Connecting Indigenous
Knowledges to the classroom

Experiment Procedure

Fire-starting topic

Physical sciences

Teacher notes (Year 8)



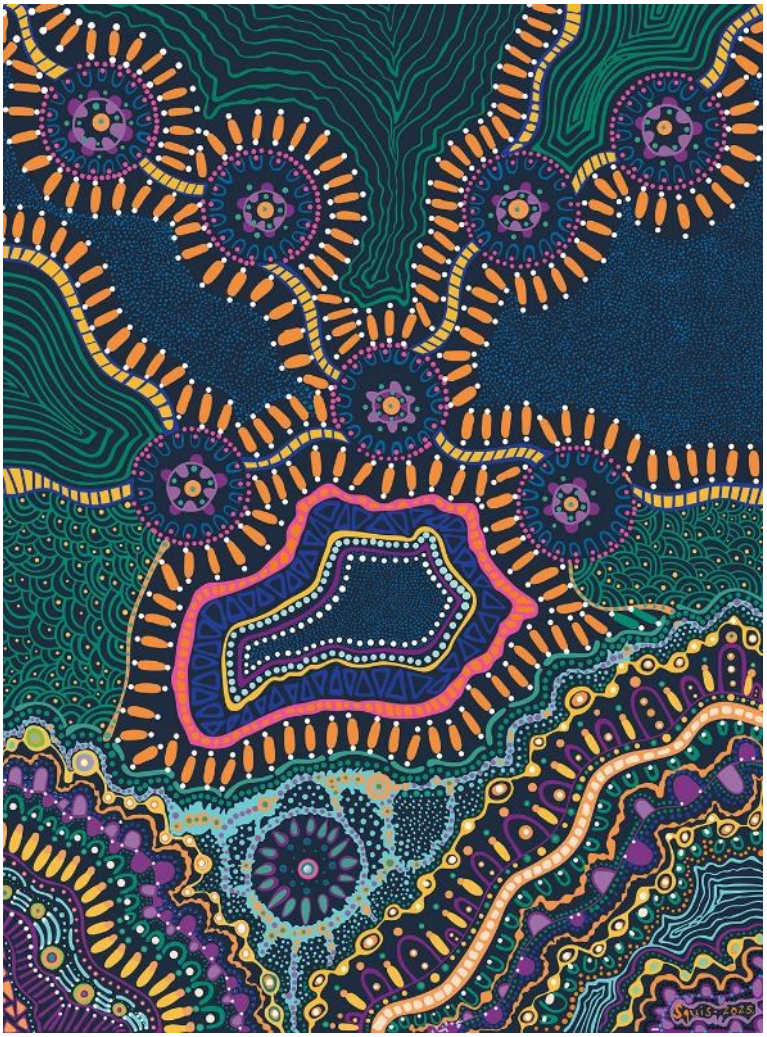
Acknowledgement of Country

CSIRO acknowledges the Traditional Owners of the lands, seas and waters of the area that we live and work on across Australia. We acknowledge all Aboriginal and Torres Strait Islander peoples and their continuing connection to their culture and pay our respects to Elders past and present. CSIRO is committed to reconciliation and recognises that Aboriginal and Torres Strait Islander peoples have made contributions to all aspects of Australian life including culture, economy and science.

Artwork

‘Meeting on Country, Shifting Sands’
by Aunty Sandra Angus
working with Saltwater People
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Aunty Sandra Angus is an acknowledged Elder and well respected Aboriginal leader in her community. She proudly identifies as an Australian ‘Saltwater Murri’ with ancestral roots that extend to the Wiradjuri and Wongaibon people in NSW, the Ngarrindjeri people in SA and the Gunggari and Jaggera people in QLD.



Contents

Contents 3
Introduction 4
Experiment procedure 7
Take it further 11

Introduction

In this experiment, students explore how Aboriginal and/or Torres Strait Islander Peoples use traditional fire-starting methods to understand energy and energy transformation. For thousands of years, fire has been a deeply connected practice linking culture, Country, and community. It is central to spiritual connections to Country and is used in ceremonies and cultural traditions. Fire has also been carefully used to care for Country through controlled burning to help maintain healthy ecosystems, protect sacred sites, and reduce the risk of bushfires. In daily life, fire has supported cooking, warmth, hunting, and communication through smoke signals.

These fire-starting practices are based on deep ecological knowledge. Knowledge on how to select suitable materials for drill sticks, hearth boards, saws and tinder is important to successfully starting a fire, as is understanding how to transform mechanical energy into heat energy using friction. All methods rely on dry wood to create friction and force to transform kinetic energy into heat energy to ignite fire. Common tinder includes dry grass, eucalyptus leaves, coconut fibre, bark and dried animal dung.

This experiment focuses on two common methods explored in one lesson between two groups: the hand drill and the fire saw. Other methods, such as the fire plough and percussion techniques, are used in parts of north-eastern Western Australia and are explored in the Fire-starting context PowerPoint.

Note: In a classroom setting, students will not be able to create an actual fire using these methods. Instead, they should aim to observe signs of heat energy transfer, such as visible smoke, a burning smell, or slight browning/charring of the wood.

Hand drill

The hand drill is the most widely used fire-starting technique across Australia and the Torres Strait Islands. It involves twirling a straight wooden drill stick between the hands in a socket carved into a hearth board. Friction produces heat and fine wood dust, which falls through a notch onto tinder and forms a smouldering ember. The method can be done by one person but is less strenuous when shared by two.

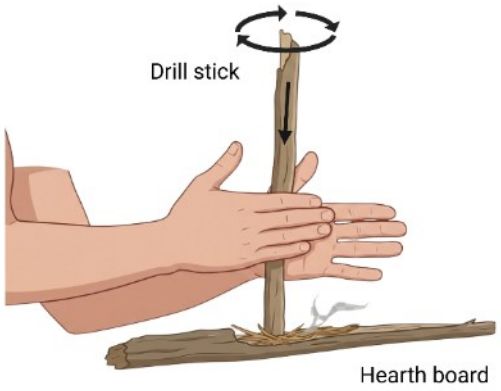


Figure 1 Hand drill method

A harder wood is used for the drill stick and a softer wood for the hearth board. The hearth must not be too soft or rotten, as it will crumble and fail to create enough friction. Wood with a pith core (a soft white centre) usually works well. Harder woods require much more energy to produce the hot sawdust needed for ignition. Drill sticks must be straight and about 30–170 cm long, and approximately 1 cm in diameter.

Important points to note with the hand drill method:

- Rub both hands together while exerting downward pressure so the drill stick rotates into the hearth board.
- Rolling the stick across the whole palm is more effective than short movements.
- Begin with light downward pressure as the sticks warm up, then increase the pressure when smoke begins to appear, being careful to maintain the vertical position of the drill stick.
- Recommended: An electric drill fitted with a short 50-75 mm stick (as the drill piece) can be slowly spun to simulate hand twirling. Safety glasses must be worn for this method. This can help avoid arm and hand strain.

Fire saw

The fire saw was the second most common technique, particularly in central Australia, north-western coastal regions and parts of Victoria. It involves rubbing the sharp edge of a hard wooden object (known as a “saw stick”) back and forth across a softer wooden base (known as “hearth stick”) placed over tinder. The friction produces hot wood dust that smoulders and ignites the tinder.



Figure 2 Fire saw method

This method is efficient, requires minimal preparation, and can be done by one or two people. Fire saws are made from rough pieces of wood, avoiding the need for precise shaping, while the base is made from softer wood.

A key advantage is its versatility. Everyday tools such as spear throwers, boomerangs, and wooden dishes could also be used as fire saws, reducing the need to carry extra materials. For example, a concave spear thrower could be used for hunting, fire-making, cutting, carrying, and making music.

Important points to note with the fire saw method:

- Get students to wear gloves to avoid blisters. Gloves with the grip on the inside are ideal so that they can still hold onto the wood.

To see the full list of materials, refer to the *Fire-starting equipment list and hazard management document*.

Safety Note: This investigation involves friction-generated heat, fire, sawdust and optional use of an electric drill to simulate fire-starting techniques.

Experiment procedure

Which method produces visible smoke faster: the hand drill or the fire saw?

PART A – Hand drill

Equipment

For each group:

- Base plate (dressed pine), 140 mm x 19 mm x 200 mm, with two adjacent 6 mm holes positioned 20 mm from the top edge and 20 mm from the side edge at one end.
- Drill stick: *Eucalyptus grandis* – flooded gum (dowel) 800 mm in length and 12 mm in diameter. Taper the end manually with sandpaper to smooth the edge.
- Hearth board (Tasmanian Oak), 30 mm x 12 mm x 1200 mm, with 13 mm deep starter holes/notches across the hearth board. The board must also have drill holes that align with the base plate (two adjacent 6 mm holes positioned 10 mm from the top edge and 10 mm from the side edge at one end).
- 2 x 80 mm metal bolt and wing nut (for attaching hearth board to base plate)
- G-clamp
- Timer (stopwatch)
- Safety glasses
- Optional – Temperature measurement device.
- Optional – Electric hand drill (see important notes).

For each student, copies of:

- Fire starting experiment procedure – Student
- Fire-starting experiment planner
- Additional fire-starting experiment PowerPoint.

Safety

- Do not touch the materials, as they could be hot. The heat produced can cause burns.
- Wear safety glasses. Sawdust could fly into your eyes.
- Keep your working area clean. Flammable materials can catch on fire.
- Have a fire blanket, fire extinguisher or fire bucket on hand.

Equipment set-up



Figure 3 Set-up for hand drill experiment

Method

1. Secure the hearth board to the base plate using the bolt and wing nuts, ensuring it is firmly fastened.
2. Use the G-clamp to attach the base plate to a workbench. Position the base plate so that the hearth board is close to the edge of the bench. Tighten the clamp securely to hold the hearth board and base plate steady. It should not move.
3. Position the drill stick vertically in the notch of the hearth board.
4. Have the timer ready to start when at the beginning of step 5.
5. Place both hands at the top of the stick and use a quick back-and-forth motion moving the hands down the stick while exerting some downward pressure on stick.
6. When the hands reach the bottom of the stick, reposition them to the top and continue spinning (or change operators if there are two people).
7. Continue using the hand drill until you observe clear signs of ignition such as visible smoke or a distinct burning smell. Stop the timer when you notice this. The wood may have started to darken or char.
8. Record observations and timing in Part A of the Experiment planner.
9. Repeat steps 3 – 8 at least two more times, making sure to make observations as you go.

PART B – Fire saw

Equipment

For each group:

- Base plate (dressed pine) 140 mm x 19 mm x 200 mm. With two adjacent 6 mm holes positioned 20 mm from the top edge and 20 mm from the side edge at one end.
- Hearth stick (Tasmanian Oak), 30 mm x 12 mm x 1200 mm, with 13 mm deep starter holes/notches across the hearth. Board needs to have drill holes that align with the base plate (two adjacent 6 mm holes positioned 10 mm from the top edge and 10 mm from the side edge at one end).
- Saw stick (*Eucalyptus grandis* – flooded gum), 400 mm in length and 30 x 12 mm in width.
- 2 x 80 mm metal bolt and wing nut (for attaching hearth board to base plate)
- G-clamp
- 2 pairs of gloves (gardening type)
- Safety glasses
- Timer (stopwatch)
- Optional – Temperature measurement device.

Safety

- Do not touch the materials, as could be hot. The heat produced can cause burns.
- Wear safety glasses. Sawdust could fly into your eyes.
- Keep your working area clean. Flammable materials can catch on fire.
- Have a fire blanket, fire extinguisher or fire bucket on hand.

Equipment set-up



Figure 4 Set-up for fire saw experiment

Method

1. Secure the hearth stick to the base plate using the bolt and wing nuts, ensuring it is firmly fastened.
2. Use the G-clamp to attach the base plate to a workbench. Position it so that the hearth stick is close to the edge of the bench. Tighten the clamp securely to hold the hearth stick and base plate steady. It should not move.
3. Position the saw stick across the top of the hearth stick.
4. Have the timer ready to start at the beginning of step 5.
5. Wearing gloves, place one hand on each end of the stick (or one person on each side if there are two operators) and use a back-and-forth sawing motion, exerting downward pressure on the stick. Start slowly, then gradually increase pace and pressure. This creates a groove in the hearth where the dust will collect and heat up.
6. Continue using the fire saw until you observe clear signs of ignition such as visible smoke or a distinct burning smell. Stop the timer when you notice this. The wood may have started to darken or char.
7. Record observations and timing in Part B of the Experiment planner.
8. Repeat steps 3–7 at least two more times.

Results

Students are to record their observations and time measurements in the Experiment planner.

Analyse the results

Students use their data and observations to determine which fire-starting method was more efficient in producing smoke. They record their analysis in the Experiment planner.

Teacher prompts

Aboriginal and Torres Strait Islander contexts and knowledges:

- How is fire used by Aboriginal and/or Torres Strait Islander Peoples? Think about Country, Culture, and community.
- What forms of energy were involved in operating the hand drill, and how were these forms transferred or transformed during the activity?
- What does this experiment highlight about Aboriginal and/or Torres Strait Islander Peoples' understanding of energy transfer and transformation?
- How is this knowledge applied?
- Why is understanding energy transfer important when learning about traditional fire-starting techniques used by Aboriginal and/or Torres Strait Islander peoples?

Working scientifically:

- Why are there different methods?
- Which method produced smoke the fastest?
- What is common between the two methods?
- What are the basic materials needed to start a fire?
- Why does the wood need to be dry?
- Where did the heat/smoke come from?
- What did your group change and measure?
- What will your group control to ensure a fair test?
- What data is going to be collected?
- How is the data going to be recorded?
- What forms of energy were used in the fire-making process?

Take it further

Guided investigation

Increase student autonomy and critical thinking in this activity by providing students with the experiment question only. Students brainstorm their own method of investigation, actively considering whether their method will produce fair results.

Suggestions include:

1. Investigating which is the best combination of wood for starting a fire.
    - Use different wood combinations (hard/hard, hard/soft, soft/hard, soft/soft). Ideally, use local wood.
    - If using the hand drill method, an electric drill may be used to rotate the drill stick to improve consistency and reduce blisters.
2. Investigating which tinder is most effective for catching fire.
    - Use different tinder materials (locally sourced is ideal) with an ignition source such as a smouldering coal or piece of wood. Avoid using a match or lighter to ensure a fair comparison of flammability.
    - Tinder options include dry grass, coconut fibre, dry leaves from *Eucalyptus spp*. (sometimes pounded into a powder), dry head of the flower stalk of a grass tree (*Xanthorrhoea spp.*) and dried kangaroo dung.

Refer to 'Optional: Additional materials' section in the Fire-starting equipment list and hazard management document.

Local Indigenous Knowledge

The above experiments/activities ideally start with cultural Knowledge taught by a local Indigenous Knowledge Holder. Schools and Indigenous community members should take the time to learn from each other and plan activities together. Learning on Country and the local Indigenous language should be used whenever possible in the learning program. When connecting with a Knowledge Holder, it is important to listen actively to what they say and demonstrate respect for and value for their Knowledge systems and traditions.

Knowledge Holder links

- Find Indigenous organisations such as Indigenous Ranger programs or cultural land management organisations that use fire to manage Country. Ask local Knowledge Holders if they will share their knowledge of fire with students.
- What local wood is best used to start a fire?
- What fire-starting technique do they use?
- Which material/s make the best tinder?
- How is fire transported as groups of people move across their traditional lands?

Assessment

Evidence that can assist teachers in making professional judgements about a student's progress and achievement of curriculum outcomes can be gathered in a variety of ways during the unit, including:

- Teacher-student discussions
- Observing student participation in the experiment
- Gathering student work samples including oral, written and multimedia
- Assessing students' application and use of knowledge and skills
- Strategic questioning

In the experiments, students may be assessed on their ability to:

- Identify questions and problems that can be scientifically investigated
- Plan and conduct safe investigations
- Identify variables to be changed, controlled and measured
- Collect and record data, including appropriate use of digital technologies
- Analyse data and information
- Identify relationships and draw conclusions
- Apply scientific understanding.

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Contact us

1300 363 400
+61 3 9545 2176
csiro.au/contact
csiro.au

For further information

CSIRO Education and Outreach
1300 363 400
education@csiro.au
csiro.au/education