The Checks Lab

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Overview:

Each team has an envelope containing a series of personal bank checks. A few are removed at a time, and the team attempts each time to construct a plausible scenario that involves those checks. With each subsequent removal of checks, appropriate revision of the scenario is done. Final scenarios are compared by the class. Class discussion is designed to show **how the available evidence, along with human values, experiences and biases, influence observation** and **interpretation**, even in science. **Scientific argumentation** (requiring evidence for all claims) is encouraged, in compliance with the new NGSS and Common Core Standards.

This is one of the few nature-of-science lessons that has a biological connection. This is also one of the few lessons that model the "historical" sciences, e.g., geology, paleontology, astronomy, forensic science, and evolutionary studies (where one uses clues - rather than experimentation - to infer past events).

Lesson Concepts:

- Scientific knowledge is uncertain, tentative and subject to revision.
- Scientific explanations and interpretations can neither be proven nor disproven with certainty.
- Scientists use a variety of criteria to compare explanations and select the better ones.
- Human values deeply influence science (its terminology, the questions asked, and the criteria used for choosing among theories).
- Scientists can study events of the past for which there are no witnesses available, by proposing plausible explanations, then **testing** those ideas by looking for **clues** expected due to a proposed explanation.
- Scientific argumentation requires that all claims be supported and justified by material evidence. This is an important part of all good science.

Grade Span: 5-12

Materials:

A **series of 16 checks** in an envelope (1 envelope per team)

There are two sets of checks (which you can use in alternate periods). Note that set "A" has check numbers, providing an extra clue that might make it easier to figure out a sequence of events.

Set A: 16 checks (with numbers), 4 checks per page on 4 pages:

Page 1 Page 2 Page 3 Page 4

Set B: 16 checks (without numbers), 4 checks per page on 4 pages:

Page 1 Page 2 Page 3 Page 4

Student Information Sheet (Optional. Usually works better if teacher calls for all teams to "Pull X checks." – all about the same time, so all teams are about together.)

Student Worksheet (one for each student)

Teacher Notes (you will find directions here, as well as a key to the student worksheet)

Advance Preparation:

- Run off enough copies of each of the 4 Checks Pages in Set "A" to have one for each team.
- Cut apart the checks in a set of 4 Pages, and insert all 16 checks (random assortment) into a team envelope. Repeat this to make one envelope of checks for each team in the class. All envelopes of checks can be used again in each period. If you want to alternate sets of checks for each period, repeat the above for the other set (Set "B") of checks.
- Make enough copies of the Worksheet so there is one for each student.

Time: One class period.

Grouping: 3-4 per group

Teacher Background:

- Because this lesson provides an excellent opportunity to understand important elements of the Nature of Science , be sure to read Teaching the Nature of Science, with tips for presenting the ENSI NOS lessons for maximum effect and Dispelling some of the popular myths about science.
- CONTEXT: This lesson is best used in your Nature of Science unit, preferably in the first 2-3 weeks of your course. If you used something else to convey the concepts listed above, then this lesson could be done later in the year as a little "something different" break, to reinforce those concepts.
- Sample Scenario That Focuses on How This Lesson Models the Approach to "Historical" Sciences: See excellent article by Dr. Laura Henriques "Theoretically Speaking. "The Checks Lab is one of the few interactive lessons (along with various forensic lessons) that illustrates how science deals with problems of the past, events not experienced by available witnesses (sometimes called **"historical" sciences**, like astronomy, geology, paleontology and evolution science), nor open to repetition. This is in striking contrast to most investigative experiences found in textbooks and adhering to an overemphasis on "The Scientific Method," giving the impression that that is the only way science is done. Be sure to provide your students with this information while doing the Checks Lab (since this important process of science is usually ignored in textbooks).

Teacher Resources:

- Teaching the Nature of Science, with tips for presenting the ENSI NOS lessons for maximum effect and Dispelling some of the popular myths about science..
- What IS the Nature of Science , with NOS Key Concepts, NOS Elements and Benefits, Science Assumptions and Limits, and the NOS-ENSI Lesson Selection Matrix.
- Additional Teaching Tips for the Checks Lab.
- Scientific Argumentation: Learn strategies for doing this. This is an important component of the NGSS and the Common Core Standards.

Teaching Tips: See Teacher Background and Teacher Resources above.

Vocabulary: scenario, uncertainty, hypotheses/explanations, testing, historical science

Procedure: See Teacher Notes for details

1. Arrange students into groups, and give envelope of checks to each group (saying "Don't open yet!"
2. After reading Lab Intro (on **Student Information** sheet) to the class, ask each team to draw 4 checks at random. Arrange checks and develop a tentative storyline to explain why each check was made.

3. After about 5 minutes or so, (and they have all recorded Tent. Expl. #1), tell them to remove 4 more check (repeating item 2)
4. After about 5 minutes more, tell them to remove 2 checks from the envelope, and record TE #3.
5. After a few minutes to do this, have students check other team checks and storylines. Remove NO MORE checks.
6. After sharing data and storylines, each group proposes their final tentative explanation.
7. Have representative from each team stand and report his/her group's final storyline to the class.
8. Lead class discussion of the different storylines, pointing out the parallels to science (see detailed points).
9. Have students return their checks to envelopes and hand them in (for use in next period).
10. Allow students to begin answering Discussion questions (probably best to let them discuss each question with their teams, and come up with "team" answers.
11. When most teams are done, engage class in sharing and discussing those answers, guiding their understanding toward the concepts indicated in your key.

Assessment:

1. During team work, take note of active engagement by each student in each team. Were they asking questions? Were they offering ideas, suggestions? Were they pointing out items on checks that could be helpful?
2. During class discussion, who participated?
3. Given components of the checks experience, students will recognize their equivalents in the processes of science. For example, the final explanation, based on items of evidence and student discussion, would be equivalent to --?—in the process of science. [hypothesis].
4. Are all possible explanations equally tentative, or are some more tentative than others? [Some more than others].
5. In the Checks lab, which explanations were most tentative? [The ones based on limited evidence, early in the lab].
6. Ask why scientific information is tentative. [personal biases, opinions, experiences do influence the explanations suggested. Also, they may not have all the evidence; new evidence could be found at a later time].
7. Ask what do scientific claims require in order to be considered useful in building a plausible storyline or explanation [evidence].
8. What features must the "best explanation" have? [It must fit all the evidence (data), be logical, testable, and it must work when applied to new sets of similar data.
9. Ask why it's good (and normal) that scientists disagree and scientifically argue about their proposed explanations.

Extensions:

1. As suggested, after doing this lesson, you could take a closer look at the criteria scientists use to determine the "best" answers to their questions. Check out "Fair Tests: Basic Model for Critical Thinking; How Do Scientists Pick the Best Explanations?", and TRY it!
2. A second activity is built around a structured comparison of the relative strengths of different scientific ideas (theories). See "Is Evolution Weak Science, Good Science, or Great Science?", and TRY it!
3. A similar lesson to this **Checks Lab** is **The Great Fossil Find**, already on this site. It could be used instead of the **Checks Lab**, or in addition to it (at a later date, as reinforcement of the concepts, in an appropriate context). The **Laetoli Trackway Puzzle** lesson also provides an engaging experience, analyzing 3.4 million year old footprints of "Lucy's species.

4. There are many elements of science in crime scene investigations (CSI), or forensic science, and, as in the Checks Lab, there are many ways to incorporate this exciting field in your Nature of Science efforts. Two lessons on our site that do this well are the **Crime Scene Scenario**, and **Crime Against Plants**. Try it. And an excellent online resource for all sorts of ideas and materials can be found on Reddy's Forensic Page: "Forensic Science for High School Students."
5. A nice alternative activity can utilize a sampling of the same set of checks used in this lesson in an interactive online mode on the PBS-Evolution site: "The Check Mystery".
6. **MYSTERY BOXES**: Try this other excellent and very popular lesson which, as presented here, embodies many of the same elements as the Checks Lab. Makes a good alternative to the Checks Lab.
7. For another type of **Mystery Tube** to add to your NOS Tool Kit, take a look at the **3-D Molecular Design** version. They are about 18 cm (7 in.) long. They come with presentation directions and discussion questions. Specific ways these tubes meet the NGSS are pointed out. Prices and contact information are provided for ordering (use their phone number).
8. Also, consider getting **The Data Dilemma** lesson from **3-D Molecular Design**. This engaging lesson models how **scientific models** are developed, tested and modified with new information. It uses **Tangram** pieces as examples of "information" used to build a particular shape, as a metaphor for how science works. Instructions are provided along with sample questions for class discussions. Specific ways this lesson meets the NGSS are pointed out. Prices and contact information are provided for ordering (use their phone number). Enough material in one kit for 12 teams.

Acknowledgements:

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