If the Shoe Fits

Analyzing Forensic Impression Evidence

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Grade Level	9th – 12th Grade	**Time Frame**	200 minutes
Subject	Science	**Duration**	2–3 periods

Essential Question

How is forensic impression evidence collected and analyzed?

Summary

In this lesson students will learn about forensic impression evidence. They will come to understand the methods for documenting and analyzing two- and three-dimensional impressions by collecting dental stone castings and inked impressions of shoe prints. After analyzing the characteristics of these unknown samples, students will attempt to match them to known shoes. The lesson concludes with a discussion of the strengths and challenges of using impression evidence to make positive identification of suspects.

Snapshot

Engage

Students are introduced to the concept of impression evidence and how to collect and document three-dimensional impressions.

Explore

Students make casts of three-dimensional shoe-print impressions with dental stone.

Explain

Students learn about characteristics of impression evidence and analyze their three-dimensional impressions.

Extend

Students create two-dimensional impressions of their own shoes, and as a class attempt to match the impressions to corresponding shoes.

Evaluate

Students answer lab questions and as a class discuss the strengths and challenges of collecting and analyzing impression evidence.

Standards

Georgia Standards of Excellence: Forensic Science (Forensic Science)

SFS2.a: Plan and carryout an investigation to determine the value of physical and trace evidence.
SFS4.c: Construct an explanation to support the significance of impression evidence in an investigation.

Attachments

- Impressions Investigation—If the Shoe Fits.docx
- Impressions Investigation—If the Shoe Fits.pdf
- Lab Data and Questions—If the Shoe Fits.docx
- Lab Data and Questions—If the Shoe Fits.pdf
- Lesson Slides—If the Shoe Fits.pptx

Materials

- Lesson Slides
- Dental stone (2 lbs per group)
- Digital scale
- Plastic zip-top bags, gallon (1 per group)
- Tongue depressors or spoons (1 per group)
- Rulers
- Black printer's ink
- Ink roller
- White butcher paper
- Shoes (1 per group for 3D; 1 per student for 2D)
- Impressions Investigation handout (attached; one per student)
- Lab Data and Questions handout (attached; one per student)

Preparation for the Lesson

Teacher's Note: Forensic Science Standards

Note that there are no national or Oklahoma-specific standards outlined for Forensic Science courses. We have used the following Forensic Science standards from the state of Georgia as a high-quality point of reference for this lesson:

- Plan and carry out an investigation to determine the value of physical and trace evidence. *SFS2.a*
- Analyze and interpret data regarding impression evidence. *SFS4.b*

Before beginning, edit slides 19 and 32 in the Lesson Slides with your classroom-specific instructions, as noted in the Explore and Extend sections below.

20 minutes

Engage

Display **slides 2–4** to introduce the essential question and learning objectives. Continue to **slide 5** and present the crime scene scenario that sets up the first activity.

Crime Scene Scenario

A suspect's shoe and a series of shoe prints have been found in the mud at a crime scene.

Your team must recover these impressions using dental stone.

Then you and your team will document and analyze any observable characteristics to determine if the suspect's shoe matches any of the prints.

Display **slides 6–10**. These slides define impression evidence, provide a brief overview of categories of impression evidence, and focus specifically on three-dimensional impressions. After covering the content, tell students that they will be focusing specifically on shoe prints in this lesson, but the techniques for documenting other kinds of impression evidence are similar.

Continue to **slides 11–12** to review with students how to document 3D impression evidence. Emphasize to students the importance of including a measuring device for scale to ensure that the evidence can be measured accurately. Point out that measurements should be triangulated from two fixed points. Next, go to **slides 13–16** to show examples of photographs of the same impression taken from different flash angles.

To finish this section of the lesson, go to **slide 17** and share with students how 3D impressions can be collected via dental stone. Tell students that they will be collecting their own dental stone impressions next.

60 minutes

Explore

Teacher's Note: Investigation Preparation

1. Acquire several shoes ahead of time, enough that there will be one shoe for each student lab group. These can be from student volunteers or come from another source. Select one of these to be the “known” (i.e., suspect’s) shoe
2. Make an impression of each shoe in the mud ahead of time. These will serve as the crime scene impressions for students to collect. Be sure to clean the mud from the known shoe before students evaluate it.
3. Note that the dental stone may take 30–45 minutes to set, depending on the brand. Be sure to account for this when planning for the investigation. Consider measuring out the water and dental stone ahead to save time.
4. Be sure to edit **slide 19** with your classroom-specific instructions for proceeding with the investigation (e.g., getting materials, procedures for going outside, etc.).

Group students into groups of 2 or 3 and provide each student with the **Impressions Investigation** handout. Have students use the “Dental Stone Casting - 3D Impression” section of the handout as you review the investigation procedures for casting the impression. Display **slide 18** to show an abbreviated version of the casting instructions.

Go to **slide 19** and give the class instructions for how they will proceed with the activity. Complete the dental stone castings and set them aside for now.

Teacher's Note

If resources are not available to complete the activities in person, the Tire and Shoe Evidence online interactive (Task 1) and Impression Lab (Task 2) can be used instead. These may also serve as a supplement for students who need a review or who struggle to understand the content.

45 minutes

Explain

Tell students they will be analyzing their 3D impressions and comparing them to the known shoe to determine if any of the impressions match. (Note that only one group's impression will match the known shoe.)

Next, go to **slide 20**. Students will do a modified I Think, We Think strategy. For the "I Think," have students in small groups generate a list of shoe features an investigator might look at in order to determine whether an impression matches a known shoe. Then come together as a class to share out those ideas as the "We Think."

Go to **slides 21–26** and review considerations, class characteristics, individual characteristics, and wear. Slide 25 has a zoomed-in comparison of an impression and matching shoe, with slide notes describing the individual characteristics numbered on the image. Next, distribute the **Lab Data and Questions** handout and display **slide 27** to go over the data table format. In their investigation groups, have students document their 3D castings with a sketch and measurements, and record individual and class characteristics. While students work on this, pass the known shoe around the room and have students record the same information for it as well.

After completing their side-by-side comparison, have students answer the question beneath the *Known Shoe - Outsole* table:

- Were you able to make a positive identification of the suspect's shoe from your dental stone impression?
- How did the data help you reach your conclusion?

Have the group with the matching impression explain their reasoning to the class.

45 minutes

Extend

Teacher's Note: Pre-Investigation Set-Up

1. Each student should bring a pair of shoes for use in this lab. These shoes will serve as the known exemplars to make inked impressions. These shoes should contain good tread patterns, they should not be new shoes, and they cannot be the shoes worn to class by the students.
2. Assign each shoe a number for students' reference.
3. It is recommended that you use butcher paper for this activity, but any white paper should work in lieu of that.
4. Edit **slide 32** to include your classroom-specific instructions for how students will match shoes and prints.

Students now practice making, collecting, and analyzing two-dimensional (2D) impressions and matching prints to their peers' shoes.

Go to **slides 28–30** and introduce two-dimensional impressions and documentation of evidence. **Slide 30** has example photos of oblique lighting for reference.

Return to the lab instructions and review with students the investigation procedures under the *2D Inked Impression* heading. **Slide 31** has an abbreviated version of these instructions that you can display as well. Have each student make their impression, and label each impression with a unique letter.

Teacher's Note: Assigning Known Shoes/Unknown Prints

Depending on what type/size of paper you have students create their shoe prints on, you may take multiple approaches to assigning a known shoe or unknown print to students. Students should record their characteristic data based on whichever source they are assigned. Two possible options are as follows.

1. If the prints are on paper that is small enough to pass around, randomly distribute the prints to students and have them compare the inked print to the class set of known shoes. Students should record characteristic data about their inked print. They can include measurements and labels on the print itself rather than the data sheet, in this case.
2. If the prints are too large to pass out, have each student take a shoe that is not their own and compare it to the inked prints around the room. Students should record characteristic data about their known shoe on their data sheet, as with the 3D impressions.

After students have completed their impressions, redistribute the prints or have them take a known shoe. Go to **slide 32** and give students instructions for how they should proceed with the activity. Have them document measurements and characteristics on their data sheet (or inked impression) as they did for the 3D impressions. Using the data, have students circulate the room to match the 2D impressions and shoes.

After completing their comparisons, have students answer the questions beneath the *Inked Impression* table*:*

- Were you able to make a positive identification between a print and a shoe?
- How did the data help you reach your conclusion?

30 minutes

Evaluate

Bring the class back together after they have successfully matched their prints and shoes and ask them to answer the lab questions at the end of the data sheet. This can be done individually or collaboratively. Next, go to **slide 33** and open up a discussion with the students about how they used evidence to draw their conclusions about whether an impression matched a shoe (i.e., what characteristics they used). Use **slides 33–36** as a jumping off point to discuss the lab questions together. The goal is for students to come away understanding some of the strengths and challenges associated with collecting and analyzing impression evidence, and using it for identifying suspects.

Teacher's Note

Rather than an informal discussion, you might consider making a table of data from the students' analysis (e.g., the characteristics used) as another way to draw conclusions about the effectiveness of the methods used to make a positive identification from impression evidence.

Conclude the lesson by going to **slide 37** and having students complete an "I Used to Think... but Now I Know..." reflection about forensic impression evidence.

Optional Activity: Forensic Activities

Consider having students apply their skills of impression collection and analysis within a forensic case context. By stepping into the role of a forensic scientist, students can examine evidence, make comparisons, and draw conclusions using authentic investigative techniques. The Mr. Mathematics Mysterious Murder - Student Laboratory Kit includes a case that supports this type of analysis, along with additional resources, such as Flinn Forensic Files- Footwear Evidence, that reinforce a range of core skills essential to forensic science.

Resources

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- *FIInn Forensic FilesTM Footwear Evidence Laboratory Kit*. (n.d.). https://www.flinnsci.com/flinn-forensic-files---footwear-evidence/ap7752/?_gl=1*pzhs2s*_up*MQ..*_gs*MQ..&gclid=CjwKCAjw1tLOBhAMEiwAiPkRHmOj75BEiTeaKJ1usFJAj1zAYVBdeZZv0y7N5XDj7-q2lzsMiXD63hoCRTwQAvD_BwE&gbraid=0AAAADgmIc863S1f-WEn69MnX5qWba8-K
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