Lesson 1 Components

I. Presentation 1: Bias in Science
II. Activity 1: Smoking Bias
III. Homework 1: Identifying Bias - Bald Eagles and DDT

I. Presentation 1: Bias in Science
slideshow

Description

- Reviews and corrects some common misconceptions about science.
- Introduces the concept that science can be done poorly, that bias can be introduced into research through sample selection and/or measurement techniques and this can lead to inaccurate results.
- Describes methods scientists use to eliminate or at least decrease bias in their investigations.
- Outlines tools students can use to identify potential sources of bias in research.

Goals

- Students understand that science can be done poorly and that good science requires extreme care in developing an experimental design that will minimize bias.
- Students learn how bias can be introduced into scientific experiments and steps the scientific community takes to minimize bias.
- Students learn ways to identify potential bias when presented with scientific information.

Materials

Download Files from Lesson 1:

- "Presentation 1"
- "Lesson1_WB"
- "Lesson1_WB_KEY"
- "TeacherManual1"

Other:

- Copies of the student workbook for presentation 1 for all students
- Equipment to show slideshow or transparencies

II. Activity 1: Smoking Bias
group or class activity

Description

- Students evaluate the design of several experiments designed to determine the rate of smoking among high school students and discuss possible sources of bias.
- Students devise their own experiment to determine the rate of smoking among high school students.

Goals

- Students gain a better appreciation for the way bias can be intentionally or unintentionally introduced through sample or measurement bias.
- Students develop critical thinking skills.

Materials

Download Files from Lesson 1:

- "Activity1_Smoking"
- "Activity1_Smoking_KEY"

Other:

- Copy of Activity1_Smoking for each student.
- Slide or transparency of Slide 21 from Presentation 1

III. Homework 1: Identifying Bias - Bald Eagles and DDT

Description

- Students are put in the role of a reporter writing an article on DDT. Guided by the advice of a children's science magazine reporter, Mariana Relos, Students evaluate an article that claims DDT has no effect on bird reproduction and the response of a U.S. Fish and Wildlife Service scientist to the article.
- Students identify signs of bias and decide what they would report about DDT based on their evaluation of the different sources of information.

Goals

- Students review ways to identify potential bias in scientific information.
- Students practice identifying bias in different information sources.
- Students learn about the history of DDT use in the United States.

Materials

Download Files from Lesson 1:

- "Homework1_BiasDDT"
- "Homework1_BiasDDT_KEY"

Other:

- Copy of Homework1_BiasDDT for each student
- Slide or transparency of Slide 22 from Presentation 1

Presentation 1: Bias in Science

Throughout the PowerPoint presentation material on slides if not immediately apparent can be brought up by mouse clicks. As the presentation proceeds, students are asked to write down specific information in their workbooks, such as key definitions and concepts. In the slide notes below, these questions are indicated by the ♣ symbol. The notes for each slide are also found in the notes section of the slideshow.

Teacher Preparation

1. Download files "Presentation 1", "Lesson1_WB", and "Lesson1_WB_KEY".
2. "Presentation 1" – contains the slideshow and can be used directly with a classroom computer projector or to make transparencies.
3. "Lesson1_WB" – contains a handout for students, the student workbook for presentation 1. Students use this handout to follow allow with the presentation and are prompted to take notes on key points.
4. "Lesson1_WB_KEY" – answer key for student workbook for presentation 1.
5. Print/copy workbook for every student.
6. Preparation equipment/transparencies for slideshow.

Student Preparation

1. Hand out student workbook packets and ask students to read and answer the 7 true/false questions, section 1.1 of their packets.
2. After students have had a chance to think about each statement, review the statements as a class using the slides that follow. Each true/false statement slide first comes up on the screen with only the statement visible. A mouse click will bring up the answer, "True" or "False". A second mouse click will bring up an explanation.

Slide 1

♣ This slide contains the 7 true/false questions that compose the Opening Questions section in the student workbook. It can be displayed while students work on answering the questions.

> Flammer, Larry. Teaching the Nature of Science – A sample unit plan for high school biology. http://www.indiana.edu/~ensiweb/lessons/unt.not.html.

Slide 2

Science is primarily concerned with understanding how nature and the physical world works.

TRUE.

Science is a process by which we try to understand how the physical and natural world works and how it came to be that way. The physical world includes the world we can observe with our senses with or without technological aids.

Slide 3

Science can prove anything, solve any problem, or answer any question.
FALSE.
The process of science, when properly applied, actually attempts to disprove ideas (hypotheses) by testing or challenging the hypothesis with observations (data) gathered from carefully designed experiments. If the idea survives testing, then it is stronger, and more likely an accurate explanation. Science is a process which can only produce "possible" or "highly probable" explanations for natural phenomena; these are never certainties. With new information, tools, or approaches, earlier findings can be replaced by new findings.

Science is limited strictly to solving problems about a world that we can observe with our senses. Science is not properly equipped to handle the supernatural realm, nor the realm of values and ethics, realms that cannot be observed with our senses.
Scientific explanations must be potentially disprovable.
Explanations based on supernatural forces, values or ethics can never be disproved and thus do not fall under the realm of science.

Slide 4

Any study done carefully and based on observation is scientific.
FALSE.
Science must follow certain rules; otherwise, it's not science (just as soccer is not soccer if its rules are not followed).
The rules of science are intended to make the process as **objective** as is humanly possible, and thereby produce a degree of understanding that is as close to reality as possible. Scientific explanations must be based on careful observations and the testing of hypotheses.

♣ *Define objective*

Slide 5

Science can be done poorly.
TRUE.
Anything done scientifically can be relied upon to be accurate and reliable.
FALSE.
Science can be done poorly, just like any other human endeavor. We are all fallible, some of us make fewer mistakes than others, some observe better than others, but we are still subjective in the end.
Quality control mechanisms in science increase the reliability of its product.

Slide 6

Different scientists may get different solutions to the same problem.
TRUE.
Science can be influenced by the race, gender, nationality, religion, politics or economic interests of the scientist. Scientists are people, and although they follow certain rules and try to be as objective as possible, both in their observations and their interpretations, their

biases are still there. Unconscious racial bias, gender bias, social status, source of funding, or political leanings can and do influence one's perceptions and interpretations.

Slide 7

Knowledge of what science is, what it can and cannot do, and how it works, is important for all people.

TRUE.

People need to be able to evaluate scientific information and make decisions about the information. Scientific information is used to support political arguments, advertise products, and inform people of factors that affect their health. It is important for all people to be scientifically literate in order for them to be able think critically about what to vote for, what to buy and how to protect their health.

♣ *Give two examples of how you use scientific information in your life.*

Slide 8

♣ Given that science can be poorly done, *what is good science?*

Slide 9

♣ *Define bias*

♣ *What are the two main types of bias?*

Slide 10

♣ *What is a sample?*

♣ *When is sampling bias introduced?*

Slide 11

Discuss these examples to help explain the way these different factors can cause sampling bias.

Sample Size:

Ex: To determine the average height of students in this classroom, how many students should I measure to get the best estimate? If I only measure 3 will my mean be accurate?

Sample Selection:

Factors such as location, age, gender, ethnicity, nationality and living environment can affect the data gathered for a sample. A good experiment controls for these factors by using a random sample or by limiting the question asked to the specific group represented by the sample.

Random sample = Every individual has an equal likelihood of being selected.

Example of random sample: Rolling dice, flipping a coin

Example of sample selection bias:
I want to find the average height of students in the classroom. I notice a list of students that are to be excused early because they are on the basketball team and have a game. I decide to use this list to pick the students that will be in my sample. How might this method of selecting my sample bias my estimate of average height?

♣ *What are factors that contribute to sampling bias?*

♣ *What are some ways to minimize sampling bias?*

Slide 12

Discuss these examples to help explain the way measurement technique can cause measurement bias.

Use measurement tool correctly
Ex: When measuring height, I must be careful to start the measuring tape at exactly at 0, not at 1 cm.

No additions to the environment that will influence results
Ex: I take height measurements of everyone in the classroom and let them keep their shoes on. All shoes add height, some more than others, and this will change the measure I get for average height.

Experiment designed to separate out the affect of multiple factors
Ex: I propose the hypothesis that students that sleep more than 7 hours the night before a test will perform better on the test. I ask students to report how much sleep they received the night before on their tests and compare this with their test scores. I do not ask or control for other factors such as how much each student studied or whether they ate breakfast. How can I know that any trend I observe is reflective of how much sleep they received and not other factors?

♣ *What are 3 factors that contribute to measurement bias?*

Slide 13

Summarizes qualities of good science.

Slide 14

The scientific community has long recognized that bias can be found in scientific studies either by unintentional mistakes on the part of scientist or by intentional attempts to make data show a particular, desired result. There are several "rules" or procedures used by the scientific community to eliminate (or at least reduce) bias in science. These procedures include independent duplication and confirmation by others and the requirement for publication in a peer-reviewed journal.

♣ *What measures does the scientific community take to minimize bias in science?*

Slide 15

The problem is most of this debate and procedures take place in scientific journals which are rarely read by the public with good reason. I do not speak Japanese. If I picked up a book written in Arabic I would only be able to admire the beautiful characters; I wouldn't understand a thing unless I received training in the Arabic language. Scientific articles are full of scientific references and language that usually require advanced training in the scientific field in order to be understood. This has nothing to do with intelligence!

So, how can those of us who have not (yet) received advanced scientific training identify good science?

Slide 16

♣ *What are some clues that scientific information you are reading is biased?*

Slide 17

Discuss examples for evidence of bias.

1. "scientifically-proven" – science sets out to disprove, not prove things. Thus anytime you encounter the phrase "scientifically-proven", be suspicious.

2. Emotional appeal – gives emotional reasons for believing or not believing the scientific conclusions. "People will senselessly die unless we use Vacinax now!"

3. Identify strong language – "cleanest", "cheapest", " most efficient", "in the world"

Slide 18

For each point you can use the examples used previously:

Are samples and measurements appropriate for the conclusion presented?
Ex. Determining average height in classroom using basketball team or taking measurements with shoes on.

Are multiple factors properly accounted for to justify the interpretation of the data?
Ex. Correlation between lack of sleep and test results.

Slide 19

You may want to highlight that there are plenty of examples of both good and bad research done by all of these groups. A careful understanding of the interests and funding sources of research will give you an idea of what the bias might be if the research is biased. However, even if a scientist has an interest in getting certain results it does not mean that their research will be biased. If they are good scientists, they will be true to the scientific process and they will design good experiments and report data honestly, regardless of their interests.

Slide 20

Exploration of the concepts presented in this presentation are the focus of the classroom activity on teenage smoking.

At this point, handout the activity, Smoking Bias. You can keep this slide up while you complete the activity and return to the last two slides at the conclusion of the activity to wrap up and assign homework.

Slide 21

After you have reviewed the 6 experiments in the Smoking Bias activity as a class, share these finding with the class. This is **real** research and clearly shows that bias unfortunately can and does affect scientific research.

Slide 22

This slide can be used to introduce the homework assignment, "Identifying Bias- Bald Eagles and DDT. Dr. Mariana Relos is an example of a person who must evaluate different sources of information for bias and accuracy every day as part of her job. She writes children's articles for science magazines. The homework assignment begins with an interview of Dr. Relos. Students are placed in the role of a reporter while they review concepts about bias in science, practice identifying bias, develop critical thinking skills and learn about history of DDT use in the United States.

Activity 1: Smoking Bias

In this activity, Students gain a better appreciation for the way bias can be intentionally or unintentionally introduced through sample or measurement bias by evaluating the design experiments conducted to determine the rate of smoking among high school students. After evaluating the experiments, the students design their own experiment to determine the prevalence of teenage smoking.

Depending on time restraints and class dynamics, the 6 example experiments can be reviewed as a class or by students in small groups. Students can then design their own experiment either independently, working quietly alone, or in groups. If time permits, students can present their experiment ideas to the class.

Teacher Preparation

1. Download the files, "Activity1_Smoking" and "Activity1_Smoking_KEY".
2. Print/copy a handout of the Smoking Bias activity for every student.

Activity

1. Handout Smoking Bias packets to each student. Review directions.
2. Have students work in small groups to evaluate the 6 experiments or review the experiments as a class.
3. If students are working in small groups, review the evaluations of each of the experiments before students continue to design their own experiment.
4. Share the table of results on Slide 21 with the class. This is **real** research and clearly shows that bias unfortunately can and does affect scientific research.
5. Have students design their own experiment as specified in section 2.
6. If time allows have each group or student volunteers share their experiments with the class.

Homework 1: Identifying Bias – Bald Eagles and DDT

The last slide from Presentation 1, Slide 22, can be used to introduce the homework assignment, "Identifying Bias- Bald Eagles and DDT. Dr. Mariana Relos is an example of a person who must evaluate different sources of information for bias and accuracy every day as part of her job. She writes children's articles for science magazines. The homework assignment begins with an interview of Dr. Relos. Students are placed in the role of a reporter while they review concepts about bias in science, practice identifying bias, develop critical thinking skills and learn about history of DDT use in the United States.

Teacher Preparation

1. Download the files, "Homework1_BiasDDT" and "Homework1_BiasDDT_KEY".
2. Print/copy a handout of the homework assignment for every student.

Student Preparation

1. Introduce the homework assignment using Slide 22.
2. Handout the homework assignment and review the directions.
3. Have students complete the homework before continuing on to the next lesson.