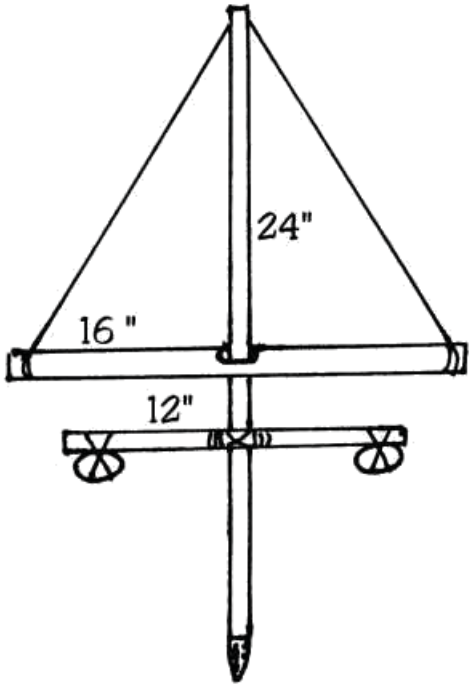
CALIFORNIA INDIAN MUSEUM & CULTURAL CENTER

Weaving Native Culture into the Future

Native Maker Program Lesson Plan

Pump Drill



Wooden Pump Drill - The pump drill is a wooden tool that drills little holes/circles into a certain item. Native people have used the pump drill for centuries to start fires and drill holes. This tool was ideal for making holes in bone, wood or shells and for making beads.

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Summary:
Introduce California Indian shell money currency and pump drill tool used throughout California and beyond.

Goal:

Material:

Cultural Information:

Prior to the European migration into California, the Native Americans used sharply pointed stones (chert or quartzite) as drills. These stones were secured with sinew to a stick. This tool, when rotated between the palms, would slowly drill a hole in a shell or produce the spark needed for fire. Later, when the Mexicans moved in to this area, they brought the pump drill. It was made of wood and hide thongs with a metal drill. The Native Americans soon adopted the metal bit. The stick with the bit attached twirls around when the upright cross-stick is pumped up and down. Native American tools came from the local natural surroundings or were acquired in trade with other nearby tribes. A common unit of exchange in the Bay Area, was made from olivella or shell disks that had been carved, polished, and strung on fine string. This money was used like our paper money is today, and it was often used in trade. With strings of money the early California Native Americans could buy items from all over the western geographic area that were unavailable in their locale. **Adapted from Early California Indians: An Environmental Focus**

Ohlone people first used the hand drill with a stone point. After contact with the Spanish, they used the pump drill with a metal point. The pump drill was more effective since it was faster and easier to use. One way Ohlone people used these drills was to create holes in shells used in making jewelry, for example, an abalone shell necklace. **Adapted from Santa Clara County Parks & Recreation Chitactac-Adams Heritage County Park Teaching and Activity Guide**

Overview:

- Brief history of shell money and pump drill
- Cultural information of shell money and pump drill
- View pictures of shell money and pump drill
- Distribute material to make jewelry/pump drill
- Describe the process by doing a demonstration
- Create accessory/pump drill
- Share what students created

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Lesson 1- Operation of Pump Drill:

Slide pump handle down the shaft and insert leather string into the groove at the top of the shaft. Wind the leather string around the shaft by turning it. Placing your fingers on pump handle exert downward pressure. The string should rewind with each stroke. If not, apply less downward pressure. (Northeast Georgia History Center Native American Travel Trunk)

A pump drill is made of three parts: a drill shaft on which a string may twist and which is tipped with the drill bit; a fly wheel which provides momentum after each downward thrust; and a bow and string which change vertical action to rotary action.

The Drill Shaft

A slim, round shaft of well-seasoned hardwood 18-24 inches long is needed for a drill shaft. A peeled sapling or shoot can be used, or it can be whittled from a large stick. Three-eighths inch diameter at the top is good to taper to 1/2 - 3/4 inch at the bottom. A narrow shaft gives more rotations to each "pump". Too narrow a shaft may bend or wobble with each stroke. The upper end can be drilled to receive a bow string so it will stay in place well; a notch makes the apparatus easier to disassemble without untying the bow each time. When you have completed a nicely tapered shaft, smooth it with sandpaper or rub it on sandstone for a nice finish. Check it for straightness by sighting along its length. Rolling it on a flat surface will also show bends. Warm the warped area over heat and bend it true with your hands. If you hold it until cool, it should retain this adjustment. The bottom of the shaft must have a bit attached to it which can cut in either rotation. If you are in a hurry, some hardware stores carry drill bits for a modern "Yankee" pump screwdriver, if you use a "Yankee" bit, you'll have to grind some flats on that part which will be inserted into the shaft to keep it from rotating in the shaft instead of the work. The little notches which are intended for the screwdriver tool just aren't enough. By the way, don't bother with regular twist drill bits which cut only in a clockwise rotation. Stone points can be re-flaked right on the drill shaft to re-sharpen them until not enough material remains for a good point. The same is true for a steel point. In this context, remember that primitive drills seldom were intended to bore deeper than an inch and holes often were drilled from opposite sides to meet in the middle of the work. Mechanically precise diameters were not important. Also remember that these holes were usually conical, not cylindrical.

The Drill Bow

The bow needs no flexibility. It can be made of any wood or even a long piece of bone. It can be quite short, less than 8 inches, or as large as 2 or 3 feet. A convenient rule-of-thumb might be to make the bow half the length of the drill shaft. Although a simple round stick can be used bow and-arrow fashion at the side of the shaft, a flat bow, about 1/2 by 1 inch in section, is better and can be drilled in the center with a hole larger than the drill shaft above the flywheel. Thus, the shaft is pushed up through the bow's hole so that the bow cannot slip off during use. The ends of the bow can be notched or drilled to receive the bow string. You'll not want to make this attachment permanent, because you'll probably need to make adjustments in tension from time to time. A good craftsman will want to put a nice finish on the bow, but a nice finish does not add to its function. Any cord can be used for a bow string. Original

pump drills used a buck skin thong. If you use buckskin, cut it as even as possible. If you use a cord, get a strong, thin one which is limp so that it will wind smoothly around the shaft. Tie one end of the bowstring on the bow, insert the shaft (with the flywheel in place) through the bow's hole, and put the string through the hole or notch at the top of the shaft. The attachment of the string through the top of the shaft should not be permanent to allow for adjustments later. Tie the free end of the string to the other end of the bow so that the bow can be suspended from the shaft about 2-3 inches above the flywheel. The closer it is, the longer each pump-stroke can be, but, if it's too close, you will find it difficult to operate the drill as your fingers get in the way of the flywheel. Adjust the string in the shaft top so that the bow is in a horizontal position. Slide the bow up and down a few times to see that the shaft can twirl in the hole freely.

The Flywheel

Flywheels are made of stone, ceramic, or wood. The weight of stone is preferred, but the process of manufacture is more involved and is not worth the time unless you intend to put the drill to much use. Any type of stone can be used. Try to find a beach pebble which is already worn to a flat, circular, disc-shape. Peck or grind this to a true circle as much as possible. A stone 3-5 inches in diameter and less than an inch thick should give plenty of momentum for your drill. Clay is easy to shape but will need to be fired before use. A tree branch or small log can be sawed crosswise to produce a flat disc. A disc about 3/4 inch thick and 4-6 inches in diameter needs little refining to make a good wheel. With cross-cut wood such as this, you may have some problems with cracks as the wood dries. These cracks will not diminish its function unless the wood cracks in half. In general, the size of the flywheel is dependent upon the size of the drill and the weight of the material used. Shape the flywheel by whatever means is appropriate to the material you have selected to make it nearly perfect in shape and thickness. Drill a hole in its center large enough to receive the shaft. The flywheel should slip down the shaft to a point close to the bit end — a few inches from the tip. This is necessary to give a bottom heavy weight to the shaft to keep it rotating without wobbling. Enlarge the hole or narrow the shaft accordingly. In any case, the fly wheel should be seated snugly so that the wheel and shaft rotate together. Twirl the shaft and wheel in your hands to see if any adjustment can be made on the flywheel to make it as balanced as possible. A wood wheel can be trimmed, and a stone one can be pecked a little more on the heavier portion to run more balanced. A wheel a little out of balance will run well, but not perfectly well. As much as possible, see that the hole in the wheel and the section of the shaft oval are squared with a shoulder on the shaft below to keep the wheel from slipping too far down. In this way, the flywheel can be changed easily from one shaft to another with little worry about it rotating itself. **Adapted by the Northeast Georgia History Center Native American Travel Trunk**

Lesson 2 - Ask students to identify which of the shellfish were used traditionally:

- Mussel – food source/the shell is used as a woman's eating spoon
- Clam – food source, small clam shells were used for regalia
- Olivella – regalia (necklaces and ceremonial dresses)

- Abalone – food source and regalia (necklaces, ceremonial dresses, quivers)
- Dentalium – money and regalia (necklaces)
  Shell Money - Abolone, Blue, Glass, Red Beads, Callus Shells, Clamshell Beads, Dentalium Shells, Haliotis Shells, Magnesite Beads, Olivella Shells, Venus Shells, White Beads.

Show students pictures of the regalia items and help them identify the different kinds of exoskeletons that are being used. **Adapted from Lessons of Our Land**

Pump Drill Project

I. Project Ideas

Project 1: Using Different Sizes of Pump Drill on Different Materials

Background: I think you could still make this a project by using different sizes of pump drills and materials. In the article (and bear with me, because I think it is a white guy appropriating Native technology), the author talks about using different sizes of pump drills for different jobs. He said that using a pump drill that is too big on shells will break them because it uses too much force.

Goal: Teach the students problem-solving skills.

Activity: For the activity, you could give the kids a worksheet with different sizes of pump drills and different materials and ask them to match up the corresponding materials with the correct drills. This activity will teach them problem-solving skills.

Steps

- Pass out the worksheet
- Students build the pump drills on the stand
- Using the worksheet, the students log in how the pump drill works on each different type of material (did it break? Was it hard to drill into?).
- If students have trouble drilling into the material or are unable to drill into it, ask them to identify the material on their worksheet and explain why.
- Turn in/present worksheets at the end

Drawback: This activity would require us to build different sizes of pump drills and collect different materials to drill. It could take a while to fine tune the project, but it could be something that can be used for a long time.

Project 2: Building Different Sizes of Pump Drill from a Pile of Assorted Parts

Activity: Alternatively, you could have kids follow instructions to assemble a pump drill. You could even give a group of kids a pile of materials for different sized pump drills and ask them to construct a few pump drills by separating the different parts for the different drills. If you want to make the activity easier, you could make the parts for each drill a specific color, so that the kids have an easier time sorting the parts. This activity would teach them teamwork, leadership, problem-solving, and construction skills.

Drawback: Again, this project may require trial and error to complete (I am not sure how easy it will be to assemble a pump drill from scratch and then disassemble it for the next group).

Project 3: Pythagorean Theorem and Pump Drills

Activity: In the Bushcraft article, the author states that an ideal pump drill is made from a triangle with dimensions that are proportional by 3, 4, and 5 on each side. These dimensions create a Pythagorean triangle, also called a 3-4-5 triangle. A Pythagorean triangle is a triangle with a right angle, whose sides can be calculated using the Pythagorean theorem: $a^2 + b^2 = c^2$. In a 3-4-5 triangle, c = the hypotenuse of the triangle.

You can teach kids about the 3-4-5 triangle and then demonstrate why it works with pump drills by building drills that do not use 3-4-5 triangles and having them test each drill. See the Bushcraft article for how to apply the 3-4-5 triangle to the pump drill.

Pump Drills and the Pythagorean Triangle

As you are constructing your pump drill, keep in mind that an ideal pump drill uses the dimensions of a Pythagorean triangle, or a 3-4-5 triangle. This triangle is a right angle, with its sides proportional to 3 and 4 and its hypotenuse proportional to 5.

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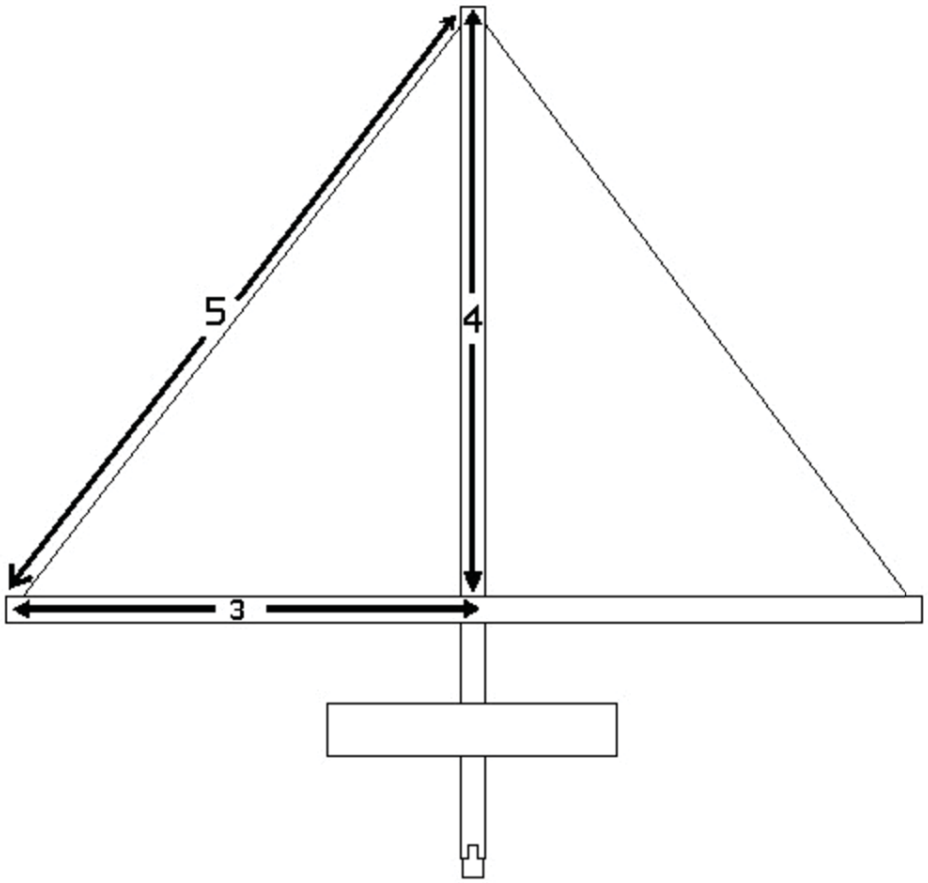
Take a look at the diagram below:



A Pythagorean triangle is a triangle with a right angle, whose sides can be calculated using the Pythagorean theorem: $a^2 + b^2 = c^2$. In a 3-4-5 triangle, c = the hypotenuse of the triangle. Try to find materials to make a pump drill that uses the Pythagorean triangle for the best results.

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Pump Drill Activity Worksheet

Type of Material Used	Were You Able To Drill A Hole In It?	If Not, Why Do You Think It Did Not Work?

II. Sources

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- https://books.google.com/books?id=HlwUo0IccoMC&pg=PT40&lpg=PT40&dq=Pump-Drills:+Their+Design,+Construction,+and+Attunement+by+Anthony+Follari&source=bl&ots=tR8m9tbHEl&sig=GnVljlaW1NFfc_nIBDVD2YAxuoU&hl=en&sa=X&ved=0ahUKEwj6zdPM__zVAhXixF

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  - See pages 46-52

- http://www.maths.surrey.ac.uk/hosted-sites/R.Knott/Pythag/pythag.html
  - Pythagorean triangles
- https://www.mathsisfun.com/pythagorean_triples.html
  - Website for kids that demonstrates the Pythagorean theorem/triangle

Resources:

Shell Necklace Kit: https://www.youtube.com/watch?v=pQDockLdTiw

Shells, Dentalium and the Ocean:
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Make your own Pump Drill: http://a2zhomeschooling.com/graphics/Pump%20Drill.pdf