If the Shoe Fits Activity Version

Sherry Franklin, Aubrey Cole, Heather Shaffery, Michael Kraus
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Essential Question(s)

- How is forensic impression evidence collected and analyzed?

Summary

In this series of activities the 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. These activities concludes with a discussion of the strengths and challenges of using impression evidence to make positive identification of suspects. This activity is based on the LEARN lesson: If the Shoe Fits and can be used in a Forensic class or club.

Learning Goals

Standards

College and Career Preparation Standards 6–12 (6th -12th)

9.6 (S): Students will foster curiosity, inquisitiveness, wonder, and imagination by applying scientific reasoning and engineering practices to investigate, analyze, and explain phenomena in the natural and designed worlds, demonstrating an understanding of scientific relationships and patterns. (Clarification Statement: To achieve this standard, instruction should align to grade-level state standards for science and engineering.)
10.6 (S): Students will foster curiosity, inquisitiveness, wonder, and imagination by applying scientific reasoning and engineering practices to investigate, analyze, and explain phenomena in the natural and designed worlds, demonstrating an understanding of scientific relationships and patterns. (Clarification Statement: To achieve this standard, instruction should align to grade-level state standards for science and engineering.)
11.6 (S): Students will foster curiosity, inquisitiveness, wonder, and imagination by applying scientific reasoning and engineering practices to investigate, analyze, and explain phenomena in the natural and designed worlds, demonstrating an understanding of scientific relationships and patterns. (Clarification Statement: To achieve this standard, instruction should align to grade-level state standards for science and engineering.)
12.6 (S): Students will foster curiosity, inquisitiveness, wonder, and imagination by applying scientific reasoning and engineering practices to investigate, analyze, and explain phenomena in the natural and designed worlds, demonstrating an understanding of scientific relationships and patterns. (Clarification Statement: To achieve this standard, instruction should align to grade-level state standards for science and engineering.)
9.13.1: Students will join or initiate at least one school- or community-based organization aligned with their personal or social identities (e.g., cultural clubs, service groups), documenting how participation strengthens their sense of self and fosters connections with mentors and like-minded peers.

Attachments

- Activity Slides—If the Shoe Fits.pptx
- 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

Materials

- Activity Slides (attached)

Activity 1

- Impressions Investigation handout (attached; one per student)
- Dental stone (2 lbs per group)
- Digital scale
- Plastic zip-top bags, gallon (1 per group)
- Tongue depressors or spoons (1 per group)
- Rulers
- Water (8–12 oz per group)
- Camera (or students can use their phones)

Activity 2

- Lab Data and Questions handout (attached; one per student)
- Dental impression (from previous activity)
- Shoe (one for each group, see Prep Notes)
- Rulers
- Paper (one per group)

Activity 3

- Butcher paper
- Black printer's ink
- Ink roller
- Shoes (one per student)
- Lab Data and Questions handout (attached; from previous activity)

Activity 4

- Lab Data and Questions handout (attached; from previous activity)
- Paper (one per student)

60 minutes

Activity 1

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.

Go to **slide 6–7** and define impression evidence and share with students how three-dimensional impressions can be collected via dental stone. Tell students that they will be collecting their own dental stone impressions next.

Group students into groups of 2–3 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 8** to show an abbreviated version of the casting instructions.

Go to **slide 9** and give the classroom-specific instructions for how they will proceed with the activity by working through steps 1–5 on the Impressions Investigation handout. Have students complete the dental stone castings and set them aside to dry.

While the casts are drying, display **slides 10–13**. These slides 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 focus specifically on shoe prints in this lesson, but the techniques for documenting other kinds of impression evidence are similar.

Continue to **slides 14–15** to review with students how to document three-dimensional 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 16–19** to show examples of photographs of the same impression taken from different flash angles.

Display **slide 20** and provide the student time to finish steps 6 and 7 on the Impressions Investigation handout.

Alternative Online Activities

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

Activity 2

Tell students they will be analyzing their three-dimensional 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 21**. Students will use a modified version of the I Think, We Think strategy. For the "I Think," provide a sheet of paper and 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 have the class come together to share out those ideas as the "We Think."

Go to **slides 22–27** 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 28** to go over the data table format. In their investigation groups, have students document their 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 group.

45 minutes

Activity 3

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

Go to **slides 29–31** and introduce two-dimensional impressions and documentation of evidence. **Slide 31** 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 32** has an abbreviated version of these instructions that you can display as well. Have each student make their impression. Collect finished impressions and label each with a unique letter.

Students should record characteristic data about their known shoe on their data sheet, as with the three-dimensional impressions. After students have completed their impressions, redistribute the prints or have them take a known shoe.

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 pieces of paper 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.

Go to **slide 33** and give students classroom-specific 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 three-dimensional impressions. Using the data, have students circulate the room to match the two-dimensional 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

Activity 4

Bring the group 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, use **slides 34–37** to 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). 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.

Alternative Conclusions

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 activity by going to **slide 38** and having students complete an I Used to Think...But Now I Know reflection about forensic impression evidence. Provide each student with a sheet of notebook paper. Have them create a table with two columns and label the left side with "I Used to Think" and the right side with "But Now I Know".

Optional 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.

Research Rationale

See Career Exploration Through Experiential Learning - Forensics Evidence in Action Plan.

Resources

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