their ‘best exemplar’ to present to the whole group. Students would work in small groups and then, when they re-convene as a whole group, have a group team leader share their clue/problem for their digit.
  - Another option is to place some restrictions on the clues that students write. For example: For Beyoncé’s birthday, have Group A write a clue for the ones digit.
that involves the subtraction of decimals, have Group B write a clue for the tens digit that involves the multiplication of two fractions, have Group C write a clue for the hundreds digit that involves the perimeter of rectangle, and so on.

- You can lead a numbers talk based on the students’ exemplars and other key numbers in this puzzle, modeling/reviewing/reinforcing some of the relevant skills as appropriate.

- **Level 3: Provide structure for students to write each clue.**
  - Edit the given clues to provide structure for students to write their own clues. See example below. Note that in each case, you provide the desired digit of the Mystery Year. You may have each group or team work on “authoring” one of the four clues.

  **Use these clues to find the Mystery Year when Beyoncé was born.**

  ▪ When you evaluate the expression below, you will find out the year when the hit, *Survivor*, was released by the group, Destiny’s Child: [2001]
    
    Your expression: _______________________________
    
    The **ones** digit of the above year is the **ones** digit of the Mystery Year.
    
  ▪ In the year 2008, Beyoncé’s hit, *All the Single Ladies*, was ranked #8 on Billboard’s list of Greatest Music Videos of the 21st century. To find this number (same digit for both), determine __________________________.
    
    This **digit** is the **tens** digit of the Mystery Year.
    
  ▪ Through 2020, Beyoncé had been nominated for an amazing 804 awards — and won 417 of them! Using these numbers, write a problem that has a result of 9.
    
    This **answer** is the **hundreds** digit of the Mystery Year.
    
  ▪ Use this clue as a check on the Mystery Year:
    
    In 2011, Beyoncé turned 30, and her hit, *Run the World (Girls)*, won the MTV Video Music Award for Best Choreography.
    
    ________________
    
    | Thousands | Hundreds | Tens | Ones |
    |-----------|----------|------|------|
    | [1981]    |          |      |      |

  - **Level 4: Have students work with the original puzzle either in heterogeneous groups or in differentiated groups.**

    Provide groups of students with the original version of the puzzle. Either have students work in heterogeneous groups on all clues or in differentiated groups — where you assign the clues based on the ability of the students. An ideal group size is four. If a group struggles, implement the policy, “**C3B4Me**” — meaning “**See three** (all other group members) **Before Me** (the teacher). When all four hands of the members of a group are raised, provide a partial solution of a clue to help the group move forward.

**Reflection**

During delivery and immediately after, it is advantageous to note any observations — such as unanticipated questions or misconceptions. It is worth noting now, while fresh in your memory, to facilitate subsequent deliveries. Ask yourself: **What went well? What would you change for next time?**

**The Common Core State Standards**

The key **Common Core State Standards for Mathematical Content** that are addressed in each puzzle are listed with the Solutions for the puzzle. The puzzles are designed so
that through class discussions, students will also engage with the **Common Core State Standards for Mathematical Practice**. This will especially be evident through robust discussion when you work with students in person or synchronously online.

**Disclaimer on the citations for Common Core State Standards:** Our "correlation" to the Content Standards is not an exact science. Based on how students solve a clue, different standards may be addressed. For example, a Grade 6 student may use intuition or number sense; a Grade 8 student may use algebra. Also, while a Grade 5 standard may be cited, the clue may allow for more advanced or divergent thinking on the part in the student’s reasoning and strategizing. *How* students arrive at an answer may be just as important as *what* their answer is. This supports building students’ confidence, competence, and dispositions when their multiple pathways to solutions are honored. Finally, some clues do not lend themselves to a particular standard. Sometimes math is “just math” — rich in and of itself, with the critical thinking, reasoning, and strategizing.

We remain committed to the **Active** teaching and learning that goes on in mathematics classrooms. Additionally, we are committed to promoting best practices in the teaching of mathematics. To this end, we ask for and welcome your feedback and suggestions:

> How/when are you using the puzzles?
> What do you find most beneficial from their use?
> What would you like to see or suggest for improvement?
> Would you be willing to share student sample work?

Any feedback can be sent to activemath39@yahoo.com.

Thank you for allowing us to come into your classroom and work with you. We wish you the best as you continue to provide rich mathematical learning experiences for your students that support building the critical-thinking skills expected of the thinkers and leaders of tomorrow.

~David & Karen

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