

CENTRAL QUESTION: How do synthetic materials impact society?

CASE STUDY QUESTION: How did ceramics impact the lives of people who first invented them and how has that impacted society today?

TIME: 2.5-3 hours

OVERVIEW:

- **SECTION 1: WARM-UP** (20 minutes)
What is a synthetic material?
- **SECTION 2: GATHER & ANALYZE** (60 minutes)
What was the form and function of the object this sherd came from?
- **SECTION 3: INTERPRET** (50 minutes)
How do ceramics compare to other tools that are not synthetic?
- **SECTION 4: COMMUNICATE** (40 minutes)
How did ceramics impact the lives of people who first invented them and how has that impacted society today?

DISTANCE LEARNING STRATEGIES:

- Activate collaboration and critical thinking by putting students into research groups to work on this together.
- Link to electronic Research Assistant Notebook for students to record their notes digitally.
- Use the chat feature in your preferred video conferencing system to allow students to ask questions, share ideas, and reason together.
- Use breakout rooms for small group discussions.

MATERIALS:

- One computer per two students
- One computer with the ability to broadcast material onto a screen visible by the entire class
- Printed *Research Assistant Notebooks* for students to record notes
- White board or other surface for teacher to use while facilitating class discussions
- Additional resources:
 - *Student Learning Assessment Tool*
 - *Student Rubric for Presenting Arguments*
 - *Student Rubric for Assessing Learning Outcomes*

STANDARDS ALIGNMENT:

Utah SEEd Standard

- **8.1.4** - Obtain and evaluate information to describe how synthetic materials come from natural resources that undergo a chemical process that changes their molecular structure, what their functions are, and how society uses these new materials. Examples of synthetic materials could include medicine, foods, building materials, plastics, and alternative fuels.

NGSS Standard

- **PS1.A** - Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.

Utah Social Studies Standard

- **U.S. I Standard 1.1** - Students will analyze evidence, including artifacts and other primary sources to make evidence-based inferences about life among several American Indian nations prior to European exploration of the Americas.

ELA Standards

- **Writing Standard 1:** Write arguments to support claims with clear reasons and relevant evidence.
- **Speaking & Listening Standard 1:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.

GETTING STARTED

This investigation provides support for teaching the content standards, along with the nature of science/how science is done, developing claims, working with evidence, and using reasoning skills. (**Hint:** Review the *Student Learning Assessment Tool* for other alignments and to assess learning with your students.)

Before class...

- Review this instructional guide and determine your student learning goals, which sections you want students to work on during each class period of the investigation, and the steps where your students will need guided instruction.
- Review the following recommended strategies for optimizing student learning outcomes.
 - Working in pairs ensures that every student has the opportunity to share their ideas. As students progress through the investigation, you may want to combine pairs of students into small groups to provide more practice sharing and responding to the ideas of their peers.
 - Build a shared vocabulary for the learning tasks by identifying key vocabulary beforehand and encouraging students to use these words often. Model correct usage if needed.
 - **Key Vocabulary:** natural resource, natural material, synthetic material, temper, paste, corrugation, slip/polish, surface treatment, sherd
 - Think about places you can activate prior knowledge by prompting students to relate new concepts to a familiar context.
 - Think about how to integrate the *Research Quest* investigations with other curriculum-aligned activities.
 - Create and engage student interest in the program by expressing your enthusiasm and/or describing your personal interest in this investigation. You may also want to emphasize that students will be working with authentic materials on research questions that scientists actually address in their own work.
 - Introduce students to sentence stems that reinforce flexible thinking and help students verbalize their thought processes:
 - “I see...”
 - “I think...”
 - “I wonder...”

Set Up...

- Make copies of the Research Assistant Notebook (RAN) for each of your students, or use the PDF with your desired digital classroom platform (ie. Google Classroom, Canvas, etc).
- Navigate to www.researchquest.org and login using the email address and password you used to create your *Research Quest* account. Then, navigate to the “My Account” tab at the far right of the navigation bar. You will find your **Student Access Code**.
- Have your unique Student Access Code and URL link [www.researchquest.org/student/] ready for students. **It is important you have students use this particular URL and access code to get into the investigations for FERPA & COPPA.**

In class...

- Introduce the daily objectives and provide a brief overview of the investigation to the class.
- Provide each student with a copy of the *Research Assistant Notebook* (RAN).
- Arrange students into pairs, one pair per computer. Instruct them to navigate to the URL [www.researchquest.org/student/] and enter your unique Student Access Code.
- Students will find themselves on a landing page with the option to go into one of two investigation modules. They should choose, “Archaeology.” Then, they should click on the investigation “How do synthetic materials impact society?”
- Once logged in, students will be on the introduction page for this investigation. They can read the overview and start at your direction.

SECTION 1: WARM-UP - WHAT IS A SYNTHETIC MATERIAL? (20 minutes)**OVERVIEW**

Students will identify and explain the difference between natural materials and synthetic materials.

ASSESSMENT

For the assessments in this investigation, the instructor may find it useful to focus on the following critical thinking skills, defined in more detail in the *Student Learning Assessment Tool* located in the **Support Materials** page for this investigation.

- **Observation:** Make observations to detect patterns of synthetic materials.
- **Connections:** Use the Venn diagram to identify similarities and differences between natural and synthetic materials.
- **Interpretations:** Construct a definition for synthetic materials.

STUDENT ACTION**TIPS FOR SUPPORTING CRITICAL THINKING****STEP 1***(5 minutes)*

- Watch the video on Step 1 of the investigation. (2:20 min.)
- Listen for the key questions that will help guide your investigation.

- Direct students' attention to the following before beginning the video:

In this video Aidan will break down the differences between natural resources, natural materials, and synthetic materials. Remember to take notes!

- **Key Vocabulary:** natural resources, natural materials, synthetic materials

STEP 2*(10 minutes)*

- Compare each infographic below to determine which objects are synthetic.
- Share your hypothesis with your partner or write it in your RAN.

Research Assistant Notebook (RAN): page 1

- Students are looking for patterns that help them distinguish between natural and synthetic materials. In this case cotton is the only natural material.
- Prior to starting this step, tap into students' previous knowledge to discuss what they know about natural and synthetic products.

STEP 3*(10 minutes)*

- Drag and drop these statements into their correct place on the Venn diagram.

Research Assistant Notebook (RAN): page 1

- The Venn diagram will mark correct responses with a green 'check' and incorrect responses with a red 'x'.
- Encourage students to apply the patterns they identified in the infographic.

STEP 4*(10 minutes)*

- Use your Venn diagram to construct a definition of synthetic materials and record it in your notes.

Research Assistant Notebook (RAN): page 1

- Students will synthesize what they learned to develop a definition for synthetic materials.
- Use this step to assess student reasoning and check for understanding.

SECTION 2: GATHER & ANALYZE - WHAT WAS THE FORM AND FUNCTION OF THE OBJECT THIS SHERD CAME FROM? (60 minutes)

OVERVIEW

Students will gather and analyze data from ceramic sherds (synthetic material). Make observations of sherd characteristics to identify its form and make inferences about its function.

ASSESSMENT

- **Observation:** Make detailed, sense-based observations to identify ceramic characteristics.
- **Connections:** Use the collected data to identify the form and discern the function.

STUDENT ACTION

TIPS FOR SUPPORTING CRITICAL THINKING

STEP 5

(5 minutes)

- Watch the video on Step 5 of the investigation. (5:23 min.)
- Listen for tips to help you with your research.

- Direct students' attention to the following before beginning the video:

In this video Aidan will introduce us to Dr. Glenna Nielsen-Grimm, an archaeologist at the Natural History Museum of Utah. Her research focuses on one of the earliest known synthetics, ceramics. Listen for tips to help you with your research.

STEP 6

(55 minutes)

- This is a multi-part interactive.
 1. **Select a Sherd**
Select a sherd to examine.
 2. **Observations**
Work through the same eight questions Dr. Glenna does to learn as much as you can about the sherd you selected.
 3. **Analysis**
Use your observation data to make comparisons between the characteristics of your sherd and the characteristics of common objects found in the places your sherd was found.
 4. **Synthesize**
Using the evidence you've collected about the sherd you are studying, communicate the form this sherd came from, your evidence for this idea, and what you think it may have been used for. Share your reasoning!
 5. **Reflection**
How do your observations and inferences compare with Dr. Glenna's thinking? Reflect on and discuss these comparisons with your research partner. If needed, go back and revisit your findings.

Research Assistant Notebook (RAN): page 2-3

- This is a multi-part interactive: select a sherd, observations, analysis, synthesis, and reflection.
 1. **Select a Sherd**
 - You may choose to divide up all 11 sherds so that each sherd is evaluated. We recommend students work in pairs.

2. Observations

- Observation scaffolding is provided in the form of questions and pop-up screens with useful information. *Hint: Green indicates a pop-up.*

3. Analysis

- Direct students' attention to the following before beginning the video:

In this video Aidan and Dr. Glenna discuss how to use artifact observations to figure out what type of object a sherd comes from and what that object was used for. Listen for tips that will help you with your research.

- Click on the image to see information about each form that will help with comparing features.

4. Synthesize

- Guide students to use all of the evidence they collected to described the form and function their sherd came from.

5. Reflection

- Encourage students to compare their reasoning with Dr. Glenna's and go back to re-evaluate their sherd, as needed.

SECTION 3: INTERPRET - HOW DO CERAMICS COMPARE TO OTHER TOOLS THAT ARE NOT SYNTHETIC? (50 minutes)

OVERVIEW

Students will interpret findings to develop an evidence-based claim for why people would invest in developing ceramics.

ASSESSMENT

- **Observation:** Make detailed, sense-based observations between natural and synthetic materials.
- **Interpretations:** Make inferences that clearly articulate a link between the evidence and the interpretation.

STUDENT ACTION

TIPS FOR SUPPORTING CRITICAL THINKING

STEP 7

(5 minutes)

- Watch the video on Step 7 of the investigation. (5:49 min.)

- Direct students' attention to the following before beginning the video:

In this video you'll reconnect with Aidan and Dr. Glenna to talk about the ways archaeologists think about and study ancient people and their communities. How do they think about the ways in which synthetic materials impact a society?

STEP 8

(10 minutes)

- Use the interactive to examine several common tasks related to food. Think about whether the synthetic material (in this case, ceramics) or the natural material functioned best for the task and why. Then, when your ready for the face-off, click the "Next" button.

- This step will give students a closer look at the artifacts they will compare in the next step. We recommend students work in pairs.

STEP 9

(20 minutes)

- Select a scenario to see both the natural and synthetic objects react. Then compare their production details and performance stats to collect data.

*Research Assistant Notebook (RAN):
page 3*

- This is where students will collect their data to learn how societies used both natural and synthetic material. Then, students will determine which material type is best using the data they collect.
- You may want to model this activity as a group. Use the animation and the production and performance stats to discuss the pros and cons of using natural or synthetic materials for a task.
- You should let students know how many scenarios they should analyze and/or if you want to assign these by small research groups. This can be useful if you want students to share their findings in a mock scientific conference where collective knowledge can reveal new insights.

STEP 10

(15 minutes)

- Now that you have made multiple comparisons between natural and synthetic materials determine which type of material would be preferred for a particular job. Be sure to include reasoning from what you learned about the production and performance of each material.

- Use this activity as an assessment of student reasoning. There isn't a "right" answer. Instead, look for reasoning that is supported by the evidence (production and performance stats). The goal is to have students reason, argue and defend their thinking. This is also an excellent time to foster flexibility in thinking. When presented with new perspectives, do students reflect on them and adjust their thinking where useful?
- Modeling can be useful for some students. Consider choosing one scenario students didn't evaluate to model how they can use their findings to construct an explanation.

SECTION 4: COMMUNICATE - HOW DID CERAMICS IMPACT THE LIVES OF PEOPLE WHO FIRST INVENTED THEM AND HOW HAS THAT IMPACTED SOCIETY TODAY?*(45 minutes)***OVERVIEW**

Students will generate an evidence-based claim that explains how ceramics impacted the societies who first invented them.

ASSESSMENT

- **Interpretations:** Develop a visual representation to describe this phenomena.

	STUDENT ACTION	TIPS FOR SUPPORTING CRITICAL THINKING
STEP 11 <i>(5 minutes)</i>	<ul style="list-style-type: none"> • Watch the video on Step 11 of the investigation. (4:59 min.) 	<ul style="list-style-type: none"> • Direct students' attention to the following before beginning the video: <i>In this video Aidan checks back in with Dr. Glenna to find out how Dr. Glenna thinks about these same ideas you've been developing to explain how these ceramic sherds - these synthetic materials - impacted the societies who made and used them.</i>
STEP 12 <i>(20 minutes)</i>	<ul style="list-style-type: none"> • Use your findings from this investigation to develop an evidence-based claim to explain why you think humans started using ceramic pottery. <p><i>Research Assistant Notebook (RAN): page 4</i></p>	<ul style="list-style-type: none"> • Encourage students to use the evidence they collected to develop their argument. • You can have student pairs work with other pairs of students to discuss and test their reasoning.
STEP 13 <i>(15 minutes)</i>	<ul style="list-style-type: none"> • Share your claim with other research groups in your class. • Then, consider the following question and discuss your thinking with your peers. • How has the invention of ceramics (A synthetic material) affected our lives today? <p><i>Research Assistant Notebook (RAN): page 4</i></p>	<ul style="list-style-type: none"> • Think, pair, share. Have students think about their own answer to the new question, then share their thinking with their partner, and then have a class or group discussion. • This can be an assessment opportunity. You may choose to use the <i>Student Learning Assessment Tool</i> to assess arguments.