# Mystery Box

**Students explore the nature of scientific inquiry by investigating and determining the contents of a sealed mystery box.**

**Grade Level:** 6th

**Phenomena:**
**The scientific methods allows us to make decisions and draw conclusions.**

**Objectives:**
- Students will investigate and make observations about their box.
- Students will draw conclusions about the contents of their box and support it using observations.
- Students will describe the process and methods used to collect data about the boxes.

**Materials:**
- Small cardboard box or other opaque container for each student
- 3-6 small items for each box: erasers, ping pong balls, pennies, cotton balls, packing peanuts, hard candies, etc.
- Investigative Tools: magnets, balances, empty boxes, lamps, etc.

**Appendixes:**
- Mystery box answer key: Page 4

**Time Considerations:**
Preparation: 60 minutes
Lesson Time: 60-70 minutes
*Introduction: 15 minutes*
*Activity 1: 30 minutes*
*Activity 2: 10-15 minutes*
*Conclusion: 5-10 minutes*

**Related Lesson Plans:**
Flubber, Yellow/Blue Switcheroo, Mentos Super Fountain, Eggs-

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## Next Generation Science Standards

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

**Science and Engineering Practices (SEP):**
Constructing Explanations and Designing Solutions

**Disciplinary Core Ideas:**
Developing Possible Solutions

**Crosscutting Concepts:**
Influence of Science, Engineering, and Technology on Society and the Natural World

## Excellence in Environmental Education Guidelines

**Strand 1— Questioning, Analysis and Interpretation Skills**

**A)** Learners are able to develop, focus and explain questions that help them learn about the environment and do environmental investigations.

**B)** Learners are able to design environmental investigations to answer particular questions—often their own questions.

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**C)** Learners are able to locate and collect reliable information about the environment or environmental topics using a variety of methods and sources.

**G)** Learners are able to synthesize their observations and findings into coherent explanations.

**This lesson has been adapted from Evolution & the Nature of Science Institute's *Mystery Boxes: Uncertainty and Collaboration*:**
Beard, J. (1999). *Mystery Boxes: Uncertainty and Collaboration*. Retrieved April. 22, 2011, from Evolution & the Nature of Science Institutes: http://www.indiana.edu/~ensiweb/lessons/mys.box.html

## Background

Many people view scientific inquiry as a rigid framework for doing experiments. Yet we use the scientific method every day to make decisions as simple as what to make for dinner, how to get to school or whether to take an umbrella.

Scientists use questions to guide their research. Careful observations, data collection and other questions help scientists make a hypothesis about their research. While the

scientific method consists of the following steps, these steps can be carried out in any order:

- Define the question to be answered
- Make a hypothesis about the answer by using prior knowledge
- Research: determine how to gain more information and examine the results of the investigation.
- Determine what conclusions can be drawn from the data.
- Determine whether the conclusions support or refute the hypothesis, or form a new hypothesis from the data.

For example, if someone hears a screech and crash and thinks there must have been an accident up the street, they have collected some data and formed a conclusion. To test their theory, they may walk outside to collect more data. That new information will pose new questions like I wonder how the accident happened. Perhaps there are no signs of a car crash, and more data must be collected to come up with a new hypothesis.

While this is a simple example, it is identical to the process carried out by research scientists. Science is actually a very dynamic and creative process driven by questions and observations (*Science Education*).

Scientists use all their senses to collect data about how something sounds, looks, smells or feels. However, scientists can't always see what they're trying to study so they observe the effect their subject has on other objects instead. For example, it was discovered that germs caused disease by examining the effect of germs on healthy rats.

Since it can be hard to view things from different perspectives, scientists share their observations with each other and find information in scientific publications. Sharing ideas and observations helps scientists ask and answer more questions.
Make a mystery box for each student that contains a few erasers, short pencils, pennies or other small items.

## Preparation

For every box, there should be a second with matching contents.

Seal and number each box so you can keep track of the contents.

Create an answer key that lists what item is in each box.

Before the lesson begins place a mystery box on each student's desk.

## Doing the Activity

***Introduction: What's this?***

You may need to encourage students to examine the boxes in any way they feel necessary without opening the box.

Encourage students to use investigative tools to help make more observations. Investigative tools can either be provided by the instructor or discovered by students.

Ask the students to write down any observations, hypotheses, conclusions or experimental methods that they used during the initial examination of their box.

Explain to the students that the goal of this activity is to determine what is inside their box without opening it. Brainstorm possible ways to determine the contents.

Allow the students to explore the boxes on their own for 5-10 minutes.

Mystery Boxes

Tell the students that they were being good scientists by using a variety of methods and all their senses to examine the boxes.

Ask the students to stand in a line to show how confident they

are, that their investigation told them exactly what was inside the box.

To do this, designate one end of a line as “Most Confident” and the other end “Least Confident”. Provide an example to students by standing on the line yourself.

Ask the students what would make them more confident in their hypotheses.

***Activity 1: Whatcha got?***

Tell the students that there is someone in the room whose box has the same type and number of objects. Since scientists share ideas and observations you can discuss your box with the person who has the matching box.

**Depending on the class you may let students find the matching box or tell them which numbers match.

Give the students about 10 minutes to share and make more observations about their boxes with their partner. Have the students write down new ideas, information, procedures and hypotheses in their notebooks.

After swapping ideas, have the students stand in a line again to indicate how confident they are in their hypotheses.

Ask the students what would make their research easier. One suggestion might be telling students what kinds of things are in the boxes.

Tell students that just like sharing with peers to gain more information, scientists also look in the literature to help with their research. Provide students with a list of possible contents that you’ve taken from the “literature” for them.

***Activity 2: Third Time’s a Charm***

Give the students about three minutes to collect more information about their boxes before writing a final prediction in their notebooks.

The students should explain what information led them to that conclusion.

Ask the students how many of them are at least 90% sure that their conclusion is correct.

Explain that it is ok if people are still unsure. Even though some things in science are eventually accepted as fact, there is still a possibility that the theories could be disproven.

Discuss with the students what methods and observations they used to examine their boxes.

Ask what the first step the students took was. This will vary between students.

## Conclusion

Discuss with the students whether they followed a certain pattern or set of steps to reach their conclusions.

Explain that even though they all took a different approach, the students all used the scientific method to examine their boxes.

After the wrap up, you may either tell the students what is in each box or let it remain a mystery as an example of how scientific theories stand until disproven.

## Assessment

Assess the students based on whether they can make objective observations and use them to draw evidence based conclusions.

The students’ abilities to incorporate outside information and explain their experimental method can also be used as an assessment.

## Extensions

Brainstorm ways to study other “invisible” things.

Have the students compare their box to one with different contents to help confirm or disprove their original findings.

Have all the groups choose a new box and repeat the exploration to determine whether different groups reach the same conclusion.

## Vocabulary

**Conclusion:** decision based on the facts available

**Experiment:** a scientific test to try out a theory or to see the effect of something

**Hypothesis:** a temporary prediction that can be tested about how a scientific investigation or experiment will turn out

**Observation:** information gained by careful examination using the senses

**Scientific Method:** principles and procedures for the systematic pursuit of knowledge including problem, hypothesis, experiment, observation and conclusion

**Scientific Inquiry:** Using the scientific method, logic and questioning to examine something

**Theory:** an idea or statement based in fact, but not proven, about how or why something happens

## Mystery Box Answer Key

| Box Numbers | Contents |
|---|---|
| 1, 12 | 8 beads |
| 2, 11 | 8 pop tabs |
| 3, 10 | 3 keys |
| 4, 9 | 10 Q-tips |
| 5, 8 | 6 toothpicks |
| 6, 7 | 4 crayons |
| E1, E2 | Empty |

## Sources


- Beard, J. (1999). *Mystery Boxes: Uncertainty and Collaboration*. Retrieved April 22, 2011, from Evolution & the Nature of Science Institutes: http://www.indiana.edu/~ensiweb/lessons/mys.box.html
- Tang, X, & E. Coffey, & D. Levin, & A. Elby. (2010). The Scientific Method and Scientific Inquiry: Tensions in Teaching and Learning. *Science education*, 94 (1), pp. 24-47.