



Forensics: Get a Clue!

Unit Summary

Contrary to what Sherlock Holmes may have told Watson, criminal investigation is not so elementary. These days, detectives use a vast array of tools to solve crimes. In this project, students delve into the world of criminal investigation and learn how forensics scientists collect, analyze, and process evidence to solve a crime. In preparation for solving a simulated classroom "crime," students engage in deductive reasoning activities and practice math and science forensics labs. Then, using the scientific inquiry process, they collect clues, test and analyze evidence, and draw conclusions to solve the crime. Student groups use the *Seeing Reason* causal mapping tool to determine the relationships between the evidence and the suspects to help solve the classroom crime. They also use *Seeing Reason* to help analyze and interpret data as they conduct forensic labs.

Curriculum Framing Questions

- **Essential Question**
How are math and science put to work in the real world?
- **Unit Questions**
How is the scientific inquiry process used to solve a crime?
How does one gather and process scientific data to support a conclusion?
- **Content Questions**
What is forensic science?
How is evidence collected and used to solve a crime?

Instructional Procedures

Prior to instruction

1. This project is an integrated math and science unit. The math activities could be taught separately in a math class.
2. This unit makes use of the *Seeing Reason* causal mapping tool. Before using *Seeing Reason* with your students:
 - a. Examine the [Seeing Reason Web site](#) to become familiar with the tool.
 - b. Set up a project and teams in the teacher workspace. Name the project Forensics: Get a Clue. The research question is: How do you interpret evidence? Assign group names and set up two maps for each group. For example, name them team1lab and team1investigation. Each student group completes at least two maps, one for a forensic lab experiment and one for the crime investigation.
 - c. Set up a test team and make practice maps to uncover potential directions student mapping might go, and to refine the investigation.
3. This project revolves around a simulated classroom "crime." The unit is written with an example that may be replicated. However, you may also choose to develop your own "crime" and will need to adapt the materials to fit your crime. If using the example crime, change the name of the school and people involved to reflect your situation. Become familiar with the crime by reading [what really happened](#). Set up the room in advance by referring to this [crime scene set up](#). Prepare [evidence](#) baggies and lab reports from the evidence page and get to know the suspects by reading [suspects' information](#).

Introducing crime investigation

1. Begin the unit by explaining that students are going to learn the skills of crime investigation and ultimately solve a simulated crime themselves. The first exercise is a vocabulary-building activity and an introduction to the process of solving a crime.
2. Distribute [school crime scenarios](#) on slips of paper to small groups of students. Tell students that the crimes occurred in the school, and students are going to study the scenarios in order to establish the steps of investigating crime. Have each group brainstorm how they would go about solving the crime, and write up a list of about 10 investigative questions that they would need to pursue in order to solve the crime. For example, for the first crime scenario: When did Louise notice that her CD was missing? Was there a witness? How was her locker broken into?
3. Have each group share what its process would be for solving the crime. Through sharing and discussion, establish that the steps for solving a crime are:
 1. Investigating the crime scene
 2. Diagramming and photographing the scene
 3. Gathering physical evidence from the scene
 4. Processing the evidence
 5. Collecting testimonial evidence (i.e., witness statements, interviews)
 6. Identifying suspects

At a Glance

Grade Level: 6-8
Subject(s) Sort: Math, Science
Subject(s): Math, Science
Topic: Forensics
Time Needed: 3-4 weeks, one period
Key Learnings: Scientific Inquiry, Logic, Data Analysis

Things You Need

- Standards
- Resources
- Print This Unit
(PDF; 31 pages)

7. Analyzing suspects and evidence

8. Drawing and reporting conclusions

These steps mirror the scientific inquiry process (observing, hypothesizing, collecting and experimenting with data, and drawing conclusions).

Emphasize that the goal of criminal investigation is to reconstruct a past event (the crime) in order to solve it.

4. Define and discuss vocabulary words as they come up, such as witness, testimony, red herring, trace evidence, alibi, and physical evidence. As students share their investigative questions, provide feedback to help them improve their questioning skills. Help them ask specific, relevant questions that build on information that they already know
5. Explain that while students will not be solving these particular classroom crimes, they will be solving a different, more complex, classroom crime later on.

Building Crime-Solving Skills

Forensics labs

1. Explain to students that they are going to learn how to be Crime Scene Investigators (CSI) who locate physical evidence left behind at the scene of a crime, subject it to analysis and comparison in a forensic science laboratory, and then use all of the evidence to figure out what happened at the scene of the crime.
2. Discuss examples of physical evidence left at a crime scene such as: weapons, blood, fingerprints, soil from shoeprints, glass, hair strands, fibers from clothing, and tool impressions.
3. To build a foundation in forensics science, have students analyze evidence with [forensic labs](#). Choose some labs to do, such as fingerprint analysis, ink chromatography, glass density, soil analysis, hair classification, lip print test, tool mark experimentation, or a fiber match. The experiments provide students with an opportunity to learn how to examine evidence, conduct lab tests, and draw conclusions from the evidence. This experience prepares them for the analysis of evidence related to a classroom crime that they investigate later in the project. Because of this initial work, they should be able to conduct the experiments themselves later on.
4. Spend a few days doing the practice forensic tests. Tell students that they need to know how to do the tests and how to analyze the results in order to help them solve a classroom crime. Choose one of the labs to use as a model with the *Seeing Reason* mapping tool.

Using Seeing Reason to organize and analyze

1. Introduce students to the *Seeing Reason* mapping tool by exploring the [Try Out the Tool](#) demonstration space together. Start by discussing the sample map. Next, clear the map, and make a map of student thinking about a non-research-based question such as, "What makes a movie a popular?" Show students how to read, construct, and describe factors and relationships. Demonstrate how chains of factors emerge as discussion goes deeper. Show students how they can support their map models by including data in the factor and relationship description fields. Explain that maps can show how thinking changes over time, and encourage students to engage in cycles of mapping, research, discussion, and re-mapping. Tell students they will work in teams so they can discuss their developing ideas.
2. Explain that students will be using *Seeing Reason* for two purposes and will make at least two maps. The maps are used to answer the research question: How do you interpret evidence? Choose one of the lab tests to show how the *Seeing Reason* mapping tool can be used to help students organize their data and analyze the results of forensic lab tests. This can be done as a demonstration to the whole class, or each group can do its own map. Choose a lab such as the fiber test, and have students map their testing process, results, and conclusions about the evidence drawn from the tests. See [sample fiber test investigation](#).
3. Students will also use the *Seeing Reason* mapping tool to organize and analyze all of the information that they gather from their crime investigation. As they examine evidence and determine what the evidence reveals about suspects, they construct relationships between the evidence and suspects on their maps, and ultimately determine who the guilty parties are in the crime.

Developing deductive reasoning skills

Solving a crime involves good thinking skills. During math, have students engage in [daily logic activities](#) to help them improve their deductive reasoning and logical thinking skills. Each day of the investigation, have students do a deductive reasoning skill-building activity, such as solving a mystery of the day, doing puzzles involving deductive reasoning, participating in exercises to practice problem-solving strategies, and solving a mini-mystery.

Developing diagramming skills

Explain that in order to document a crime scene, investigators take careful notes, snap photos, and sketch a scale map of the crime scene. A crime scene sketch is a simple drawing that accurately shows the appearance of a crime scene. The sketch is drawn to show items and the position and relationship of the items. The advantage of a sketch is that it can cover a large area and be drawn to leave out clutter that would appear in photographs. To prepare students for sketching the crime scene later on, have them practice sketching and measuring the distance between objects in the crime scene. In math, set up a large space with six to eight items that students diagram. For each object, students measure the distance to the object from two fixed points within the classroom and then place the object on the scale diagram accordingly.

Introducing the Crime

With scientific analysis and logical thinking skills in hand, students are ready to investigate a "crime" that occurred in their very own classroom.

1. Arrange students in investigative teams of four with these identities:

- a. Detective (Group Leader): In charge of leading the crime investigation by analyzing the evidence, making informed hypotheses about the relationships between the evidence and suspects using a *Seeing Reason* map. Detectives work with the investigator to brainstorm the questions for the head of the forensic lab.
 - b. Investigator: Responsible for the asking five questions each day and recording the answers to the questions based on the lab results, lab report analysis, interviews, or search warrants. The investigator is also in charge of the *Seeing Reason* lab processing maps.
 - c. CSI 1: (Forensics Scientist): In charge of processing the evidence and relaying the information to the detective.
 - d. CSI 2 (Lab Technician): In charge of the experiments and processing the evidence.
2. Explain that you, the teacher, are director of the forensics laboratory, and you have all of the evidence. Each group is allowed to ask five questions per day, and depending on what they ask, you will provide them with [evidence](#) from lab reports, [interviews](#), [search warrants](#), or materials necessary to conduct an experiment.
 3. Discuss and model investigative questions (refer back to the crime scenarios activity). Students should understand how to pose probing and relevant questions that will provide them with the information that they need. Tell students that as they answer their questions, they should write the answers and apply their new knowledge to help them solve the crime, using a *Seeing Reason* map.
 4. Show students the [forensics rubric](#) and explain how they will be evaluated throughout the investigation.
 5. Distribute copies of the [initial police report](#). Based on the initial police report, have student groups set up their *Seeing Reason* maps for the investigation. Groups can decide how they want to set up the maps to help them process the information to solve the crime. As students create their maps, take the opportunity to gauge understanding and guide learning. Look at maps, listen to conversations, and ask students to describe their maps. Ask questions that prompt deeper thinking about their work and help them improve their own questioning skills as they develop their five questions of the day. (Example: What does the shoeprint analysis tell you about Samantha's involvement? What evidence supports your hypothesis that George got into the principal's computer?) Point out the comments feature on the *Seeing Reason* map and explain that you will be looking at students' maps, providing them feedback, and pushing their thinking.
 6. Now, using the scientific method, dig into the crime.

Investigating a Crime

Observing

1. Have groups take turns visiting the crime scene to record their observations. They should take measurements of the crime scene and create a sketch using the diagramming skills that they learned previously. This can be done in math class.
2. Based on their initial observations, they should prepare questions to ask and evidence to request.

Hypothesizing

1. Groups can begin to identify suspects, hypothesize about the relationship between the evidence and suspects, and make predictions about the events that occurred at the crime scene. Hypothesizing helps them formulate questions and determine what evidence they wish to request. This speculation drives their crime-solving process.
2. As they request evidence, emphasize that they must support their request with logical reasoning used to justify their requests. Throughout the crime investigation, students cycle back and forth between hypothesizing and testing their hypotheses.

Collecting evidence and conducting lab tests

1. Students try to solve this whodunit by preparing questions for the director of the forensics laboratory who provides physical [evidence](#) labs and test results, [interviews](#), and [search warrants](#) to help students answer their questions. Explain that each group may ask up to five questions per class. The director of the forensics lab has the authority to approve questions or make students refine or improve their questions.
2. For some of the evidence, have students do the actual labs themselves. For example, see these [math lab investigations](#). For at least one of the labs, have students use *Seeing Reason* to show their testing process, results, and conclusions drawn about the crime. Refer back to the fiber test sample map.
3. As groups conduct the experiments and analyze the reports and interviews, facilitate their use of the *Seeing Reason* tool to help them show the relationship between evidence and suspects and apply deductive reasoning skills to determine who was involved with the crime and what their involvement was.

Drawing Conclusions

1. The investigation continues as students prepare questions, analyze evidence, and try to solve the crime.
2. Call an end to the investigation when you see that students have analyzed enough evidence to solve the crime. Have each group use the relationships and explanations on their *Seeing Reason* investigation map to draw a conclusion about their interpretation of the crime. They should write their conclusion as a short [report](#) and share it with the class.
3. Distribute copies of [what really happened](#), and discuss the crime.

Prerequisite Skills

1. Cooperative group skills
2. Experience with the scientific method and doing science labs

3. Basic computer skills

Differentiated Instruction

- **Resource Student**

Special needs students will have the benefit of working in a cooperative team for the project. Peers may be assigned within the group to provide extra assistance to special needs students. Special needs students can also benefit from a glossary of vocabulary words related to the project.

- **Gifted Student**

Gifted students may take the lead in processing more crime labs. The CD, [Clues in Crime](#)*, can also be purchased, and gifted students can do the virtual forensics labs, and then provide additional suggestions for evidence or labs to request.

- **English Language Learner**

Develop a glossary for students with vocabulary words related to the unit and help English language learners define the words throughout the unit.

Assessment Processes

Use the [forensics rubric](#) to assess students. Check in with students' work on a daily basis by reviewing their *Seeing Reason* maps. Provide feedback in the "comments" area of the map.

Credits

Theresa Maves, a science teacher and Meile Harris, a math teacher, at O'Leary Junior High School in Twin Falls, Idaho developed and implemented this unit.

Contact Education 



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Seeing Reason

Content Standards and Objectives

Student Objectives/Learning Outcomes

Students will:

- Analyze data and draw conclusions
- Use patterns to gain information
- Understand how math is used in science to solve problems
- Understand how science relates to criminal investigations
- Become better investigators through questioning strategies
- Develop group collaboration skills
- Use the scientific process to solve a crime that took place in one's own classroom

Targeted State Frameworks/Content Standards/Benchmarks

National Science Education Standards

- Design and conduct a scientific investigation
- Use appropriate tools and technologies to gather, analyze, and interpret data
- Develop descriptions, explanations, predictions, and models using evidence
- Think critically and logically to make the relationships between evidence and explanations

National Standards for School Mathematics

- Apply and adapt a variety of appropriate strategies to solve problems
- Monitor and reflect on the process of mathematical problem solving
- Select and use various types of reasoning and methods of proof
- Recognize and apply mathematics in contexts outside of mathematics

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Seeing Reason Resources

Printed Materials

- *Neo-Sci - Introduction to Chromatography (science kit)*, PO Box 22729 Rochester, NY 14692-2729, 800-526-6689.
- Walker, Pam & Elaine Wood. *Crime Scene Investigations: Real Life Science Labs for Grades 6 -12*. West Nyack, NY: The Center for Applied Research in Education, 1998.

Supplies

- Various science and math laboratory supplies depending on the labs
- Crime scene set up with evidence

Internet Resources

[Seeing Reason](#)

Other Resources

Technology - Hardware

- Computers
- Internet Connection

Technology - Software

[Clues in Crime](#)*, Duke University

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What Really Happened

Samantha, Ashley, Sally, Bob, and George are all friends at O'Leary Jr. High. One night they were bored and dared Sally, who is new to the school, to steal chemicals from Ms. Miller's storage room so they could make explosions. Ashley, Ms. Miller's ninth-grade clerk, said she didn't think this was a good idea and would have no part of it. Sally said she would do it, hoping to gain more acceptance at O'Leary and prove she was "cool." So the others devised the plan behind Ashley's back.

Since Ashley said she wouldn't help them get Ms. Miller's key, George said he would make an impression of one of the custodian's master keys and get one made at his older brother's hardware store. He did this at lunch. The custodian has his keys hanging off his belt. While a bunch of students distracted the custodian, George pulled the key and made the impression in wax before anyone figured out that it was missing. The students didn't know the code to the building alarm system, so they knew they would have to be in the building before the custodians set the code when they left at 11 p.m. George, Sally, and Samantha stayed after school to get help from their teachers, and then instead of leaving, they hid in the bathroom, which is always cleaned by 5 p.m. They stayed in the bathroom playing cards, reading magazines, and eating snacks until 11 p.m.

The custodians left the building at 11 p.m., set the alarm code, and locked the doors. The students then let themselves into Ms. Miller's room with the key George had made. When they tried to use the key for the back room, it didn't work. They didn't realize that the master key does not work for the chemical storage rooms in the science classrooms. Each of these rooms has a separate key. George was disappointed that all his efforts had gone to waste in getting the key made, but it then dawned on him that he could probably get into other rooms...even the custodian's room. He left to see if he could find the storage room key. When he got to the custodian's room, he couldn't find any of the keys. He didn't know that they are actually stored in the safe in the front office. He then went to look in the principal's office to see if any more keys might be stored there, but had no luck there either. It was then that he had a brilliant idea.

George had gotten into trouble the week before with a substitute teacher who wrote up a referral on him. He just needed one more offense and he would get in trouble with his probation officer and possibly have to go back to the juvenile detention center. Even though he acted like he didn't care about school, he really did like O'Leary. He knew that all discipline referrals got entered into the discipline database on the school's computer system. He had taken several computer classes and thought maybe he could hack into the system and erase the referral. He planned to come back to the principal's computer later, after he solved the storage door situation.

Meanwhile, the girls decided to try picking the lock in case George couldn't find the key. They didn't have much luck, but they did strip the key hole. George came back and had the brilliant idea of hacking into the door with a crowbar that he saw in the custodian's room. This actually worked while causing minimal damage to the door. George told the girls to get the chemicals and meet at the edge of the field by Bob's house. He lives very close to O'Leary, and there is a huge farm field next to his house. George told his parents that he was spending the night at Bob's house. Bob lives close to Sally. Samantha was spending the night with Sally. Sally's parents were out of town and her older brother was in charge, which means nothing because he hardly even notices her. Bob had to attend a concert at the high school with his family and would sneak out later and meet them.

The girls were curious why George was so anxious to leave so quickly. He told them it was because he had to meet Bob at a certain time. This was partly true, but he also wanted to stop by the principal's office and do some hacking. He didn't want the girls to know this because he was concerned that they would tell, and because he didn't want them to know about his history of discipline referrals.

George left and successfully hacked into the computer and changed his discipline record; while he was at it, he decided to change his number of tardies and absences, too. He had no idea that in a few days, his hacking would be noticed and would lead to his ultimate downfall.

Once the girls were in the storage room, they found the chemical shelves and were overwhelmed with the number of chemicals on Ms. Miller's shelves. If only Ashley had come; she had just completed a chemical inventory for Ms. Miller so she probably would know the uses of some of these chemicals. They knew they could take the zinc, manganese, hydrochloric acid, and hydrogen peroxide because they had just completed a lab in Ms. Miller's class and knew that these chemicals could generate hydrogen and oxygen gasses. They experimented with small quantities of these in class, but they figured they could do the same things on a bigger scale and get huge results. Just as luck would have it, they found the chemical inventory list that Ashley had completed. Ashley was helping them out and didn't even know it. She had listed each chemical and different uses for each.

Armed with the chemical information, they decided to also take zeolite (powerful deodorizer), aluminum potassium (powerful astringent), potassium chloride (fertilizer), sodium silicate (gel), and sodium chloride (salt). This would be their little gift to George. George had terrible foot odor, and the zeolite would certainly solve his problem. The girls thought the silicates would be fun to play around with and it reminded them of the diaper lab they did in class and how each of those little beads soaked up 200 times its weight in water and formed a gel. They figured they could get creative and find something to do with the potassium chloride and aluminum potassium. They decided to also take the sodium chloride because they thought it was a chemical that reacted violently with water. They didn't realize it was just salt.

Sally used the ladder to get the chemicals from the shelf. In reaching for the chemicals, she lost her balance and fell backward, hitting her head on a shelf, dropping the jar of zinc, and spilling a bottle of sodium borate (borax) onto the ladder and the floor. Samantha caught her before she fell completely to the floor. Neither of them realized that when Sally hit the shelf with her head, it left some of her hair and blood. She had a bump on her head with a little bit of bleeding but otherwise was fine. She used some napkins that were on a shelf to wipe the blood and threw the napkin away into the trash can.

There was a small whiteboard in the storage room. Just to be funny, Samantha wrote on the board, "Thanks Ashley." Sally said that was too mean to do to their friend, so they erased the board and gathered all of the chemicals.

At midnight, just as they were getting ready to leave, they were startled to hear the school alarm go off. Afraid to go out into the hall and out the door, they quickly left through the classroom window. Samantha grabbed the crowbar and while escaping through the window, tore her shirt and dropped her gum onto the ground. As Sally went through the window, she spilled some zinc and then snagged her hair, leaving several strands on the window ledge.

Samantha and Sally ran to the meeting place in the field, sure that George had left long ago, but when they arrived they found him there. They didn't have a clue what made the alarm go off. George knew, but wasn't planning to tell them. After he finished with his task in the office, he left through the side doors. When he opened the door, the alarm sounded. He thought the alarm would only sound if it was opened from the outside, but apparently he was wrong. Bob finally arrived, and they told him what happened. They decided to go home since the police would be checking the surrounding area. They planned to meet again over the weekend and continue with their fun. This gave them more time to figure out what to do with the chemicals. Sally kept the chemicals in her bedroom.

The police arrived at the school and noticed a car parked by one of the buildings and checked that building first. They found Ms. Ramirez working in the auditorium cleaning up after the big school play that had been performed that night. They checked her ID badge and verified her story. The police concluded that she must have set the alarm off accidentally when moving around in the building. They are always getting false alarms like this from teachers, who never seemed to know how to arm and disarm the system properly. Everything appeared normal. There was no apparent vandalism and nobody lurking around the premises, so they left.

The next morning when the principal and custodian came to school, they noticed their doors were unlocked. They thought that the night custodians forgot to double check all the doors before leaving. Nothing was stolen and no vandalism was apparent, so they didn't think any more of it until Ms. Miller discovered her back room had been broken into and was a mess.

Sally, Samantha, Bob, and George met in the designated field two days later at 9 p.m. to experiment. They successfully made a big enough explosion that neighbors nearby called the police about the disturbance. The kids ran to Sally's house and later dispersed. They agreed that they were done with their antics. They decided there were too many variables involved with mixing chemicals, and they didn't really want to hurt anyone, least of all themselves. This was too close of a call. Police did a search near the neighbor's house and found an area in the field that had fresh footprints. Later testing revealed residue of hydrochloric acid, hydrogen peroxide, manganese, and zinc in the same area. The police filed a report, but didn't have any real leads.

Crime Scene Set Up

Teacher's Copy

A back storage room is ideal for the crime scene. The storage room should have high shelves with science equipment and other school supplies. Rest a ladder against the shelves. The "crime scene" can be cordoned off with yellow crime scene tape (available from police stations). The following evidence should be in the storage room:

- The storage door has tool marks on it, and the keyhole is stripped
- A piece of fabric is on the window ledge
- Blonde hair strands are on the window
- A piece of chewed gum is outside the window
- Several footprints are outside the window, but they are on top of each other
- Zinc metal (white substance) is spilled outside the window and on the window ledge
- The window is open
- There are two different types of shoeprints leading from the storage room to the window
- Blonde hair and some blood are on the ledge of a shelf about 5 feet high
- Sodium borate (borax, a white powdery substance) is on the ladder and floor
- Nine chemicals are missing
- Zinc metal is spilled on the ground
- Broken glass is on the floor
- A chemical inventory list is on the table in the storage room
- A bloody napkin is in the trash can in the storage room
- A water bottle with lipstick on it is on one of the shelves
- Spilled black carbon powder is on the floor
- Small white board hanging on the wall

Evidence

Teacher copy

Evidence at the Crime Scene

- The storage door has tool marks on it from the crowbar, and the keyhole was stripped.
- A piece of white cotton fabric with blue marker on it was on the window ledge. Blouse belongs to Samantha.
- Fairly fresh gum (Wintergreen) was found outside the window, belongs to Samantha.
- A torn piece of a playing card found outside the window, but no fingerprints could be recovered (too smudged).
- Spilled zinc metal outside the window spilled as the girls were leaving.
- Several footprints were found outside the window, but they were on top of each other and could not be distinguished as to what kind. One size could be determined as 10 women's (or 9 men's).
- Two different types of shoeprints with sticky residue of spilled soda left in the back room. One set of prints is 10 women's (or 9 men's) and the other is 5 women's (or 4 men's).
- Two different types of soils found in the back room, determined to have fallen out of grooves in shoes belonging to Sally and Samantha. From Sally's shoes: pH 4, lighter soil, almost orange with very fine granules. From Samantha's shoes: pH 7, medium size granules, darker color with large amounts of minerals and fertilizers.
- Partial footprints leading from the storage room to the window also left by the sticky residue. They matched a size 10 women's Adidas and a size 5 women's Doc Martens.
- A ladder beside the chemical shelf had spilled sodium borate powder, a cleaning agent.
- Nine chemicals were missing but none strong enough to eat skin: zeolite (powerful deodorizer), aluminum potassium (powerful astringent), potassium chloride (fertilizer), sodium silicate (gel), and sodium chloride (salt). Zinc, manganese, hydrochloric acid, and hydrogen peroxide were taken because the students had just completed a lab in Ms. Miller's class in which these chemicals could generate hydrogen and oxygen gases to make rocket fuel.
- Fingerprints were all over the storage room. None of the fingerprints belonged to this group. The students wore gloves. Seven different prints were recovered matching Ms. Miller, Ashley, Ms. Anderson, Ms. White, the custodian, and two unknowns. Ms. Miller's prints were all over the room; the custodian's were on the doorknob and the chemical shelf; Ashley's prints were found all over the shelves with the chemicals and on the table; Ms. Anderson's prints were found on the shelves where the paper is stored and on the water bottle; Ms. White's prints were found on the shelf with the napkins, plates, and cups; and two sets of unknown prints were on the door, shelves, and some chemical bottles.
- Zinc metal was spilled on the ground in the storage room.
- Broken glass was on the ground in the storage room.
- A chemical inventory was found on the table in the storage room.
- A bloody napkin (Sally's type AB) was in the trash can in the storage room.
- Natural blonde hair and some blood (AB) were found on the ledge of a shelf about 5 feet high, belonging to Sally.
- Dyed blonde hair strands were found on the window, belonging to Samantha.
- Black dog hair from a black lab (which belongs to Sally's black lab) was found in the soil in the back room.

Other Evidence (not at crime scene)

- A crowbar found at Sally's house in garage. The girls put it there thinking it would just go unnoticed in her dad's tools. The crowbar has paint chips from the school door. (Search warrant)
- The same glass density found on Sally's and Samantha's shoe soles match the jar in room. Also, the glass has residue of black carbon powder. (Search warrant)
- A mold with the master key imprint found in George's bedroom. He kept it in case he needed it later. (Search warrant)

- Samantha's torn shirt left at Sally's house. It is white cotton with blue permanent marker on it. (Search warrant)
- Latex gloves found in a trash can outside the school belong to George, and the prints can be lifted from the inside.
- Zeolite found in George's shoes at home. (Search warrant)
- Sally's and Samantha's gloves found in the trash at Sally's house. Prints of both girls can be lifted from these. (Search warrant)
- Police report filed by Bob's neighbors describes a disturbance in the area two days after the breaking and entering.
- Residue of the chemicals taken found out in the field where neighbors reported disturbance two days after the breaking and entering of Ms. Miller's room.
- Shoeprints found in the field near the explosion, size 11 men's Etnies (or 12 women's) and a size 10 women's Doc Martens (or size 9 men's).
- A playing card was found in the bathroom (with several fingerprints that match Samantha, George, and Sally) behind the sink as well as traces of food (cheese popcorn and chips) and sticky residue from soda that was spilled.
- An activity report on the principal's computer (completed every 24 hours) notes a modified file from the discipline database at 11:50 p.m. Further investigation shows that it was George's discipline file.
- Video camera surveillance revealed three unknown people entering Ms. Miller's room with a key. Their faces were not shown. Two of these people never left the room. One person (about 5'6") left the room and entered the custodian's room, then the principal's office, then went back to the custodian's room, then to Ms. Miller's room with something long in his hand. He then left Ms. Miller's room to go back to the principal's office and then left through the side doors. He threw something in the outside trash and took off running. This was about midnight.
- Handwriting analysis matches Samantha's writing on the "Thanks Ashley" that had been erased from the white board in the storage room.
- A luminal test under UV light detected blood in the storage room. The approximate blood loss is .80 mL and the type is AB for the blood found on the shelf. Students can also do a drop analysis. The blood was found on the lip of a shelf perpendicular to the chemical shelf. This was the same type of blood found on some napkins in the trash. There was also some blood found on a razor blade that was type O. The cut was probably a slice about 2 ml deep.
- A police report filed two days after the crime, noted that an explosion happened in some farm field (by Bob's house). They found traces of manganese, zinc, hydrochloric acid, and hydrogen peroxide. They were able to distinguish one shoe print that matches a pair of Etnies, size 11 men's.

Red Herring Evidence

- Water bottle with lipstick (Ruby Red by Estee Lauder) on the rim belongs to Ms. Anderson. She often borrows construction paper from Ms. Miller's back room and left her water. The lip print and fingerprint on the bottle matches her.
- Spilled black carbon powder was spilled by Ms. Miller several weeks ago, and she didn't clean it up very well.
- Mr. Evan's door left open by accident.
- Sierra, an angry student, overheard saying she wanted a chemical to eat skin. None of the chemicals taken are strong enough to do this. The HCl is only strong enough to burn and irritate skin.
- To confuse matters, the custodians had used explosives involving potassium chloride (one of the chemicals stolen), to uproot a tree stump on O'Leary's property. The explosive they used was manufactured and involved several chemicals.
- Razor blade with Ms. Miller's blood from a previous accident (type O).
- Tire tread marks matching a 2002 Dodge Caravan* (Ms. Anderson's) were found by Ms. Miller's back door. Tracks were less than one day old, and the tire tread was new. Two different types of soil were found in the track print, with a pH of 5 (probably O'Leary) and a pH of 8.

Evidence that is processed by labs

- Fabric test: Students compare how different fabrics react to flame.
- Hair analysis: Students use microscopes to compare crime scene samples of animal and human hair (dyed and natural colors).
- Fingerprint analysis: Students compare fingerprint patterns on fingerprint cards for suspects and the prints from the back room.
- Soil analysis: Students are given the soil samples from the crime scene, and they compare the granule size, color, pH, and mineral content (with UV light) with soil samples from different locations in the county limits.
- Presences of blood: Students spray the back room with a chemical and then use the UV light to see how much blood residue if found. This is when they rule out a gruesome crime scene because they don't find much.
- Glass density: Students find the density of the broken glass so they have it for reference when they discover broken glass on shoes.
- Shoeprint (Math lab)
- Blood drop (Math labs)
- Fingerprints: Students lift prints from inside a latex glove and the water bottle and do a fingerprint analysis.
- Lip print: Students do a lip print matching lab.

Evidence that is given as a lab report:

- Tool mark identification
- Gum analysis
- Sticky pop residue
- Chemical analysis: Students are given a chart (or can do the research on the Internet) on each of the chemicals and their most common five uses
- Chemical inventory
- Handwriting analysis
- Napkin analysis
- Video surveillance
- Computer activity report
- Police report
- Tire track report
- Grid search of field for anything unusual when explosion went off

pH locations

- O'Leary's pH is 5.5
- Samantha's soil at her house is pH 7
- Sally's soil at her house is pH 4
- George's soil at his house is pH 9
- Custodian's soil at his house is pH 2
- Ashley's soil at her house is pH 7.5
- Bob's soil at his house is pH 4
- Ms. Miller's soil at her house is pH 5
- Ms. Anderson's soil at her house is pH 8

Interviews

- Ashley
- Bob's parents
- Custodian (Paul)
- George
- George's parents
- Mr. Evans (teacher)
- Ms. Anderson (teacher)
- Ms. Miller (teacher)
- Ms. Ramirez (teacher)
- Ms. White (teacher)
- Principal

- Sally
- Sally's parents
- Samantha
- Samantha's parents
- Sierra

Suspects' Information

Teacher's Copy

Samantha: Samantha is an eighth-grade student. She has natural brown hair but has highlighted it blonde. She is about 5'7". Her blood type is B, and the pH at her house is 7. She has two pairs of Doc Marten shoes. One of her Doc Martens matches the size 10 shoeprint. She loves Winterfresh gum. Her alibi said that on the night of the crime she was at the O'Leary play until 10 p.m., and then spent the night with Sally. She left her white cotton shirt at Sally's. It is ripped and has blue pen stains on it.

Ashley: Ashley is Ms. Miller's ninth-grade clerk during fourth period. She has natural brown hair but dyes it blonde. Her blood type is B, and the pH at her house is 7.5. She is 5'6" and wears a size 8 shoe. She does not have any Doc Marten shoes, but wears Adidas. She is a good friend of Bob, George, and Samantha. She recently did a chemical inventory for Ms. Miller. On the night of the crime, she stayed after school until 5 p.m. to get help from a teacher and then went to the O'Leary school play. The custodian saw her waiting for a ride around 9:30 p.m. She finally left at 9:45 p.m. in a blue car. Her fingerprints were found all over the back room.

Custodian: Paul wears a size 11 shoe and is 5'10". He has dark brown hair that does not match any of the hair found in the back room. He wears Adidas shoes. He has a cut on his hand that is jagged. His blood loss is about .5ml. His blood type is B and the pH of the soil at his home is 2. The pH at O'Leary is 5. He cleans rooms at the school from 3-11 p.m. He cleaned Ms. Miller's room from 7-7:15 p.m. The custodian noticed Ashley waiting for a ride after the school play, and a blue car finally came and picked her up at 9:45 p.m. She was the last student to leave the grounds, which is why he noticed her. Glass fragments and white powder were found on his shoes. The glass does not match the density of the glass in the storage room. However, the white powder does, as it is a sodium borate, a cleaning agent found in cleansers. The custodian borrowed it and was planning to replace it when his order came in. The custodians had recently blown a stump out of O'Leary's ground because the roots were messing up the sprinkler system.

Sierra: Sierra is in Ms. Miller's eighth-grade class. She has dark brown hair. She is 5'4" and wears a size 6 shoe. She loves Doc Martens but doesn't own any now. She does not own any Adidas either. She also wears K-Swiss and Sketchers shoes. She was overheard saying she wanted a chemical to eat someone's skin. She was very angry at her friend Lucy (another eighth-grade student) who she discovered stole her brand new Doc Martens and ruined them. On the night of the crime, Sierra stayed at the school working in Ms. Anderson's room, then went to the basketball game until 10:30 p.m., and then she went home.

Sally: Sally is an eighth-grade student at O'Leary. She wears a size 5 shoe and is 5'3" with a blood type of AB. She has natural blonde hair and often wears Doc Martens. The pH of the soil at her house is 4. She has a cut on her head with an approximate blood loss .85 mL. She owns a black lab dog. She is new to O'Leary and is having a tough time transitioning to such a big school. Her parents are often out of town for their business (they own resorts all around the world), and her older brother (a senior) is supposed to take care of her while they are gone. On the night of the crime, Sally attended the O'Leary play, went home at 9:30 p.m., and was alone until her brother came home at 1 a.m. A search warrant will reveal a crowbar in her garage with traces of wood stain and chips that match Ms. Miller's storage room door. Also, a torn white cotton shirt with marker on it was found in Sally's hamper. The marker and the fabric match the one left on the window. Latex gloves were found in the trash with prints on the inside that match Sally and Samantha.

George: George is in eighth-grade, and this is his first year at O'Leary. His blood type is B, his shoe size is 8, and he is 5'6" tall. He has red hair. The pH of the soil at his house is 9. He likes to wear Nike shoes. On the night of the crime, he was at the high school concert with Bob and his family and then he spent the night at Bob's house. George has really bad foot odor. He is always

being teased in the locker room, and his family won't let him take off his shoes anywhere but in his bedroom.

Bob: Bob is in the ninth-grade. His blood type is A, he wears a size 11 shoe, is 6 feet tall, has brown hair, and wears Etnies shoes. The pH of the soil at his house is 4. The night of the crime he was out with his parents at a concert and returned home at 10 p.m., but snuck out of his house at midnight to meet the others. He was wearing Etnies the night they were in the field making the explosion.

Ms. Miller: Ms. Miller is 5'8", has natural strawberry blonde hair, wears a size 10.5 shoe, and has a blood type of O. Ms. Miller only wears K-Swiss shoes and loafers. She hates Doc Martens and Adidas shoes. The pH of the soil by her house is 5. Ms. Miller also has a cut on her hand about 2 mL deep. She cut it on a razor blade stuck on a shelf in her room. Her favorite bottled water is Evian. On the night of the crime, Ms. Miller left O'Leary at 3 p.m. to attend her night class with Ms. Holmes. She got home at 11:30 p.m. Ms. Miller said she definitely had all of her classroom windows closed; after all, it is 30 degrees outside, why would she leave any windows open? She also said she locked her classroom door. She has no known enemies, but she did overhear a student (Sierra) say she would like a chemical to eat someone's skin. Ms. Miller she didn't think Seirra would actually do anything like this.

Principal: The principal is 5'7" and wears a size 8 shoe. He left the school at 5 p.m. to attend an art show. He took his wife Shelly out to dinner and then home for the rest of the evening.

Ms. Anderson: Ms. Anderson is 5'5" tall and wears a size 7 shoe. The pH by her house is 8, and she lives in the middle of town. Her favorite bottled water is Crystal Geyser. On the night of the crime, she left O'Leary at 5:00 p.m. after helping students. She went out to dinner and a movie with her husband and then went home and graded papers until 1 a.m.

Ms. White: Ms. White is 5'6" tall and wears a size 10 shoe. Ms. White left the school at 4 p.m. to pick up her kids and then went home and graded papers until midnight.

School Crime Scenarios

Louise's locker was broken into. She had just saved up her babysitting money to buy a new portable CD player, and it was stolen.

On Monday, when the principal arrived at O'Leary Junior High School, she noticed graffiti in the boy's locker room. Spray painted in big bold letters was, "Break up with Mary!"

O'Leary Junior High School has a very strong tennis team. In fact, they have qualified for the national championship. When Coach Larson came back to school after a weekend, she went to get some tennis rackets for the team's practice and discovered that ten rackets were missing.

Mr. Evans, a ninth-grade math teacher, had a substitute the other day. When he returned to school, he found an anonymous note on his desk. The threatening note said, "Give me an A or else..."

During a school-wide exam, an explosion went off, and the whole school smelled awful. Everyone had to evacuate the building for the rest of the day.

Recommended Forensics Science Labs

The following labs are suggested for science and available from:

Walker, Pam, and Wood, Elaine. *Crime Scene Investigations: Real Life Science Labs for Grades 6 -12*. West Nyack, NY: The Center for Applied Research in Education, 1998.

Neo-Sci – Introduction to Chromatography (science kit), PO Box 22729 Rochester, NY 14692-2729, 800-526-6689.

Ink and Lipstick Chromatography

Chromatography is an ancient method of separating parts of a mixture. In this chemistry lab, students learn to separate the mixtures of dyes used in ink and lipstick. They determine whose pen the ink matches or whose lipstick was found on a napkin.

Unknown Substances Chemical Analysis

Crime labs often receive unknown substances taken from a crime scene. In this lab, students learn how to identify an unknown substance by performing a series of tests to determine the physical and chemical characteristics of several unknown powders.

Soil Analysis

Soil taken from the shoes of suspects can provide excellent evidence for a crime. In this lab, students analyze the characteristics of various soil samples. They perform an experiment to test the soil's ability to hold water in order to determine the amounts of sand, clay, and humus, and determine the pH of the samples.

Hair Classification

Hair recovered from a crime scene can be valuable evidence. Forensic scientists use color, shape, and distribution of pigment granules to tell the difference between individual' hairs. In this lab, students classify several hair samples from animals and humans.

Lip Print Test

Like fingerprints, lip prints are unique and can therefore be used to identify individuals. In this lab, students learn how to analyze lipstick prints and compare print patterns to determine who committed a crime.

DNA Inquiry

Every person has unique DNA that can be seen in a single cell found in a fingerprint. DNA fingerprinting has an accuracy rate of 99 percent for determining whether a fingerprint sample came from a particular individual. In this lab, students create and analyze the patterns of fictitious DNA fingerprints to determine paternity.

Handwriting Analysis

Handwriting analysis is often used in forensic science to identify who wrote a particular document. Handwriting experts usually analyze requested writing and collected writing done before the investigation begins. In this lab, students learn to recognize patterns in handwriting by analyzing handwriting on a questioned document to determine the author of the document.

Shoepprints Observation

Shoepprints or footprints can be important evidence. Therefore, it is necessary to carefully preserve the impressions for observation in a laboratory. In this lab, students make a cast of a shoe impression. They then analyze the tread pattern and measure the size to determine whether the suspect's shoe matches prints taken from a crime scene.

Tool Marks Experimentation

Tool marks are often found at burglary scenes where there was forced entry. The object used to pry a window or door open can leave a mark in the wood or other material. Investigators usually make a cast of the mark and analyze it in the lab by comparing the mark with several test tool marks. In this lab, the teacher shows students how clay can be used to make a cast of a tool mark. Using five different screwdrivers, the teacher demonstrates how each makes a different mark. Students use microscopes to examine the patterns of the tool marks and determine which tool was used to commit a crime.

Glass Bulbs Density Test

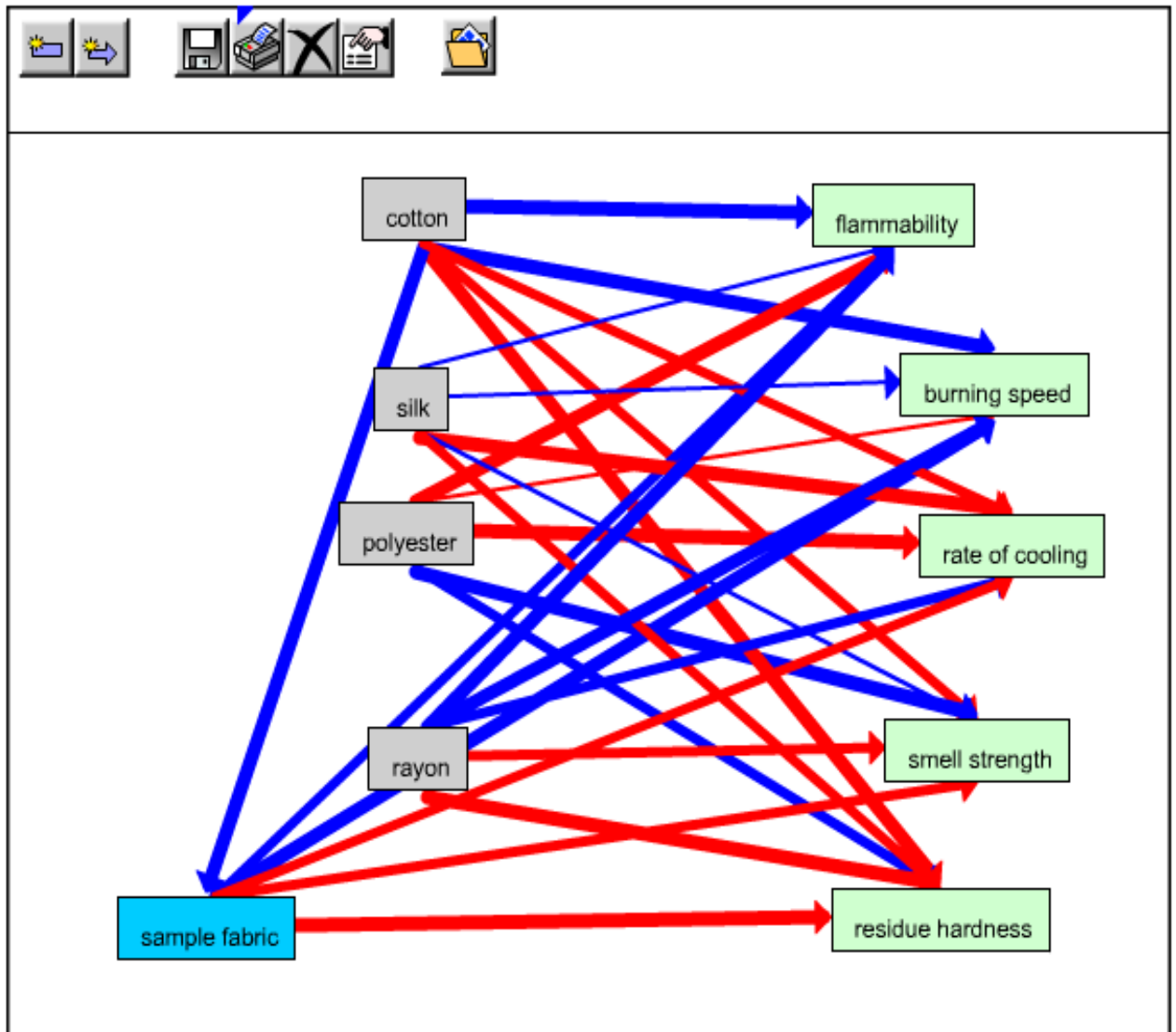
In many cases, there is broken glass. In this lab, students learn how to differentiate whether two glass samples originated from the same piece by determining the densities of several glass samples.

Fiber Match

Fibers taken from a crime scene can help an investigator determine who has been on the scene and where the victims of the crime have been. In this lab, students record their observations of fabric's odor, residue, and reaction to flame as it approaches and is removed from the flame. They then try to identify the type of fabric.

Lab Investigation

Students use the Seeing Reason mapping tool to help them better understand the process and results of their labs. This can be done for any of the forensic lab investigations. The example below shows a map for a fiber test. In the fiber test lab, the students tested cotton, silk, polyester, and rayon for their reaction to flame. The relationship lines in the map show the effect of the different tests on each of the materials. Students then tested an unknown fabric to compare its reaction to a flame in order to determine which fabric it matched. The test showed the fabric was cotton.



Deductive Reasoning Activities

Mystery of the Day

Each day, students are given a "Mystery of the Day," short interactive mysteries that present brief crime scenarios with clues to determine who is guilty. Students must find the subtleties in the clues in order to draw connections between the evidence and a suspect. These crime scenes prepare students for focusing on a single problem for an extended period of time. Short mysteries can be found at [Kid's Mystery Net](#)*

Quizzles

Students also do "Quizzles," which use the problem-solving strategy of deductive reasoning to solve a puzzle. Students are given a set of clues and a clue chart. They use the clue chart to organize the information from the clues and solve the puzzle.

Williams, Wayne . *Quizzles*. Parsippany, NJ: Dale Seymour Publications, 1997.

Thinker Tasks

"Thinker Tasks" are visual analogies that express relationships between objects, and students try to figure out the relationship. For example, students see a triangle and another triangle rotated 90 degrees. They are then shown a heart with four other hearts (one of which is rotated 90 degrees), and they have to choose which heart shows the correct analogy.

Holden, Liinda. *Thinker Tasks, Critical Thinking Activities Book 1: Attributes and Logic*. Chicago, IL: Creative Publications, 1986.

The Deadly Picnic

Students apply deductive reasoning skills and practice solving a mini-mystery. *The Deadly Picnic* can be used for this. In this crime, the body of a male victim with a fatal gunshot wound is found, and there are many clues left behind. As it happens, the victim was seeing six women. Students piece together the clues and sort out the information about each woman to solve the murder.

Walker, Pam, and Wood, Elaine. *Crime Scene Investigations: Real Life Science Labs for Grades 6 -12*. West Nyack, NY: The Center for Applied Research in Education, 1998.

Interviews

Ms. Anderson

On the night of the crime, I was at the school helping students until 5 p.m. I then went out to dinner with my husband and then to a movie. I went home and graded papers until 1 a.m., being the dedicated teacher that I am. The only thing that went wrong with my day before I heard about the crime is that Samantha and Lucy (two eighth-grade students) got in a huge marker fight in class. Not only did they dry out my only blue permanent marker, but they caused a huge commotion in class. Teaching is getting harder every day. I wear a size 7 shoe and I am 5'5" tall. I have natural brown hair, but I get blonde highlights. I live in the middle of town. My favorite water is Crystal Geyser. I guess I left my water bottle back there when I was borrowing paper from Ms. Miller. Is that a crime? I think not!

Ms. White

On the day of the crime, I left school at 4 p.m. to pick up my kids, and then I went to a spinning class at the health club. I then went home to grade papers until 1 a.m. My fingerprints are probably found in the back room because at the last ice cream social, I went in there to get the bowls, spoons, and napkins. Ms. Miller stores our team's teacher supplies so any teacher on our team has been back there and probably has left prints. Ms. Miller wasn't in the room yet so I just used my master key that I got from the principal when I lost my keys. I haven't given the master key back even though I found my keys. It comes in handy, especially when Ms. Miller forgets her school keys and has to borrow mine so she can get into her room. The only thing unusual that happened the day of the crime was that I just had one discipline referral that day and it wasn't even I who gave it. I had a substitute teacher the day before, and George (an eighth-grade student) was acting out in class and being a show-off, I guess. He insulted the substitute teacher so she wrote him up. I have to process it through the computer system though, since it happened in my class. I wear a size 10 shoe and I am 5'6" tall. I wear Clark shoes mainly and I have Nike running shoes. I have natural brown hair with blonde and black highlights. I live in the middle of town.

Ms. Miller

Yesterday, I left my room at 3:00 p.m. to attend a night class in with Ms. Holmes for our master's degree. We got back about 11:30 p.m. and I was exhausted so I went right to bed. I definitely had my windows locked and it has been since last October that they have been open as far as I know. My storage door and classroom door were both locked. I have no known enemies, of course, but I did overhear a student (Sierra) say she would like a chemical to eat someone's skin. She was very angry at Lucy (another eighth-grade student) who she found out stole her brand new Doc Martens shoes. Ms. Anderson did borrow paper from me with my permission. The bottled water must be hers because I don't buy that brand of water. My favorite bottled water is Evian. Ashley is my ninth-grade clerk, and she just completed a chemical inventory for me. I don't think she would do anything like this, but she hangs around some friends who are not the best influence. Their names are Bob, Samantha, and a new girl that just came to O'Leary, Sally. I don't know about her yet. I didn't take it very seriously though. I am 5'8" and wear a size 10.5 shoe. I have natural strawberry blonde hair. My favorite shoes are K-Swiss and loafers. I hate Doc Martens and Adidas shoes. I live just four blocks from O'Leary.

Custodian

O.K. I confess! I borrowed sodium borate from Ms. Miller because it is a good cleaning agent and our cleaning order hasn't come in yet. I was going to replace it. I usually don't clean Ms. Miller's back room. I clean the rooms at the school from 3:00-11:00 p.m. I cleaned Ms. Miller's room from 7:00-7:15. I noticed Ashley waiting for a ride after the school play, but then a blue car finally came and picked her up at 9:45 p.m. She was the last student to leave the grounds, which is why I noticed her. The only thing that is kind of strange is that when I was cleaning today (one day after the crime), there was spilled soda in the bathroom and some food particles and a few playing cards. Who has time to sit in there and eat? I wear a size 11 shoe and I am 5'10". I have dark

brown hair. I live south of town. I was wearing Adidas shoes that night. I have a cut on my hand that I got from blowing the tree stump out of the ground by the track (the roots sliced my hand). The roots were messing up with the sprinkler system. The explosive we used for this has aluminum potassium in it, but it is mixed with other chemicals and it is manufactured. By the way, the head custodian just informed me that we are missing a crowbar.

Sierra

I was at a basketball game until 10:30 p.m., and then I went home. Earlier, I stayed at the school working in Ms. Anderson's room until 5 p.m. before going to the game with my family. I wear a size 6 shoe and I am 5'4". I have natural dark brown hair. I live in the middle of town. I am very angry at Lucy (another eighth-grade student) who I found out stole my brand new Doc Martens and ruined them. I did say I wanted a chemical to eat her skin but I was just venting. Of course, I would never do anything like that.

Ashley

I stayed after school until 5 p.m. to get help from Ms. Dodd and then went to the O'Leary play. I don't know where my other friends were that night. They didn't want to come to the play with me. I am Ms. Miller's ninth-grade clerk fourth hour. I did recently conduct a chemical inventory for Ms. Miller, but I would never take anything from her or be part of anything like that. I have natural brown hair, but I do dye it blonde. I do not have any Doc Martens, but I wear Adidas shoes all the time. I am 5'6" and wear a size 8 shoe. My mom owns a blue car.

Principal

When I came to this morning, I ran an activity report on my computer like I always do. This lets me know if anyone has been into the computer system and what documents had been modified in the last 12 hours. This test always comes out clear except for today. It revealed that a student's discipline, tardy, and absences files had been modified at 11:45 p.m. This student's name is George. He is in the eighth grade and this is his first year at O'Leary. He had some trouble over at his other school, and he has been in the detention center. He hangs around Ashley (ninth-grader), Sally (another new student in the eighth-grade), Bob (ninth-grader), and Samantha (eighth-grader). The kids aren't the best role models, but they don't cause too many problems. I have checked to see if any teachers were in the building who might have added something to George's discipline records, and the only teacher that was here was Ms. Ramirez. She was cleaning up after the school play. I don't know what time she went home.

Ms. Ramirez

I don't even have George as a student and therefore would not be adding or changing his records. I do think I set off the alarm system at midnight. I'm not sure how, because I thought I knew how to disarm the system, but it went off at midnight when I was moving around the building cleaning up after the school play. The police came out to school and conducted a perimeter check and didn't find anything unusual, so I must have set it off. I left the school at 12:30 a.m. finally.

Samantha

I was at the O'Leary play until 10 p.m. and then spent the night with Sally. We both stayed after school to get help until 5. We walked down to the supermarket to eat in the café and then walked back in time for the play. I am an eighth-grade student. I have natural brown hair but highlight it blonde. I am about 5'7" and my shoe size is a 10.

Samantha's Parents

Sam spent the night with a new girl to the school whose name is Sally. We thought that was sweet of Sam to make Sally feel welcome. They were planning on going to the O'Leary play and then walking to Sally's house since she lives only ½ mile away.

Sally

Samantha spent the night with me last night. My parents are often out of town for their business (they own resorts all around the world), and so my older brother (a senior) is supposed to take care of me while they are gone. Samantha and I stayed after school to get help until 5 p.m., and then we walked down to the bowling alley and ate (they have the best fries and hamburgers), and then walked back to attend the O'Leary play with Samantha, and then we went home at 9:30 p.m. We were alone until my brother came home at 1 a.m. I am an eighth-grade student. I wear a size 5 shoe and I am 5'3". I have natural blonde hair. I am new to O'Leary and have been having a tough time transitioning to such a big school. My other school only had 100 students in it, and O'Leary has 900 students. I have made some new friends, though, so things are better.

Sally's Parents

We were out of town, and Sally's older brother was watching her while we were gone.

Bob

I was out with my parents the night of the crime. We went to the high school concert and then went home for the rest of the evening, and I did homework in my room. I am in the ninth-grade. I wear a size 11 shoe and am 6 feet tall with brown hair. I live southeast of O'Leary about ½ mile.

Bob's Parents

Bob was with us for the entire night, and then he was just doing his homework in his room. He is such a good boy. It was a rare evening that none of his friends were over. Two nights after the crime, there was a loud explosion in our neighborhood. We live on the edge of some farm fields, so it is hard telling where it came from. The police came out and investigated and filed a report.

George

I was at the high school concert with Bob and his family, and then I spent the night with Bob. I am in the eighth-grade and this is my first year at O'Leary. I really like O'Leary now that I have made friends with Bob, Sally, and Samantha. They don't even make fun of my horrendously smelly feet. My shoe size is 8 and I am 5'6" tall with red hair. I live by the sugar beet factory

George's Parents

George went to the concert with Bob and his family and then spent the night.

Search Warrants

George: A key imprint mold was found in his underwear drawer. The key imprint has been matched with an O'Leary master key. His blood type is B; his shoe size is 8; he is 5'6" tall; he has red hair; and the soil pH by his house is 9. He lives by the sugar beet factory. He likes to wear Nike shoes and has many pairs in his closet. Traces of zeolite are found in his shoes.

Samantha: She has two pairs of Doc Marten shoes. One of her Doc Martens matches the size 10 print. Her blood type is B and the pH at her house is 7. No cuts are found on her body. There's a pack of Winterfresh gum on her dresser. A white t-shirt is not found even though her mom says that Samantha was wearing one that day of the crime.

Ashley: She does not have any Doc Martens but has Adidas shoes. Her blood type is B, and the pH at her house is 7.5. She is 5'6" and wears a size 8 shoe. Nothing to do with the crime was found in her room.

Custodian: Has a cut on his hand that is jagged. His blood loss is about .5ml. His blood type is B, and the pH of the soil at his house is 2. Glass fragments and white powder were found on the custodian's shoes, but the glass does not match the density of the glass in the storage room. However, the white powder does match as it is a sodium borate, a cleaning agent found in many cleaners. The custodian borrowed it and was planning to replace it when their order came in. The custodian cleaned the room from 7-7:15 p.m.. The custodians had recently blown a stump out of O'Leary's ground in between Mrs. Dodd's room and the track. The roots were messing up with the sprinkler system.

Sierra: No probable cause.

Sally: She wears a size 5 shoe, is 5'3", with a blood type of AB. She has natural blonde hair and wears Doc Marten shoes often. The pH of the soil at her house is 4, and she lives southeast of town near O'Leary. She has a cut on her head with an approximate blood loss .85 mL. She owns a black lab. A crowbar was found in her garage. The crowbar had traces of wood stain chips and paint that match Ms. Miller's storage room door. Also, a white cotton shirt with marker on it was found in Sally's hamper with a tear. The marker and the fabric match the one left on the window. Latex gloves were found in the trash with prints on the inside that match Sally and Samantha's. Also, glass and soda residue were found on Sally's shoes.

Bob: Is in the ninth-grade. His blood type is A, wears a size 11 shoe, is 6 feet tall, has brown hair, and wears Etnies shoes. The pH of the soil at his house is 4 and he lives southeast of O'Leary. Some dried mud was found on Bob's window sill. Nothing relevant was found.

Ms. Miller: No probable cause for a search warrant.

Mr. Principal: No probable cause for a search warrant.

Ms. Anderson: No probable cause for a search warrant.

Ms. White: No probable cause for a search warrant.

Get a Clue Rubric

	4	3	2	1	0
Individual Contribution	Stays in character and on task throughout entire crime scene investigation; provides daily useful and relevant information to the group based on role in group.	Stays in character and on task throughout most of crime scene investigation; provides useful and relevant information throughout most of crime scene investigation.	Stays in character and on task throughout some of crime scene investigation; provides some information throughout investigation. Not all of information is useful and relevant.	Is out of character throughout most of crime scene investigation; provides minimal information to group throughout investigation.	Does not assume group role; does not provide information to the group.
Evidence Processing	Conducts all math labs and interprets results; sets up, conducts three science labs and uses <i>Seeing Reason</i> in at least one lab, to process and interpret results. Poses five questions per day that build on previous questions; demonstrates thorough answers to the questions. Analyzes all evidence available which informs group's understanding of the relationship between evidence and suspects.	Conducts most of the math labs and interprets results; sets up, conducts two science labs using <i>Seeing Reason</i> in one of them to process and interpret results. Poses four questions per day (on average) that generally build on previous questions; demonstrates complete answers to the questions. Analyzes most evidence available which somewhat informs group's understanding of the relationship between evidence and suspects.	Conducts some of the math labs and interprets results; sets up, conducts one science lab. Does not use <i>Seeing Reason</i> . Poses three questions per day (on average) that somewhat build on previous questions; demonstrates answers to the questions. Analyzes some of the evidence available, but has trouble showing the relationships between evidence and suspects.	Conducts one of the math labs and interprets results; requires a lot of assistance to do a science lab. Does not use <i>Seeing Reason</i> . Poses one to two questions per day (on average) that do not build on previous questions; does not show answers to questions. Analyzes little of the evidence available and does not show relationship between evidence and suspects.	Does not do math labs; does not do science labs; does not ask questions; does not analyze evidence.
Conclusion	Demonstrates sophisticated level of logical thinking skills in solving the crime; is able to reconstruct the entire actual crime; writes a clear, sequential, and logical conclusion that is clearly supported by the evidence.	Demonstrates above average level of logical thinking skills in solving the crime; is able to reconstruct most of the actual crime; writes a sequential, and logical conclusion that is supported by the evidence.	Demonstrates average level of logical thinking skills in solving the crime; is able to reconstruct some of the actual crime; writes a conclusion that could be more sequential, and logical; some of the evidence supports the conclusion.	Demonstrates minimal level of logical thinking skills in solving the crime; is able to reconstruct a bit of the actual crime; writes a brief conclusion that is not sequential, and is not logical; very little of the evidence supports the conclusion.	Does not demonstrate logical thinking skills; cannot reconstruct the crime; does not write a conclusion.
Group Collaboration	Group stays on task throughout entire project; members collaborate throughout entire project.	Group stays on task throughout most of project; members collaborate throughout most of project.	Group stays on task throughout some of project.; members collaborate throughout some of project.	Group is off task throughout most of project; members do not collaborate throughout most of project.	Group is off task throughout project; members do not collaborate.

Initial Police Report

On the morning of February 25, Ms. Miller entered her classroom and discovered her storage room door open, the window inside the storage room also open, and her storage room a mess! She found a broken jar of zinc metal and zinc spilled on the floor, and noticed that several chemicals were missing from the storage closet as well as some pens that were stored on a shelf behind her desk. Ms. Miller was shocked that someone had broken into her back room. She couldn't imagine why anyone would do such a thing. She said that she uses her own money to buy supplies, so she was especially upset about the incident.

Ms. Miller explained that yesterday, February 24, she left O'Leary Junior High School at 3 p.m. with another teacher, Ms. Holmes. They drove into the city to attend a night class. Before leaving school, Ms. Miller made sure to lock the storage room and her classroom. She hasn't opened her classroom windows since October, and as far as she knew, they were all locked.

Ms. Miller immediately thought of two suspects: one of her students, Sierra, whom she overheard saying that she wanted a chemical to eat skin. Ms. Miller knew Sierra was angry at another student, but was she this angry? The other suspect was her ninth-grade clerk, Ashley. Ashley had done a chemical usage inventory for her a few weeks ago, and she would know what Ms. Miller had back there and would also be familiar with her routines. Beyond these two, she didn't really know who might do this. She knew that Ms. Anderson sometimes goes into her storage room to borrow things. Perhaps she took the chemicals.

A few other rooms in the school were also open: the principal's office, Mr. Evan's classroom, and the custodian's room. The custodians, the front office staff, and one teacher, Ms. White, are the only ones who have master keys. It didn't appear that anything had been taken out of those rooms, although the custodians are still taking inventory of their tools. Everything else in the school appeared to be fine. However, a perimeter check revealed a big hole in the ground outside between Ms. Dodd's room (located across from Ms. Miller's room) and the track field. From the appearance of the dirt, it looks like the hole has been there for less than 24 hours.

Math Labs

Height Versus Shoeprint Size

1. Set up meter stick stations around the classroom.
2. Each student should measure his or her height to the nearest centimeter.
3. Students should then measure their shoeprint to the nearest centimeter. (Another option is to measure footprints to look at the difference in ratios formed by the footprint and shoeprint measurements.)
4. As a whole-class activity, create a graph to organize the information. Label the x-axis "shoeprint" using a scale of 1 cm per grid line. Label the y-axis "height" and use a scale of 10 cm per grid line.
5. Have each student plot his or her shoeprint and height. Choose different colors for boys and girls.
6. Have students look at the slope of the line formed, using two points that appear to best fit the information as a whole. Establish an equation for the line ($y=mx+b$) to determine the correlation between shoeprint size and height. (For example, 1 cm growth in shoeprint equals 3.5 cm growth in height.)
7. This can be done by creating a scatter plot using Microsoft Excel* or entering the data into a graphing calculator to do a linear regression to find the line of best fit, a straight line that best represents the data on the scatter plot.
8. Now, using the class data, have students measure the shoeprints found at the scene of the crime and make predictions about the suspects. They should be able to predict the height of the suspect, and if the suspect is male or female. Pose questions such as: If your suspect is a male 180 cm tall, what size shoeprint would you expect to find? What if your suspect is a 160 cm female?
9. This is also a good place to introduce measurement conversions, converting from feet/inches to meters/centimeters.

Blood Drop Volume

1. In this lab, groups determine how much blood is on the napkin that was in the waste basket.
2. Distribute materials to groups: a 100 ml beaker of red tempera paint, paper towel, eye dropper or pipette.
3. On the paper towel, have them drop one drop, two drops (one top of each other)... up to six drops of "blood."
4. Have them measure the diameter of each of the droplets. If the circle formed by the drops is less circular and more elliptical, they can measure the length and width and average the values. Create a graph with x as the number of drops and y as the diameter of the circle formed by the drops. Predict the line of best fit for the data or use a graphing calculator to find the line of best fit.
5. Now, have students measure the blood droplet found on the napkin from the crime scene and compare it to the line of best fit to determine how much blood is on the napkin.
6. Explain that this analysis can help students determine the nature of the crime. Based on the amount of blood, students can hypothesize as to what may have caused the blood loss, for example a weapon involved in the crime, a cut from something, and so forth.

Blood Drop Angle of Impact

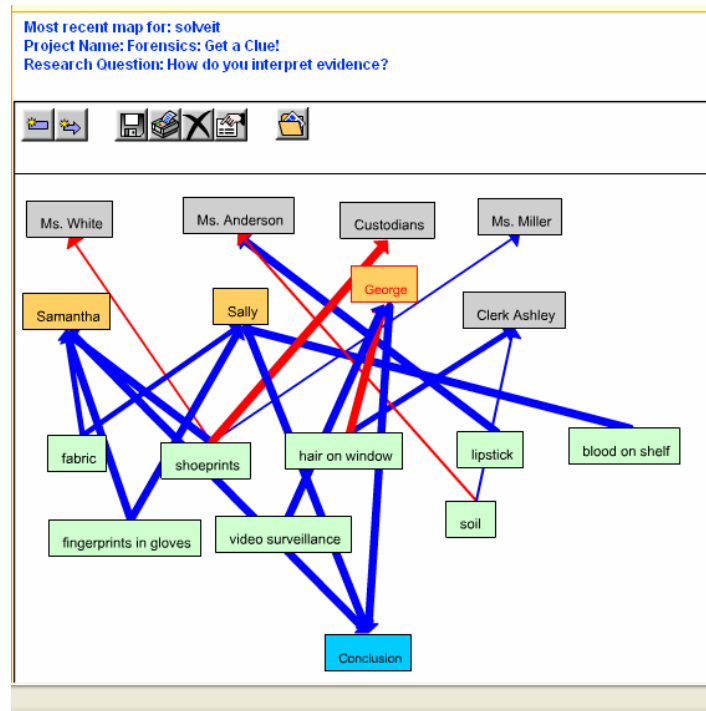
1. This test is done to measure the origin of the blood.
2. Distribute 100 ml beakers of red tempera paint to each group.
3. Have students use a dropper to drop blood samples from four different heights (12, 24, 36, and 72 inches) onto four different white cards.
4. For each of the samples dropped, have them measure the diameter of the blood drop. They should also observe the edge pattern of the drop (for example: smooth, jagged, etc.).

5. Now have them measure the diameter of the sample, compare it to the results from the experiment, and then estimate the height of the blood drop.
6. They should then measure the width at the widest point of the drop and the height at the longest point of the drop.
7. Then, have them divide the width by the length and take the inverse sine of that answer to determine the angle of impact in degrees.
8. This helps them determine where the blood was dropped from and what type of injury it was from.

What We Think Really Happened

WANTED: SALLY, SAMANTHA & GEORGE

Sally, Samantha, and George committed the crime. They broke into Ms. Miller's classroom on the night of February 24th and stole nine chemicals. All evidence points to these three guilty parties, as you can see from our map.



We did an analysis of the granule size, color, mineral content, and pH of the soil found on the shoeprints in the back room and the shoeprints of the suspects. The results of this test revealed that Sally, Samantha, and Ashley's soil at their homes most closely matched the soil found at the scene of the crime. Based on other evidence and the interview, we later ruled out Ashley as a suspect. Although George did not leave a shoeprint, other evidence points to his involvement in the crime.

We believe that the suspects were wearing white latex gloves. Two pairs of latex gloves were found in a trash can at Sally's house. We lifted the fingerprints and when we compared them to the suspects, we found that they matched Sally and Samantha's fingerprints. No surprise there. Also, upon searching Sally's house with a search warrant, we found a crowbar in her garage. Although it was hidden with her dad's other tools, it was found to have traces of paint. We tested the paint chip and found that it matched the paint from the storage room door. More evidence pointing to their guilt!

A luminal test detected blood in the storage room. Based on our blood drop volume lab, we found that the approximate blood loss was .80 mL and the type is AB for the blood found on the shelf. We also did an angle of impact test and we think that when climbing the ladder to reach the chemicals, someone picked up a glass bottle, accidentally dropped it, and cut themselves on a piece of glass. We think the blood was caused by an accident and not a violent act relating to the crime. We believe that it is Sally's blood. She has a cut on her hand and has AB blood type.

We also analyzed the hair that was found at the crime scene. The hair on the window was found to be dyed blonde hair. It seems to match Samantha's hair and not Sally's because Sally has

natural blonde hair and Samantha dyes hers. The fiber test results also point to Samantha. We compared the fiber found at the scene of the crime to other fibers by comparing the fiber's response to flame. We found that the fiber at the crime scene was cotton with blue marker on it. When we searched Sally's house, we found a white cotton shirt with blue marker in her laundry basket. Samantha had a marker fight with Lucy earlier in the day. Further investigation revealed this to be Samantha's shirt. It seems that when Samantha was escaping through the window, her shirt caught on the window ledge.

The video tape from the surveillance shows three people who match the physical description of Sally, Samantha, and George. This makes sense because they are all friends. The videotape showed the male (George) breaking into the principal's office. So, we think that George hacked into the principal's computer. Also, George claims that he was with Bob, but Bob said that he was only with his parents that night.

Here's what we think happened. Sally, Samantha, and George hid somewhere in the school – maybe in Ms. Miller's room after the custodian cleaned it or maybe in the bathroom. Then, after the custodian left, they broke into Ms. Miller's storage room with a crowbar. They stole the crowbar from the custodian's room. When they got into the storage room they took a bunch of chemicals because they wanted to make an explosive just for fun. While the girls were taking the chemicals, George was breaking into the principal's office to get into his computer and change his behavior and absence record. Somehow, he set off the alarm. When the girls heard the alarm, they quickly escaped through Ms. Miller's window. Samantha tore her shirt while they were escaping and they spilled some chemicals.