Lead in Our Environment:
A Lesson for Fourth Grade

By Lucille Lang Day and Bertram H. Lubin
ABSTRACT

A 5-lesson, 4th-grade instructional unit, “Environmental Toxics,” was developed and tested as part of a 40-lesson curriculum entitled SEEK (Science Exploration, Excitement, and Knowledge): A Curriculum in Health and Biomedical Science for Diverse 4th and 5th Grade Students. The unit begins with a lesson on lead, detailed in this article, in which students analyze a case study about a child with lead poisoning and conduct simulated experiments to test household objects for lead. The unit was tested with 144 5th-grade students at two public elementary schools in Oakland, CA; 96% were racial and ethnic minorities. On a 20-question, multiple-choice pre/posttest covering science concepts, scientific process, lifestyle choices, and careers, the experimental group showed significant improvement on 15 of 20 questions (P<.05, t-tests), including all 4 questions explicitly concerning lead, as well as on the test as a whole. A matched comparison group of 91 students showed significant improvement on only 3 questions, just one of which concerned lead, and did not improve on the test as a whole. Teachers rated the educational value of the unit as 9.5 on a scale from 1 (low) to 10 (high), and students gave it an 8.1 on the same scale.
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**INTRODUCTION**

“Lead in Our Environment” is the first lesson in a 5-lesson, 4th-grade instructional unit on environmental toxics and pollution in SEEK (Science Exploration, Excitement, and Knowledge): A Curriculum in Health and Biomedical Science for Diverse 4th and 5th Grade Students.

The 40-lesson SEEK curriculum includes 8 instructional units, each of which teaches human biology and scientific investigation in the context of examining a disease or medical condition, such as sickle cell disease, which disproportionately affects racial and ethnic minorities. Other instructional units look at obesity, traumatic brain injuries, infectious diseases, diabetes, asthma and lung disease, and heart disease.

The curriculum was designed with teacher input to make science interesting and relevant to students who come from racially and ethnically diverse, low-income environments; to help them meet state and national objectives for learning in health, science, and scientific inquiry; and to foster their interest in science, so that they may consider future careers related to biomedical science and thereby help eliminate disparities in the health care and biomedical research workforce.

**ENVIRONMENTAL TOXICS UNIT**

Each lesson has a worksheet on which students plan experiments and record their observations in drawings, writing, and tables. For classroom assessment of student learning, teachers can use these worksheets to see how well students can plan experiments, make
observations, and organize data. Teachers can also determine whether students can draw valid conclusions based on their observations and data. The Unit includes the following lessons: 1. Lead in Our Environment; 2. Testing Non-toxic Cleaning Products; 3. Mercury in Our Environment; 4. Air Pollution, Part 1; and 5. Air Pollution, Part II.

**LEAD LESSON**

**Objectives:**

Students will…

- Analyze a case study about a boy suffering from lead poisoning.
- Interview a lead expert (if available).
- Use the scientific process to conduct a simulated experiment to test household objects for lead contamination.
- Know that scientific progress is made by asking meaningful questions and by conducting careful investigations.
- Discover that lead, a toxic heavy metal, can be found in soil, paint, old houses, pipes, pottery, folk medicine, toys, jewelry, and some Mexican candy and Mexican candy wrappers.
- Learn that lead poisoning often occurs with no obvious symptoms, frequently goes unrecognized, and can affect nearly every system in the body.

**Overview:**

Students read and analyze a case study about a child with lead poisoning. The class meets a lead expert (if available) and tests objects found in the child’s house. The students make hypotheses and use cabbage indicator to simulate testing objects for lead.
Key Terms:

- **Toxic**: Poisonous.
- **Environmental toxics**: Substances in the environment that are harmful to the health of humans. Environmental toxics can be found in air, water, soil, food, and the home.
- **Lead**: An environmental toxic found in soil, paint, old houses, pipes, pottery, folk medicine, toys, jewelry, and some Mexican candy and Mexican candy wrappers. Lead is a heavy metal element.

Materials:

*Per student:*

- 1 worksheet
- 1 pair of latex gloves
- 1 cotton swab

*Per group of 4:*

- 1 household object that could contain lead (but does not, because this is a simulation), such as a brightly colored ceramic bowl, a painted toy, a piece of jewelry, a piece of metal plumbing pipe, or a piece of painted wood representing a piece of a windowsill.
- 1 10-ml vial, capped, containing white vinegar or baking soda dissolved in water (half of the groups should have vinegar, and half should have baking soda in water)
- 1 10-ml vial, capped, containing cabbage indicator (made beforehand).

Instructions for making cabbage indicator: Boil red cabbage leaves, broken into small pieces, for approximately 10 minutes or until the water turns a deep purple. Use approximately one
cup of water for each cabbage leaf.

- 1 eyedropper
- 1 paper plate

**Procedure**

**Activity 1: Case Study**

1. Distribute worksheets and read through the case study (Figure 1) as a class.
2. Ask the students what the story is about. What are the main issues? Divide the class into groups of four to identify the main ideas of the case. Ask the groups to underline the important words or phrases. Did everyone get the same underlined words?
3. Brainstorm what the students know and need to know for 5-10 minutes. Make a chart of what they know and need to know, and discuss it. Discuss any misconceptions.

**Activity 2: Expert**

Introduce the lead expert who will:

- Answer questions from the class about the case study.
- Share information about his or her profession and education.
- Discuss the symptoms of lead poisoning.
- Discuss the long-term effects of lead on the human body.
- Mention the latest research in lead poisoning detection.

If no expert is present, the presenter will need to answer questions about the case study and provide background information on lead poisoning and its long-term effects, as well as on lead poisoning prevention. Lead poisoning causes learning impairment, reduced IQ, hearing loss, and
other severe effects. In addition to neurological damage, it causes renal disease, cardiovascular effects, and reproductive toxicity.

**Activity 3: Simulated Lead Test**

1. Introduce and demonstrate the lead test. Put on a pair of latex gloves, explaining that chemicals and objects that might contain lead should not be touched with bare hands. Show a variety of items that were found in the home of the young child in the case study. Select one item. Then follow this procedure:
   a. Dip a swab into a vial containing vinegar, then rub the swab on the object.
   b. Dip the swab back into the vinegar (to simulate transferring lead from the object to the liquid).
   c. Use an eyedropper to add the cabbage indicator (call it lead indicator throughout the activity), one drop at a time, to the vinegar. When the solution turns pink, tell the students that the object contains lead, and that if it had not contained lead, the solution would have turned green. Explain that this is a pretend test for lead, because it would be dangerous to have objects that really contain lead in the classroom.

2. Have the students discuss which objects are the most likely sources of lead in the case study. Work with the students to come up with hypotheses. The students should write their hypotheses on the worksheets as complete sentences.
   Example: “The child was poisoned by lead paint in the house.”

3. Pass out a pair of gloves to each student and ask them to put the gloves on.

4. Pass out 4 swabs, 1 indicator vial, 1 vinegar or baking soda vial, 1 paper plate, and 1 test object to each group of four. Each object should be placed on a paper plate. As you hand out
each object, hold it up and ask the students to complete the first two columns of the table on their worksheets (Figure 2). Students should make their own predictions.

5. Lead the students through the steps again as they do the tests. Each student should dip a swab in the clear liquid, rub it on the object, then dip it again in the clear liquid. After all four students have done this, they should take turns adding one drop of indicator with the eyedropper until the solution changes color. Ask them to record the result in the table on their worksheets (Figure 2).

6. Collect the test objects and tabulate the students’ findings.

7. Collect and discard the plates, gloves, and swabs.

8. Discuss the lead-containing objects in relation to the case study. What do the students think poisoned Juan? They should write their conclusions on the worksheets. (Juan could have been poisoned from multiple sources.)

9. Brainstorm ways to prevent lead poisoning. Discuss important sources of lead, including paint from houses built before 1978.

“Lead in Our Environment” supports the following overall objectives of the SEEK curriculum:

1. **Students will be able to carry out a simple scientific investigation.**

   The curriculum engages students in the scientific process and group problem solving, enabling them to use critical thinking skills. They practice observing, questioning, making predictions, hypothesizing, planning experiments, identifying and controlling variables, collecting data, measuring, estimating, making graphs, and drawing conclusions.

2. **Students will be able to describe a variety of health care and biomedical science careers.**

   The curriculum uses role-playing and guest speakers to introduce careers. The lessons can be
presented without guest speakers, but are enhanced by guests who can tell the students what they do in a typical day, what kind of training they needed, and what research is currently underway in their fields.

3. **Students will be able to give examples of current topics of biomedical research.**

   Guest speakers provide information about current research. In addition, many of the experiments afford the opportunity to relate what the students are doing to cutting-edge research.

4. **Students will report engaging in healthy behaviors such as eating more vegetables and exercising more often.**

   The lessons provide information on how to avoid many of the health conditions studied and give students the opportunity to role-play healthy behaviors. Some of the practical skills covered are hand washing, eating a balanced diet, getting plenty of exercise, not smoking, avoiding secondhand smoke, and drinking plenty of water.

5. **Students will be able to define basic terms related to health and the human body such as “cell” and “toxic” and will be able to explain the function of organs and organ systems such as “heart” and “immune system.”**

   The curriculum takes a “learn by doing” approach to teach scientific concepts and terminology. Students learn through experiments, games, group problem solving, and other activities. Worksheets reinforce the lessons.

**TESTING OF THE UNIT**

The environmental toxics unit was tested with 144 4th-grade students (50% male, 50% female) at two public elementary schools in Oakland, California. Their ethnicity was
approximately 48% African American, 33% Latino, 12% Asian, 4% Caucasian, and 3% Pacific Islander. On a 20-question, multiple-choice pre/posttest covering science concepts, scientific process, lifestyle choices, and careers, the experimental group showed significant improvement on 15 questions (P<.05, t-tests), including all 4 questions explicitly concerning lead (Figure 3), as well as on the test as a whole. A comparison group of 91 students academically and demographically matched to the experimental group showed significant improvement on only 3 questions, just 1 of which concerned lead, and did not improve significantly on the test as a whole. The experimental group improved on 11 science concept questions, 2 scientific process questions, 1 lifestyle question, and 1 career question. The comparison group improved significantly on 1 concept question, 1 process question, and 1 lifestyle question. Figures 4 and 5 give the statistical analysis of the lead questions for the experimental and comparison groups. Correct answers were given a score of 1, and incorrect answers a score of 0.

Teachers were asked to rate the educational value of both the lead lesson and the unit as a whole on a scale from 1 (low) to 10 (high). The average rating they gave the lead lesson was 9.8, and the average rating they gave the unit was 9.5 (N=5). On the same scale, students were asked to rate how interesting they found the unit; their average rating was 8.1 (N=128).

Pre/posttest results, student success with the activities, and teacher and student ratings show that the lessons on pollution and environmental toxics were effective with 4th graders, thus helping lay the groundwork for further study of these topics in middle school and high school.

ACKNOWLEDGMENTS

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**REFERENCE**


**INTERNET RESOURCES**

Kansas Department of Health and Environment: Lead poisoning prevention curriculum project

http://www.kdheks.gov/lead/lead_curriculum.html

U.S. Environmental Protection Agency: Lead in Paint, Dust, and Soil

http://www.epa.gov/opptintr/lead/index.html

**CONNECTING TO THE STANDARDS**

This article relates to the following *National Science Education Standards* (NRC 1996):

Content Standards

Grades K-4

Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry
Grades K-4

**Standard C: Life Science**

- Organisms and environments

**Standard F: Science in Personal and Social Perspectives**

- Changes in environments

Case Study

Juan is a 6-year-old, Latino boy who lives in Oakland, California, with his mother, father, grandmother, and 3-year-old sister. He was a happy child who enjoyed watching TV, playing with toy cars, and eating Mexican candy. Recently, his kindergarten teacher noticed that he was acting out in class. He was having trouble learning the alphabet. In a doctor’s visit, a blood test showed that he had lead in his blood, 8 times the normal level. Investigations revealed that he lived in an apartment building with old paint and old pipes. Although the family immigrated to the US six years ago, they still use Mexican pottery, but they do not use alternative medicines. Juan spends most of his time indoors. What is the source of the lead poisoning?

Object Name | Prediction of lead (Yes/No) | Test result (Color) | Contains lead? (Yes/No)
---|---|---|---

Figure 1: Case study from lead lesson worksheet.

Figure 2: Table from lead lesson worksheet.
Figure 3: Pre/posttest questions concerning lead.

6. **Lead is found in**
   a. □ pencils        b. ☑ old house paint    c. □ soda        d. □ sea shells

7. **You can**
   a. □ easily see and smell lead
   b. ☑ sometimes taste lead
   c. □ know immediately if someone has lead poisoning
   d. □ get lead poisoning from pencils

8. **Lead affects**
   a. ☑ nearly every system of the body
   b. □ only the nervous system
   c. □ only the respiratory system
   d. □ only the digestive system

20. **Lead experts**
    a. □ treat lead poisoning
    a. □ find better ways to use lead
    b. □ make toys out of lead
    c. ☑ test paint in old houses for lead

Figure 4: Experimental group, pre/posttest results on lead questions and test as a whole.

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<th>Pretest</th>
<th>Posttest</th>
<th>t-test</th>
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Figure 5: Comparison group, pre/posttest results on lead questions and test as a whole.

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<th>t-test</th>
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</tbody>
</table>

C = Change; Q = Question number; Cor. = Correct; Inc. = Incorrect; N = Number of subjects
M = Mean; SD = Standard deviation; t = t value; df = Degrees of freedom; P = Significance; T = Total score for all 20 questions.