Mystery

What is it?

A tool that sparks interest and engagement by presenting students with a content-related "mystery" that needs to be solved; students use teacher-provided clues to develop and test possible solutions

What are the benefits of using this tool?

Students often view the process of generating and testing hypotheses as something they're forced to do in science class, not something they like to do. But when we present students with puzzling phenomena and challenge them to generate possible explanations (hypotheses), the process of generating those explanations is one they actually enjoy. This tool makes generating and testing hypotheses exciting by presenting students with content-related mysteries and asking them to generate and test possible solutions. The element of mystery serves to pique student interest, while the generating/testing process develops both content knowledge and critical thinking skills, including analyzing data, synthesizing information, and supporting ideas with evidence.

What are the basic steps?

1. Identify an event, phenomenon, or concept that you want students to understand and explain. Frame it as a mystery that students will need to investigate/solve (e.g., "How is it possible that a giant metal boat can stay afloat when this tiny piece of metal sinks in a glass of water?").
2. Develop a clear idea of the solution/explanation you want your students to generate. List the big ideas students will need to understand in order to arrive at the solution you have in mind.
3. Create a set of clues that will enable students to discover the solution and the big ideas that underpin that solution. Clues can take any form you want—data tables, images, maps, sound clips, factual information in sentence form, etc. See Teacher Talk for more on generating clues.
4. Divide students into teams. Present the mystery, give each team a set of clues, and tell students to
   - Examine the clues carefully. Group related clues together, and give each group a descriptive label. (Clarify that students may place the same clue in more than one group.)
   - Summarize the key ideas from each group. (Think: What are the clues telling you?)
   - Identify connections between or among clue groups. (Do you see common threads or themes?)
   - Think about how the clues/groups are connected to the mystery as a whole.
   - Generate a tentative solution that's supported by the clues. Be ready to share and defend it.
5. Invite students to share their ideas and solutions—and the clue evidence that supports those ideas/solutions—both as they work and at the end of the lesson. Use probing questions to help students evaluate and refine their ideas. See Teacher Talk for specific suggestions.
6. Assess and reinforce students' grasp of the relevant content at the end of the lesson by asking students what they learned and by reviewing the critical concepts/ideas as a class.

How is this tool used in the classroom?

✔ To provide an authentic and engaging context for students to generate and test hypotheses

✔ To help students acquire critical content knowledge in a fun and active way

✔ To develop students' ability to analyze and interpret data—and support ideas with evidence

Teachers across content areas use this tool to help students generate possible explanations of mysterious phenomena or observations. Mysteries are usually presented as *why* or *how* questions. Multiple sample questions are shown below, along with two fleshed-out classroom examples.

- Why is it better to sneeze into your elbow than into your hand?
- How did an untrained colonial militia defeat the mighty British army?
- Why does the sun rise and set every single day?
- In 2010, a fossil of a giant whale was discovered in a desert in Peru. How did it get there?
- How is it possible that airplanes don't fall out of the sky even though they're so heavy?
- How did people tell time before there were clocks?
- Why is George Washington considered a great war hero when he lost more battles than he won?
- How is it possible that burning a forest can be good for its health?
- Why was there an explosion of mystery novels and detective stories in the Victorian era?
- What painters painted and how they painted it changed dramatically between the Middle Ages and the Renaissance. Why? What explains the change?
- The illustrations in this box are from a story that someone was planning to write but never did. What story do you think the author might have intended to write? Why do you think so?
- There's only one correct order in which to perform mathematical operations. Can you discover what it is just by examining these clues?

EXAMPLE 1: A middle school social studies teacher wants her students to understand the various factors that gave rise to the Age of Exploration. Instead of having students read about the topic in their textbooks, she uses the Mystery tool to help them discover the key factors for themselves. To get them interested, she frames the content as a mystery: "For much of European history, no real efforts were made to explore the world by sea. Why, all of a sudden, was there an 'exploration explosion' in the fifteenth century?"

She then organizes students into teams and challenges them to solve the mystery using clues that she provides (slips of paper with relevant information drawn from a textbook). Students are instructed to organize related clues into groups and use the groups they create to develop some possible hypotheses for why the time was right for exploration in the fifteenth century. One such clue group is shown below, along with the hypothesis that students generated after examining it.

Clue 4: The science of mapmaking had become sophisticated and increasingly accurate by Columbus's time.

Clue 9: Inventions like the astrolabe and mariner's compass made longer and more difficult trips possible.

Clue 20: New ships called caravels were faster and easier to navigate than any ship before.

We hypothesize that the time was right for exploration in the fifteenth century because advances in technology and mapmaking made farther, safer trips possible.

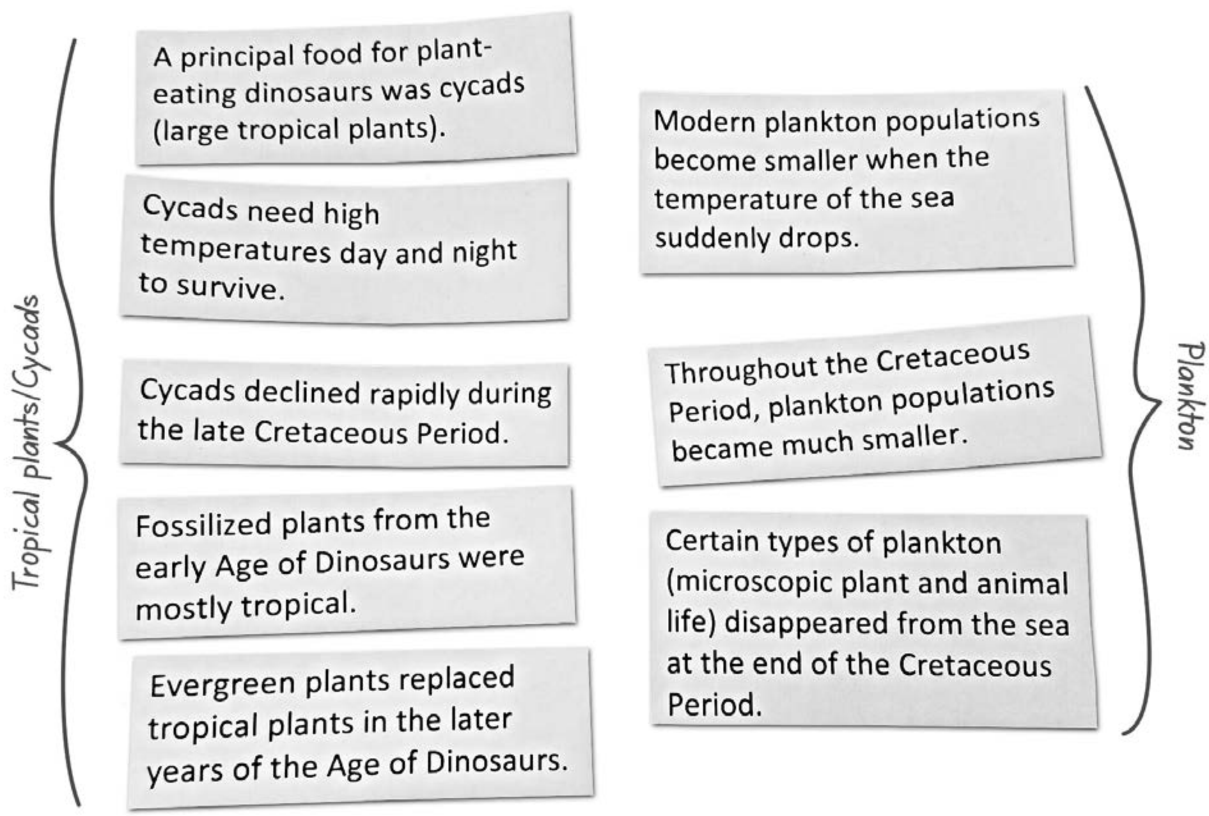
Additional clue groups (not shown) lead students to hypothesize that other factors were also responsible for triggering the Age of Exploration, including the desire to spread Christianity, find new routes for the silk and spice trades, and gain control of new territories and wealth.

After a round of discussion in which students share their hypotheses and the "clue evidence" that supports them, students use the textbook passage from which the teacher generated her clues to check and refine their ideas. ("How do the ideas you generated compare with those in the text?")

EXAMPLE 2: Instead of telling students why scientists think dinosaurs became extinct, a high school teacher challenges them to generate plausible explanations (hypotheses) on their own. To spark their interest, he frames the dinosaur disappearance as an intriguing mystery for them to solve: "We've just learned that the dinosaurs dominated the earth for over 150 million years. So how is it possible that they became extinct? Today, you'll get a chance to investigate and solve that mystery using a set of clues that I will give you."

The teacher divides students into teams of four and presents each team with an identical set of thirty-five clues. (To create the clues, he pulled bits of information from an article that presented a commonly accepted explanation for the dinosaurs' demise.) As students begin working to analyze and group the clues, the teacher walks around to listen in on, probe, and guide their thinking.

Students in one of the teams notice that there are multiple clues about tropical plants—and they group those clues accordingly. They create a plankton group as well, as shown below.



When they examine their groups more closely, the students notice some common themes. They notice, for example, that clues in both groups highlight changes in population that occurred during the Cretaceous Period. (Populations of tropical plants and plankton both declined rapidly.)

They also find multiple temperature-related clues—clues that lead them to hypothesize that a drop in temperature was what caused the cycad and plankton populations to decline.

When their teacher asks how the clues they've examined so far might relate to the mystery of why the dinosaurs died out, these students hypothesize that a shortage of food, triggered by a drop in temperature, might have caused the dinosaurs' demise. ("We learned that cycads declined, and cycads were a major source of food for the dinosaurs.")

But what might have caused such a drop in temperature? After grouping and labeling additional clues (not shown), team members hypothesize that the drop in temperature was caused by a giant meteor that hit the earth and created a large cloud of dust that blocked out sunlight.

At the end of class, after teams have shared and critiqued each other's hypotheses (and supporting clues), the teacher challenges students to develop a brief, written explanation—backed by clue evidence—that synthesizes the class's ideas about the factors that led to the demise of the dinosaurs. One student's explanation can be viewed at www.ThoughtfulClassroom.com/Tools.

Variation: Yes/No Inquiry

This variation on Mystery is adapted from the work of J. R. Suchman (1966). Like Mystery, Yes/No Inquiry begins with an intriguing phenomenon or mystery concept. Also similar to a Mystery lesson, Yes/No Inquiry withholds the solution and challenges students to discover it for themselves. Students collect data by asking yes/no questions.

In its simplest form, Yes/No Inquiry can be used to challenge students to identify a particular concept or object. Rather than simply guessing at the concept, students—guided by their teacher—learn how to formulate questions that focus on critical attributes. For example, an elementary teacher might select a shape and challenge students to ask yes/no questions that help them zero in on critical attributes of the shape in question (e.g., Does the shape have sides? Does the shape have more than three sides? Does it have parallel sides? Does it have angles of equal size?).

The same process of asking yes/no questions can be used by students to generate and test hypotheses about phenomena they observe. A science teacher, for example, might challenge students to use yes/no questions to generate a plausible explanation for something they observe during a demonstration (e.g., why, when ice cubes are placed in two identical-looking beakers filled with clear liquid, do the ice cubes float in one of the beakers but sink in the other?). At the end of the demonstration, students would be instructed to

- Record everything they know about the situation
- Generate one or more hypotheses to explain what they observed (e.g., why the ice cubes floated in one beaker but sank in the other)
- Pose yes/no questions to the teacher to help them test their hypotheses
- Develop what they believe is the best explanation for the phenomenon

Teacher Talk

➔ Here are some things to keep in mind when generating your clues:

- Clues should contain information that will help students generate their own ideas and solutions; they shouldn't *tell* students the solution. Check that the clues you generate give students enough information to develop the generalizations and conclusions you expect them to make.
- Clues can be derived from primary or secondary sources—and they can be copied directly or rewritten/summarized for length or age-appropriateness. You might, for example, reprint an entry from a captain's log or summarize information from an article on the whaling industry.
- Build different types of clues into your lessons (e.g., maps, tables, or images in addition to written-out factual information) so that students get practice interpreting different forms of data.

➔ Use probing questions to help students articulate, evaluate, and expand their thinking, both as they work (Step 4) and when they're sharing their ideas as a class (Step 5). For example: How did you group the clues and why? What did you learn from each group? Do you see any connections between groups? How might the information from these groups relate to the mystery as a whole? What solution did you develop? What clue evidence supports this solution? Are there any clues you've failed to account for or that contradict your proposed solution? Is your logic sound?

➔ Help students evaluate the explanations that they and their classmates generate (Step 5) by having them review each team's ideas, identify potential issues (e.g., flaws in logic, failure to account for critical information, information that doesn't fit), and decide which explanation is best supported by the evidence. Alternatively, you can have students compare their solutions with the actual solution. ("Read this article. How does the author's explanation compare with yours?")

➔ Clarify that it's not a problem if students generate a different solution/response than you had in mind at the start of the activity as long as their response is supported by solid evidence. In fact, you can use students' differing solutions as a way to introduce the idea that there are many instances in "real science" where multiple hypotheses are plausible and supported by evidence.

➔ At first, some teachers wonder if the time it takes to plan a Mystery lesson is worth it. In our experience, once teachers see the curiosity and engagement that the tool generates—and its ability to promote active, authentic learning—they don't tend to ask the "is it worth it" question anymore. To reduce the workload, collaborate with teachers at your school to develop and share Mystery lessons. And remember that once you've created a Mystery lesson, you can reuse it every year.

➔ If you're having trouble developing a Mystery lesson, find a passage or article that explains how or why something happens, identify the question the passage is answering (e.g., How can fish breathe underwater?), and extract a set of short clues. (If you can't frame the question in a way that makes the topic sound intriguing, pick a different how/why topic.) Mystery lessons can also be built off of "Yes, but why?" questions that challenge students to look into the causes behind phenomena. ("We all know that the ocean has high and low tides. The question is *why*? What's causing them?")

➔ Instead of *giving* students clues, you can have students discover the relevant information (clues) for themselves. To do this, set up "discovery stations" where students complete a task (e.g., watch a video, make observations, perform an experiment) and jot down what they learn.