Heat Proof Water Bowls

UNIT OVERVIEW

Heat Proof Water Bowls is a STEM unit that has been designed to address a real-world problem using the context of responsible animal guardianship (ownership). A problem that is faced by animal guardians (owners) who live in hotter areas is their animal's water sources becoming too hot for the animals to want to drink it during the summer months. To begin the unit, students will develop their understanding of the responsibilities people have with regard to animal guardianship (ownership) and the five freedoms. Students will then work collaboratively, using technological practices and knowledge to design a potential solution to this problem. As they work through this unit towards a potential solution, they will engage with scientific concepts related to heat transfer and the physical properties of different materials. They will also engage with mathematics as they work with measuring and comparing temperatures and graphing their results.

UNIT TIMEFRAME

The suggested learning experiences in this unit of learning are designed to be a starting point and framework for your students' inquiry. Given the open-ended nature of a project that has multiple potential outcomes, you may find your students have other needs that need to be addressed throughout the process to support them to achieve a successful outcome. This is not intended to be a comprehensive unit to be followed prescriptively, as students may go in a variety of directions with this project.

ANIMAL WELFARE ACHIEVEMENT OBJECTIVES

- Gain knowledge and develop understandings of each of the five freedoms.
- Identify and describe the basic needs of a specific animal species.
- Explain the responsibilities that animal guardians (owners) have with regard to caring for their animals.

Australian Curriculum Links

General Capabilities (levels 2 - 4)

It is recommended that you chose 1 or 2 General Capabilities to focus on as you teach the unit. A learning opportunity for each capability has been included as a starting point.

	Element	Learning Opportunity
CRITICAL AND CREATIVE THINKING	**Generating ideas, possibilities and actions** • Imagine possibilities and connect ideas • Consider alternatives • Seek solutions and put ideas into action	Through the design process, students will be provided with opportunities to meet this element. Encourage discussion about how students generated their ideas and what processes they use to seek the most appropriate solutions.
NUMERACY	**Interpreting statistical information** • Interpret data displays	Collect, record and display data collected in a table and graph. Interpret their own graph and the data representations that others have created.
PERSONAL AND SOCIAL CAPABILITY	**Social Management** • Communicate effectively • Work collaboratively • Make decision • Negotiate and resolve conflict	During the design process there is ample opportunity for collaborative work; as this unit progresses, provide opportunity for students to identify skills and characteristics of functional collaboration. Discuss/share/model conflict resolution strategies that students can use during the process.
ETHICAL UNDERSTANDING	**Understanding ethical concepts and issues** • Recognise ethical concepts • Explore ethical concepts in context	Identify the ethical concepts raised throughout the unit of learning. Undertake discussion as students explore the ethics involved.

DESIGN TECHNOLOGIES

YEAR 2

Knowledge and Understanding

- Identify how people design and produce familiar products, services and environments and consider sustainability to meet personal and local community needs
- Explore the characteristics and properties of materials and components that are used to produce designed solutions

Processes and Production Skills

- Explore needs or opportunities for designing, and the technologies needed to realise designed solutions
- Generate, develop and record design ideas through describing, drawing and modelling
- Use materials, components, tools, equipment and techniques to safely make designed solutions
- Use personal preferences to evaluate the success of design ideas, processes and solutions including their care for environment
- Sequence steps for making designed solutions and working collaboratively

YEAR 3 / 4

Knowledge and Understanding

- Investigate the suitability of materials, systems, components, tools and equipment for a range of purposes

Processes and Production Skills

- Critique needs or opportunities for designing and explore and test a variety of materials, components, tools and equipment and the techniques needed to produce designed solutions
- Generate, develop, and communicate design ideas and decisions using appropriate technical terms and graphical representation techniques
- Select and use materials, components, tools, equipment and techniques and use safe work practices to make designed solutions
- Evaluate design ideas, processes and solutions based on criteria for success developed with guidance and including care for the environment
- Plan a sequence of production steps when making designed solutions individually and collaboratively

YEAR 5 / 6

Knowledge and Understanding

- Investigate characteristics and properties of a range of materials, systems, components, tools and equipment and evaluate the impact of their use

Processes and Production Skills

- Critique needs or opportunities for designing, and investigate materials, components, tools, equipment and processes to achieve intended designed solutions
- Generate, develop and communicate design ideas and processes for audiences using appropriate technical terms and graphical representation techniques
- Select appropriate materials, components, tools, equipment and techniques and apply safe procedures to make designed solutions
- Negotiate criteria for success that include sustainability to evaluate design ideas, processes and solutions
- Develop project plans that include consideration of resources when making designed solutions individually and collaboratively

SCIENCE

YEAR 2

Science Understanding

- Different materials can be combined for a particular purpose

Science as a Human Endeavour

- Science involves observing, asking questions about, and describing changes in, objects and events
- People use science in their daily lives, including when caring for their environment and living things

Science Inquiry Skills

- Pose and respond to questions, and make predictions about familiar objects and events
- Use informal measurements to collect and record observations, using digital technologies as appropriate
- Use a range of methods to sort information, including drawings and provided tables and through discussion, compare observations with predictions

YEAR 3 / 4

Science Understanding

- Year 3: Heat can be produced in many ways and can move from one object to another
- Year 3: A change of state between solid and liquid can be caused by adding or removing heat
- Year 4: Natural and processed materials have a range of physical properties that can influence their use

Science as a Human Endeavour

- Science involves making predictions and describing patterns and relationships
- Science knowledge helps people to understand the effect of their actions

Science Inquiry Skills

- With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge
- With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment
- Consider the elements of fair tests and use formal measurements and digital technologies as appropriate, to make and record observations accurately
- Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends
- Compare results with predictions, suggesting possible reasons for findings
- Reflect on investigations, including whether a test was fair or not
- Represent and communicate observations, ideas and findings using formal and informal representations

YEAR 5 / 6

Science Understanding

- Year 5: Solids, liquids and gases have different observable properties and behave in different ways
- Year 6: Changes to materials can be reversible or irreversible

Science as a Human Endeavour

- Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions
- Scientific knowledge is used to solve problems and inform personal and community decisions

Science Inquiry Skills

- With guidance, pose clarifying questions and make predictions about scientific investigations
- Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks

- Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate
- Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate
- Compare data with predictions and use as evidence in developing explanations
- Reflect on and suggest improvements to scientific investigations

MATHS

YEAR 2

Statistics and Probability

- Identify a question of interest based on one categorical variable. Gather data relevant to the question
- Collect, check and classify data
- Create displays of data using lists, table and picture graphs and interpret them

YEAR 3

Statistics and Probability

- Identify questions or issues for categorical variables. Identify data sources and plan methods of data collection and recording
- Collect data, organise into categories and create displays using lists, tables, picture graphs and simple column graphs, with and without the use of digital technologies

YEAR 4

Measurement and Geometry

- Use scaled instruments to measure and compare lengths, masses, capacities and temperatures

Statistics and Probability

- Select and trial methods for data collection, including survey questions and recording sheets
- Construct suitable data displays, with and without the use of digital technologies, from given or collected data. Include tables, column graphs and picture graphs where one picture can represent many data values

YEAR 5

Statistics and Probability

- Pose questions and collect categorical or numerical data by observation or survey
- Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies

RESOURCES AND MATERIALS

SUPPORTING RESOURCES

RSPCA Kids' Portal

Skills Flow Teaching Strategy

12 Infographic Tips

11 Tips for Creating Infographics

40 of the Best Infographics to Inspire You

Canva

IXL Line Graph Questions

Science Learn Heat Energy

CK12 – Thermal Conductors and Insulators

All downloadable resources for the unit

LEARNING EXPERIENCES

1. The Five Freedoms

Learning Intentions

We are learning to. . .

- Gain knowledge and develop understandings of each of the five freedoms.
- Identify and describe the basic needs of an animal.
- Explain the responsibilities that animal guardians (owners) have with regard to caring for their animals.

As this problem has its basis in ensuring animals have their needs met, is important that students have a good understanding of the needs of animals to begin with. The foundation of ensuring that an animal's needs are met are providing them with the five freedoms.

In pairs or threes give students 6 Post-It Notes and ask them to write down one thing on each that an animal needs to have to be healthy and happy. Once students have completed this they will stick their Post-It Notes in a central area where a whole class discussion about everyone's different ideas can take place. Facilitate a discussion to group similar ideas together, for example ideas related to food and water could be grouped.

Once grouped, introduce students to the concept of the five freedoms and explain what these mean. Have students reflect on what five freedoms they covered with the needs they thought of and if there are any they missed.

You can download The Needs of Animals to use in this discussion and to display in the classroom to remind students of what they are.

Students now have a broad understanding of what the five freedoms are. Different animals have different specific needs that need to be catered for in relation to each of the five freedoms. Students will investigate these further for specific animals.

This investigation will be carried out using a Jigsaw type strategy. Organise your class into 5 equal groups (students will need to pair up in unequal groups). This will be their 'home group' and each 'home group' will be assigned one of the five freedoms. Each student within the group will then be assigned an animal – animals can be pre-chosen by the class or the teacher can assign the animals.

Each student will then use the information on RSPCA Kids' Portal to research what the freedom their home group was assigned involves for the animal they were assigned. Therefore, every child in the class is researching something different. You can download the Five Freedoms Research Template for students to record their information on. Once students have completed their research about their assigned freedom, for their assigned animal, the groups will reorganise themselves and they will meet with others who had the same animal as them. This is their 'expert group'. Students will share what they found out about their specific freedom so that everyone as a group can complete the template for all of the five freedoms for that animal.

With their new information students then return to their 'home group'. Everybody in the group takes a turn to share the information they have about their particular animal. Now everyone in the class has learnt about the five freedoms for a range of different animals.

2. Freedom from Hunger and Thirst

Learning Intentions

We are learning to. . .

- Understand why food and water are necessary for animals to stay healthy.
- Understand animals different water consumption needs.

As this problem is based in helping to ensure that animals access to water isn't restricted it links to the freedom from hunger and thirst. Students will learn the scientific reasoning behind why animals, as living things, need food and water to survive and the water needs of different animals.

To communicate this information to students about the importance of food and water for animals, teachers can carry out a skills flow activity.

Instructions for completing a skills flow task can be downloaded from Skills Flow Teaching Strategies. Download Skills Flow – Importance of Food and Water for the necessary text and images.

Following this, students will research the amounts of water that different animals drink in a day. The RSPCA Kids' Portal is a good place for students to begin their research. With their information about why water is crucial for animals' survival and the different amounts of water animals require, students will make an infographic to educate others about why providing animals access to a constant supply of clean, fresh water a critical part of responsible animal guardianship (ownership).

There is a vast selection of infographic examples that can be found through a Google search of infographic examples. Teachers can choose relevant examples to share with their students and discuss their features. For tips on creating infographics, teachers can refer to the following links. These have been provided for teachers to further their own knowledge of infographic design, rather than to share with students, as some content is not relevant for creating infographics at this level.

- 12 Infographic Tips
- 11 Tips for Creating Infographics
- 40 of the Best Infographics to Inspire you

Some tips you may wish to focus on with your students are:

- Using their infographic to tell a story.
- Organising their information in a way that readers will find easy to understand.
- Finding ways to visually represent their information and data that will allow people to quickly process it.
- Limiting the number of different font styles they choose to use.
- Limiting the number of colours they choose to use. They can use varying tones of a couple of colours for effect, rather than choose lots of different colours.
- Making use of white space.
- Ensuring that they cite their research sources.

KeyNote can be used to create infographics on iPads.

Canva can be used to create infographics online.

3. Research And Information Gathering

Learning Intentions

- Define a problem or a need to guide our technological practice.
- Develop a design brief that will describe the intended outcome and the attributes it must have.

Introduce the design process to your students. You can download a copy of The Design Process.

Refer back to the research that has been done around freedom from hunger and thirst and explain that one problem some people face in regard to this is that their animal's water sources get too hot for the animal to find drinkable in hot weather. They have to monitor their animal's water source more carefully to check that they still have constant access to drinkable water. They will be designing a solution that may be able to solve or alleviate this problem.

Following this you can begin to co-construct the design brief with your students. The design brief will be added to and revised as students begin the investigation phase of the design process. Explain to the students that the design brief will be there for them to check against as they move into the process of developing their solutions. They will also use it at end to evaluate their solution.

Some ideas to consider for the design brief:

- Choosing a water bowl/water trough for an animal that would have a problem of it getting too hot.
- It needs to be strong enough so that the animal it is being designed for won't tip it over.
- The material needs to be durable enough to withstand being outside.
- The size needs to be appropriate for the animal it is being designed for.
- It needs to be safe for the animal to drink from i.e. they can't fall in.
- It needs to be easy to clean and to keep clean.

4. What's the problem?

Learning Intentions

We are learning to. . .

- Conduct research to develop our understanding of the context to support us to develop ideas for potential outcomes.

Organise students into the small groups that they will be working with to develop a solution to this problem. Students should be grouped in a such a way that each group has students with diverse areas of strength that they can contribute to the team.

Students can begin their research into this problem individually and then share their findings with their group.

Some information that can be found through internet research will give students information about how people already try to combat this problem. This will support them in being able to start thinking about designing their own solutions.

At this stage, students can also begin keeping a record of their progress. You can download the Log Book for your students to use, which will track their progress throughout the design process, or you can use your own form of recording.

If possible, students should gain some stakeholder feedback on this issue as part of their research. Students may be able to find members of their community who have experienced this problem to discuss it with. They may also be able to speak with someone from an organisation that makes animal water source products to discuss water bowls and troughs that are already on the market. This could be carried out via a Skype interview, emailing them or inviting them to come and speak to the class.

After this research has been conducted it may be a good time to revisit the design brief now that students have a wider understanding of the problem. They may have suggestions of key attributes that they hadn't been aware of before.

Learning Experience 5 and 6 are designed to be used flexibly by teachers. A series of activities has been suggested to help introduce important scientific and mathematical concepts that will support students to be successful in developing their solutions. Determine your student's level of prior knowledge of these concepts to decide whether these need to be used in full and/or whether further instruction needs to be provided beyond these.

5. Investigation: Temperatures and Graphs

Learning Intentions

We are learning to. . .

- Recognise the need for a standard unit of temperature.
- Measure temperature (degrees Celsius) using a thermometer.
- Calculate changes in temperature.
- Display time series data using the appropriate graph.
- Interpret and make statements about data shown in a graph.

Have students share their ideas around why people need to measure temperature and how they measure temperature.

If temperature is a completely new concept for your students give them time to explore different thermometers and temperature.

Give students opportunity to measure, record and compare different temperatures with a thermometer. You can download the What is the Temperature? sheet and set up the relevant items for students to measure the temperatures of.

Students will be recording their time series data using line graphs. Show students the Kitten Growth – First 8 Weeks and have them Think-Pair-Share what things they notice about the graph.

Scaffold students as necessary to work through IXL's questions to practice interpreting line graphs.

If students need further practice with either temperature or line graphs before applying these concepts in the next activity, you can provide further activities to consolidate this learning.

6. Investigation: Insulator or Conductor

Learning Intentions

We are learning to. . .

- Describe what heat energy is and how it is transferred.
- Explain what a thermal insulator is.
- Explain what a thermal conductor is.
- Investigate and compare the effect of different materials on temperature.
- Explain why different materials are used for specific purposes.

Introduce students to the concept of energy and heat energy. Refer to Science Learn - Heat Energy for further information.

Link back to the problem – when the air temperature is hotter than the water and water bowl/trough, the water and the water bowl/trough will gain heat energy.

Ask the students to think about whether they think that heat energy can move in the same way through all materials. Have students line up down the middle of the classroom. The teacher will then list a variety of materials that are either thermal insulators or thermal conductors. Students will determine whether they think the material allows heat energy to pass through easily or not. They will step forwards if they think heat will move through it easily and backwards if they think it won't. You could select children to justify their reasoning with reference to examples – example, someone might be sure that metal is a thermal conductor because you need to use a tea towel to lift off a pot lid with a metal handle. Build on this discussion to introduce students to vocabulary thermal insulators and thermal conductors, if it has not already been said by students. Refer to CK12 - Thermal Conductors and Insulators for further information and videos.

Students will now be given the opportunity to investigate the transfer of heat energy and thermal insulators and conductors themselves, with the groups that they will be designing their solution with. You can either facilitate the following experiment or allow students to derive their own experiment to test the thermal conductivity of a variety of materials.

7. Developing Solutions

Learning Intentions

We are learning to. . .

- Find evidence to support our ideas.
- Ask questions and carry out experiments to develop explanations.
- Explain the connection between our scientific knowledge and the problem we are trying to address.
- Use our scientific knowledge to help us make decisions when developing our solutions.
- Use the design brief and the information that we have collected to develop potential solutions in response to the problem.

Provide the groups with containers made of a variety of materials (metal, plastic, ceramic, double walled, rubber, wood, something wrapped in fabric, etc.). Students can make a hypothesis about which of the materials will keep a cup of water coolest for the longest period of time. Pour the same amount of cold water into each of these containers. Depending on the availability of containers, this may be an opportunity to discuss fair testing with the students with regard to the size, shape and volumes of the various containers. Place the containers in a warm spot. Students can then measure the temperature of the water in each at timed intervals. This data can be recorded and graphed. It may be beneficial to graph all materials on the same axes so that students can compare that temperature increases of each of the materials.

You could extend on this experiment by investigating what differences there are if a larger or smaller surface area of the water is exposed and not covered by the material. You could also extend on this experiment by investigating whether the colour of the material used impacts on how long the water stays cool for. Encourage students to ask their own questions that they could test that will be relevant in developing the scientific knowledge they will use to develop their solutions.

At this stage the students should consider and record all ideas for potential solutions to this problem as they will refine these in the next step of the process.

Ideas can be recorded in their Log Book.

8. Choosing a Solution

Learning Intentions

We are learning to. . .

- Reflect on and evaluate our ideas in relation to the design brief.
- Choose and justify an appropriate solution for the problem.
- Develop a plan and identify the resources needed to produce an outcome.

Before students choose their solution this may be another useful time to revisit the design brief. After looking at some of their potential solutions from the previous activity you may realise that some further specifications may need to be put in place around the cost and feasibility of designs, if these have not been addressed already.

At this stage, students may also want to carry out further experiments to test the effectiveness of various other methods they may have found as part of their research.

With the design brief available to them, students will now work together as a group to choose the solution they want to pursue.

Some of the following question prompts may be useful when conferencing with your students about their solution to help them think critically and think about why they believe their idea is an appropriate solution:

- What are the advantages of your chosen solution over the other ideas you brainstormed?
- Are there any disadvantages of your chosen solution? How could you reduce these?
- Does your proposed solution meet all aspects of the design brief?
- What different opinions did people in the group have? How were these resolved and taken into consideration?

Students will also develop a plan to help them structure the time that they will have to work on creating their prototypes. Explain to students that these will most likely end up being adapted once they begin due to unexpected challenges but that they still need to have a plan in place before they begin.

9. Models and Prototypes

Learning Intentions

We are learning to. . .

- Create a prototype of our solution using our plan.
- Evaluate the prototype throughout the process of creating it to further refine the outcome.
- Revisit our plan when creating the prototype and record any necessary changes and their consequences.

Students will now engage in the process of designing a prototype.

Students may need time during this process to go back to an earlier stage if they encounter unexpected challenges. For example, students may realise that the way they had planned to attach different components of their water bowl/water trough together are not strong enough and they need to go back and conduct some research on more suitable adhesives.

There is space in the Log Book for them to record what they have achieved each session, what challenges they faced and what actions they need to take to try and overcome that challenge. This section also requires them to reflect on how their team is working together to promote students to be conscious of how to work effectively with others.

10. Testing and Evaluation

Learning Intentions

We are learning to. . .

- Test and evaluate the effectiveness of our solution to the problem against the key attributes in the design brief.

Students can now test their water bowl/water trough prototypes to determine their ability to keep water from heating up to a temperature that is too high for animals to drink from.

If it is possible, depending on your location and the time of year, allow students to test their water bowls/water troughs outside and measure the temperature changes over a period of time.

They can then graph their results and compare the rate the temperature rose with a control container of water.

If it is not possible to test their prototypes in an authentic setting, try to find a way they can be tested in a hot environment such as a heated room. They can then graph their results and compare the rate the temperature rose with a control container of water.

Provide students with a copy of the design brief. They will then go through each of the criteria on it to determine if their water bowl/ water trough has met the criteria. The Log Book also contains some reflection questions.