Lesson Title: Sticks and Stones: Prehistory Technology

Grade Levels: 9-12

Time Allotment: Three 45-minute class periods

Overview:

In this lesson, selected segments from the PBS series ***The Human Spark*** *are* used to help students understand both the construction and context of some of the prehistoric tools which allowed early humans to survive and thrive. Particular attention is paid to the design and use of these early tools, the specific techniques used in their construction, and the reciprocal relationship between human technology and human evolution.

In the Introductory Activity, students will review the six simple machines and their role as the building blocks of most technologies. The Learning Activities will examine the progressively more sophisticated stone-age technologies of the hand-ax, the spear, and the atlatl assisted spear. The Culminating Activity asks students to brainstorm other tools and technologies which have affected the course of human development, and to conduct further research into them.

This lesson is best used as an introduction to a unit on the history of technology, or as a supplement to an anthropology or archaeology unit about Neanderthals and/or early humans.

Subject Matter: Archaeology, Anthropology, Technology

Learning Objectives:
Students will be able to:

- Describe the six simple machines and give examples of each
- Describe detailed construction techniques for several different prehistoric tools
- Distinguish between natural and man-made wear patterns on rocks.
- Discuss how certain tools and technology have advanced human development and may have affected human biological evolution

Learning Standards:

(From the National Curriculum Standards for Social Studies, available at www.socialstudies.org/standards/strands)

Chapter 2—The Themes of Social Studies

8. *Science, Technology, and Society*

Science, and its practical application, technology, have had a major influence on social and cultural change, and on the ways people interact with the world. Scientific advances and technology have influenced life over the

centuries, and modern life, as we know it, would be impossible without technology and the science that supports it.

There are many questions about the role that science and technology play in our lives and in our cultures. What can we learn from the past about how new technologies result in broader social change, some of which is unanticipated? Is new technology always better than that which it replaces? How can we cope with the ever-increasing pace of change, perhaps even the concern that technology might get out of control? How can we manage technology so that the greatest numbers of people benefit? How can we preserve fundamental values and beliefs in a world that is rapidly becoming one technology-linked village? How do science and technology affect our sense of self and morality? How are disparate cultures, geographically separated but impacted by global events, brought together by the technology that informs us about events, and offered hope by the science that may alleviate global problems (e.g., the spread of AIDS)? How can gaps in access to benefits of science and technology be bridged?

(From the National Science Education Standards, available at www.nap.edu)

Content Standards: 9-12

Science as Inquiry

Content Standard A: As a result of activities in grades 9–12, all students should develop

- Understandings about scientific inquiry

1. Scientists usually inquire about how physical, living, or designed systems function. Conceptual principles and knowledge guide scientific inquiries. Historical and current scientific knowledge influence the design and interpretation of investigations and the evaluation of proposed explanations made by other scientists.
2. Scientists conduct investigations for a wide variety of reasons. For example, they may wish to discover new aspects of the natural world, explain recently observed phenomena, or test the conclusions of prior investigations or the predictions of current theories.

Science and Technology

Content Standard E: As a result of activities in grades 9-12, all students should develop

- Understandings about science and technology

1. Scientists in different disciplines ask different questions, use different methods of investigation, and accept different types of evidence to support their explanations. Many scientific investigations require the contributions of individuals from different disciplines, including engineering. New disciplines of

science, such as geophysics and biochemistry often emerge at the interface of two older disciplines.

2. Science often advances with the introduction of new technologies. Solving technological problems often results in new scientific knowledge. New technologies often extend the current levels of scientific understanding and introduce new areas of research.

MEDIA COMPONENTS:

Video:

Selected segments of ***The Human Spark***: ***Becoming Us.*** Video segments can be accessed on the *Video Segments Page* at http://www.pbs.org/wnet/humanspark/lessons/sticks-and-stones-prehistory-technology/video-segments/521/

If It Ain't Broke...
Archaeologist John Shea explains the context and construction of one of early humans' first tools--the stone hand ax.

Pyroengineering
Archaeologist Curtis Marean explains a recent discovery about how early humans used fire in the creation of certain stone tools.

Making Stone Tools is Sooo Millions of Years Ago
Archaeologist Curtis Marean explains a recent discovery about how early humans used fire in the creation of certain stone tools.

To Make A Spear
Archaeologist John Shea demonstrates the construction of a primitive spear and explains its impact on the social development the early humans who used them.

Websites:

"Simple Machines"
http://www.cosi.org/files/Flash/simpMach/sm2.html
A website from the Center of Science and Industry featuring animated interactives about the nature and applications of simple machines.

Materials:

For the teacher:

- A computer with internet access connected to a projector and speakers for classroom use.

Prep for Teachers:

Prior to teaching this lesson, you will need to:

Preview all of the video segments and websites used in the lesson.

Download the video segments used in the lesson to your classroom computer, or prepare to watch them using your classroom's internet connection.

Bookmark the website used in the lesson on each computer in your classroom. Using a social bookmarking tool such as delicious.com or diigo (or an online bookmarking utility such as portaportal) will allow you to organize all the links in a central location.

Introductory Activity

1. Ask students how they would define "technology" in the most simple and general terms possible. (*Accept all answers, but explain that anthropologists define technology as the use and knowledge of tools, techniques, and systems to solve problems or otherwise serve some purpose.*) Ask students how they would define a tool in the most simple and general terms possible. (*Accept all answers, but explain that a simple working definition of a tool is that it is some sort of instrument used to perform or facilitate work.)* According to this definition, ask students if they think something as complex as a computer could be considered a tool. (*Yes.*) What about the software that runs on that computer? (*Yes.)* But what were the tools that *made* these tools, and what in turn were the tools used to make *them*? Where does it end? Ask students to come up with a list of 10 of the *simplest* tools they can think of. In other words, 10 of the most physically useful objects which they think cannot be broken down into even simpler useful objects. (*Probable answers include a knife, a hammer, a screwdriver, etc.*) Write all answers on a blackboard or whiteboard.

2. Log on to the "Simple Machines" website (at http://www.cosi.org/files/Flash/simpMach/sm2.html). Click on "The Essence Of Simple Machines" tab on the bottom left of the screen. The screen will show images of the six classic simple machines. Ask the class to identify and explain the basic function of each one, clicking on the machine's link to get more information if necessary. (*Pulley, inclined plane, lever, screw, wedge, and wheel.*)

3. For each tool on their list of 10 simple tools, ask students if it is, or contains, one or more of the six simple machines. (*E.g. a knife would be an example of a wedge; a hammer would be example of a lever.*)

4. Explain that these simple machines do indeed constitute some of humanity's earliest tools—developed and used long before they were named or recognized as the basic building blocks of future technologies. Tell students that in this lesson they will be taking a closer look at some specific instances of "stone age technology," exploring how some of humanity's earliest tools were created, what they were used for, and what further evolutions and advancements in humanity itself they may have sparked.

Learning Activities

1. Tell students that in this lesson they will be watching some segments from the PBS series ***The Human Spark***, which explores different theories about what it is that makes humans unique among animals. Ask students what ideas they may have about what makes us unique? (*Accept all answers*.) Ask students if they think that making and using tools are traits unique to humans? (*Accept all answers*.) Explain that while tool making and use was once considered uniquely human, more recent research has revealed that other species also make and use tools. Chimpanzees, for example, have been observed stripping sticks with their fingers and teeth so that they may more easily be inserted into ant and termite nests as probes to collect the edible inhabitants. Nevertheless, for no other species has tool making and use—on other words, technology—been such a central part of an evolutionary strategy as it has been for humans.

2. Tell students that they will now be looking at a video segment which examines the context and construction of one of humanities' earliest tools—the hand ax. As they watch, ask students to be watching for the reason why archaeologist John Shea believes the design of the hand ax changed so little for so long. PLAY Clip 1: "If It Ain't Broke…"

3. Review the focus question: why does archaeologist John Shea believe the design of the hand ax changed so little for so long? (*The design of the hand ax was not under a "powerful pressure of natural selection" to evolve and improve; in other words, it wasn't broke, so it wasn't fixed!*) Ask what natural selection is? (*Charles Darwin's principle of "survival of the fittest."*) Explain that Shea is using an evolutionary term usually applied to organisms and applying it instead to an organism's inanimate creation; the more "fit" a tool seems to serve its purpose, the less it is refined or "evolves", and the more it "survives" in its existing form.

4. Ask students how stone-age hand axes were made, based on Professor Shea's demonstration. (*A piece of rock is hit with another piece of rock, which chips pieces off, creating a sharp edge.)* What kind of rock would work best for constructing hand axes in this manner? (*Accept all answers, but point out that flint and certain other sedimentary rocks are ideal.*) What are sedimentary rocks? (*Sedimentary rocks are created by the geological compression over time of layer upon layer of sediments, generally left behind where there were once rivers or other bodies of water.)* Why are they ideal materials for creating tools? *(Their sedimentary layers can easily be chipped or "flaked" away to produce a sharp edge.*)

5. Tell students that besides being a good stone for making into blades, flint possesses another extremely useful quality—what is it? (*Flint, when struck with a rock containing iron, can generate sparks which can be kindled into flame.*) Explain that this technique, known as "percussion firestarting," is generally though to have developed around 7,000 B.C.—much later than the stone hand axes seen in the previous clip. Recent archaeological discoveries, however, suggest that fire did indeed play a role in the creation of certain stone blades dating back at least 72,000 years ago. As they watch the

next clip, have students pay attention to what "silcrete" is and what role fire played in its use as a raw material for stone blades. Play Clip 2: "Pyroengineering."

6. Review the previous question: what is silcrete? (*A material long thought to be ideal for making stone blades, many high-quality examples of which have been found by archaeologists*). How was archaeologists' actual experimental experience with silcrete problematizing this theory? (*They themselves couldn't make silcrete into good blades.)* What was the archaeologists' breakthrough in understanding how the high-quality silcrete blades were made? (*They discovered silcrete encased in ash, suggesting that it had been heat-treated.*) What happened when they heat-treated silcrete themselves during a barbeque? (*It took on the same red color as the original silcrete blades they'd found, and when struck, flaked off sharp edges beautifully.)*

7. Tell students that hardening by fire is also known as "tempering," and that it is widely used in almost every type of manufacturing today, but that silcrete was perhaps its original use. Ask student how this type of "pyroengineering" might first have been discovered by early man? (*Accept all answers, but point out that it may very well have been discovered accidentally when raw silcrete was heated in a cooking fire not unlike that made by Curtis Marean and his fellow archaeologists at their barbeque*.) Remind students that silcrete blades have been found that date back over 72,000 years. Ask students how they think tempering would have been possible so many years before humans developed the ability to create fire? If necessary, offer this hint: how does fire occur naturally? (*Flames started naturally by lighting strikes could, with care, be maintained more or less indefinitely*.)

8. Point out how the case of silcrete is a good illustration of how much archaeological knowledge must be extrapolated from relatively mundane artifacts (e.g. an ash-encrusted rock) and confirmed through modern experimentation (e.g. the archaeologists' barbeque.) When most of the prehistoric archeological record consists of various types of rock, even the subtlest differences can be significant to the trained eye. Ask students how archaeologists can distinguish between pieces of flint which were simply broken naturally from pieces that were deliberately fashioned into axes by early humans? (*Accept all answers, and tell students to be thinking about this question as they watch the next clip.)* PLAY Clip 3: "Making Stone Tools Is Sooo Millions of Years Ago."

9. PAUSE at 1:54 right after John Shea says to Alan Alda "Of course they didn't have guns yet." Review the previous question: how can archaeologists distinguish between pieces of rock which were naturally broken from pieces that were deliberately fashioned into axes by early humans? (*Rocks that are naturally fractured tend to be worn equally over their entire surface, and chipped in all directions, whereas artificially created ax heads show careful chipping only along the cutting edges, and always in one direction. Also, the environmental context in which rocks were found gives strong indication of whether they were made by humans.)* Ask students what specific uses they think hand-axes had. PLAY Clip 3 through to the end.

10. Review the previous question: for what specific uses were hand-axes used? (*They were multi-use tools, but depending on the nature of the edge they could be used for cutting or scraping*.) Ask students to review the six classic simple machines. (*Screw,*

inclined plane, pulley, wheel, lever, and wedge.) What kind of simple machine is a hand axe? (*A wedge*.) How does a wedge work? (*It splits objects.)*

11. Ask what would happen if you somehow attached a hand axe to a long stick or shaft? (*You would have created a spear.)* What are the advantages of a spear over a hand axe? (*Greater range.)* Ask if a spear is fundamentally a different type of simple machine than a hand axe. (*No—a spearhead is a wedge exactly like a hand-axe; only the nature of the force behind it is different—i.e. the force of a thrust, or the force of momentum if thrown*.) Ask students how they think early humans went about making spears. (*Accept all answers*.) Tell students to be watching in the next clip for the answer to this question. PLAY Clip 4: "To Make A Spear."

12. PAUSE at 35:55, after Shea says "In a real one we'd have a lot of glue in there." Review the previous question: how did early humans make multi-part spears? (*A stone spearhead would be made in a manner similar to a hand ax, inserted into a groove cut in a wooden stick or shaft, held in place with pitch or some other type of glue, and secured by multiple windings of animal sinew or plant fiber*.) Explain that the spear, when thrown, was one of the earliest examples of "projectile technology." Ask what the very earliest example probably was? (*A thrown rock*.) Ask students what advantage projectile weapons had against the handheld variety? (*Greater range.)* What are the benefits of a weapon with greater range? (*Accept all answers*.) Have students pay particular attention to this question as they watch the remainder of the clip. PLAY Clip 4 through to the end.

13. Review the previous question: what are the benefits of a weapon with greater range? (*Larger, more dangerous prey like woolly mammoths could be hunted at a safer distance*.) Ask students if in the last clip they observed Shea and Alda using another example of stone-age technology to give their spears even greater range? If necessary, go back and play the clip from the previous pause point at 35:55. (*They were using wooden "spear-throwers," one end of which fit over the spear's end with the other being held in the hand of the thrower*.) Ask students how they think a spear-thrower works. (*Accept all answers*.) Tell students that the spear thrower used by Shea and Alda—also known as an "atlatl"—has been developed by many primitive cultures around the world. Ask students if they think the atlatl is an example of another simple machine? (*Yes—a lever.)* Explain that an atlatl is specifically a "third class lever," which works by applying force between the fulcrum (the thrower's shoulder) and the load (the spear or dart). By allowing a smaller movement on the fulcrum end of the lever to be magnified into a larger movement on the load end, an atlatl adds speed—and accordingly, distance—to the spear's trajectory by effectively lengthening the thrower's arm.

14. Ask students whether early humans hunted larger game animals individually or in groups? (*In groups.)* Why? *(Because even the more advanced projectile technology of the atlatl-thrown spear wasn't powerful enough for one person to kill a larger animal single-handedly*.) Ask students why John Shea suggests in the clip that the nature of cooperative hunting was in itself also a major factor in humans' evolutionary advancement. (*The coordination and cooperation necessary for a group of early humans together required communication and planning, which in turn required language*.)

15. Ask students which they think came first—primitive hunting implements or the language necessary to coordinate their use? (*Accept all answers.)* Point out that the likely answer to this "chicken and egg" dilemma is that the development of hunting tools and language was intertwined, with an advance in one leading to an advance in the other. Ask how else improvements in hunting might have affected human evolution? (*Accept all answers.)* Explain that, generally speaking, improvements in hunting allowed more and bigger game to be hunted, providing more meat in early humans' diet; more meat, in turn, is believed to have contributed to a larger brain size; a larger brain size, among other things, helped contribute to even more sophisticated tool technology and language use, and so on. Essentially, our tools are extensions of ourselves—technologies that are both the artifacts of our evolutionary development to date, and catalysts for future development.

Culminating Activity

1. Divide students into groups of 4-5. Allow 20-30 minutes for groups to brainstorm five other basic tools or technologies which they think may have contributed to human advancement. Instruct groups to keep their ideas as simple and elemental as possible (e.g. "the plow," rather than "farming machinery").

2. Have each group present their ideas to the rest of the class as you write down all ideas on the blackboard or whiteboard. Encourage questions and comments from the class. Can any tool or technology be reduced to a simpler, more basic element? Is the tool an example of a simple machine? Does it include multiple simple machines? What human advancement might it have helped facilitate?

3. After all groups have presented, have each student choose one of the tools or technologies listed on the black or whiteboard as the subject for a short research essay addressing the following questions:

- When was the tool or technology developed/invented?
- What need did it address?
- Who developed/invented it?
- What advance did it make possible?
- How has the tool or technology been developed, improved, or expanded beyond its original incarnation?