

Intended Use of Resources

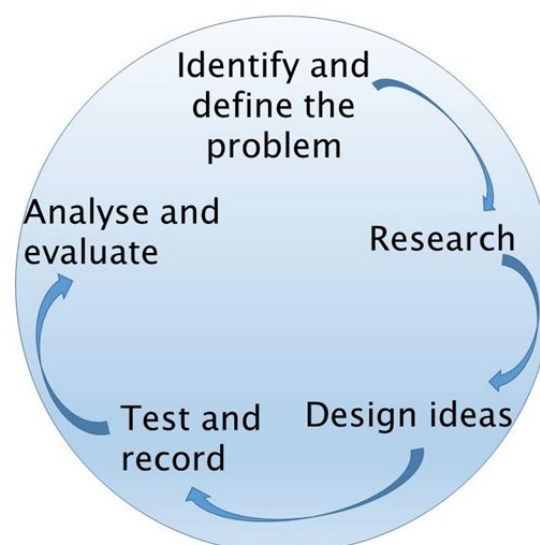
This project has been designed so that teachers from different STEM areas can pick and choose sections relevant to their subject area to work on. All activities in this package do not need to be completed to get value from the package – each activity can be completed as a stand-alone or can be approached, as a team, as a larger project. The package has potential to be extended into a much longer project to include curriculum points from different STEM subjects.

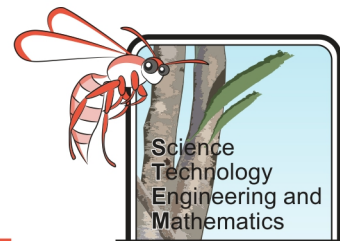
There are three **student workbooks** - **Open, Guided and Scaffolded**, that go alongside this resource; all have the same suggestions for activities, however, they have been written and edited to provide differentiated learning options to support good teaching practice. Teachers may pick and choose which versions they give which students and may wish to edit them further to address their learning needs. Due to the differentiation of the workbooks, the **Open** activities will enable more syllabus links to be addressed, which is why each activity has its own syllabus links key. However, if you wish to give a truly open-ended investigation then you could just give the students the challenge and background information section of the Student Booklet.

The Woodside Australian Science Project (WASP) STEM resources aim to be accessible and supportive for teachers and students, please contact us if you have questions, feedback, require assistance or would like to arrange an incursion or a professional development workshop - www.wasp.edu.au.

The Student Challenge

A school has decided to build a new Science, Technology, Engineering and Mathematics (STEM) facility and has asked students for design ideas. They hope the building will be environmentally friendly and cost effective.





Background Information

A passive building is one that requires minimal energy input but maintains a comfortable temperature year-round. There are a few important things which must be considered when designing a passive building. These include its orientation, shading, insulation, seals, windows, and the building materials used. Many councils will either send someone out to you or can send you equipment you can use to take measurements at different locations in your building to determine how passive and energy efficient it is. This will involve taking measurements at different times of the day and in different locations around the building, as well as completing a building inspection to look at the different materials used. The more passive the building the more energy efficient it is, this means that less energy is needed for heating, cooling and lighting. A passive design is desirable as, not only does it greatly reduce electricity and gas bills, it is better for the environment.

Activities

This booklet contains extra information on each activity, including syllabus links the overall activity objective, suggestions for recommended equipment or alternative ways to run investigations as well as useful resources and website links*.

The syllabus links have been colour coded. These links to the Australian Curriculum are also relevant to the Western Australian Syllabus. – Please see the colour key below:

Covered in Scaffolded, Guided and Open Student Booklet

Covered in Guided and Open Student Booklet

Covered in Open Student Booklet

Italics – WA syllabus for DT and D and T

List of activities

[Background Research](#)

[Investigating Insulation](#)

[Testing the Thermal Mass](#)

[Investigating Colour](#)

[Open Plan Investigation](#)

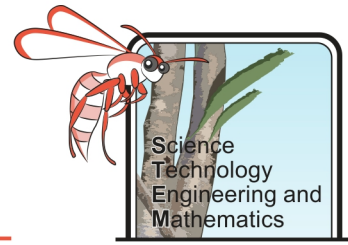
[Investigating the Effectiveness of Eaves](#)

[Critique of a Building](#)

[Design a Passive Building](#)

**Please note that any reference websites provided were accessed in January 2019 therefore these addresses may have changed slightly. We would be grateful if you could let us know if these sites are no longer accessible.*

Designing a Passive Building - Teacher Resource



Background Research

Objective

Students will gain a general understanding of the key factors which will affect how passive a building is. They will learn about how the path of the Sun changes with the seasons, as well as appearing different depending on the hemisphere you are in. Students will learn key words relating to passive design.

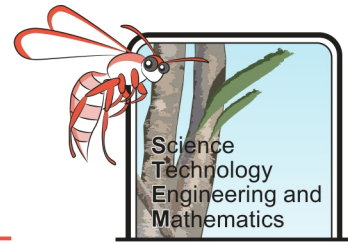
The background questions should lead them to start thinking about further investigations they could do to find out more about passive design. They are “teaser” questions about which students will be able to find out more through the other activities. Therefore, if you do not have time to complete all the activities you may wish to add to the background questions.

Students will find that in Australia houses are designed with most of the larger windows on the north side of the house (north facing) as this enables more light to enter, as opposed to in the northern hemisphere where they would place larger windows on south facing sides.

Australian Syllabus Links	
Science	ACSSU115 Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon.
Technologies	ACTDEK029 Investigate the ways in which products, services and environments evolve locally, regionally and globally and how competing factors including social, ethical and sustainability considerations are prioritised in the development of technologies and designed solutions for preferred futures.

Useful resources and websites:

- An Australian Government website outlining a large number of design features of passive design: <http://yourhome.gov.au/passive-design>



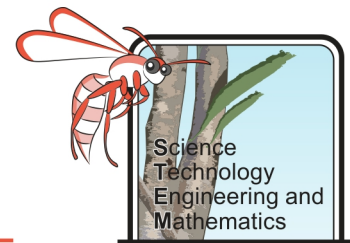
Investigating Insulation

Objective

Students complete an investigation to compare how effective different materials are as insulators. This is then discussed in relation to building design. Students focus on the scientific method and evaluating their own investigations. It is recommended that students use cold water and determine how much the water heats up over time, this is opposed to using hot water and letting it cool, for safety purposes. Suggested materials include wool, straw, polystyrene, bubble wrap and cotton wool.

Australian Syllabus Links	
Science	<p>ACSIS125 Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed</p> <p>ACSIS126 Measure and control variables, select equipment appropriate to the task and collect data with accuracy</p> <p>ACSIS130 Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence.</p> <p>ACSIS131 Reflect on Scientific investigations including evaluating the quality of the data collected, and identifying improvements</p>
Technologies	<p>WATPPS41 Design, develop, review and communicate design ideas, plans and processes within a given context, using a range of techniques, appropriate technical terms and technology.</p> <p>WATPPS42 Follow a plan designed to solve a problem, using a sequence of steps</p> <p>WATPPS44 Independently apply given contextual criteria to evaluate design processes and solutions.</p>

Designing a Passive Building - Teacher Resource



Testing Thermal Mass

Objective

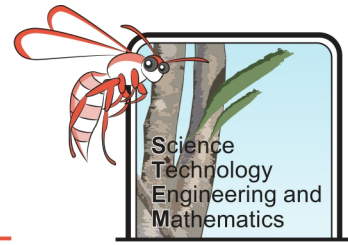
Students will test different materials to determine which has the highest thermal mass and relate their findings to passive house design.

Students will evaluate the investigation and discuss if their investigation was a fair test and consider areas of improvement. They will become familiar with key terms.

This investigation could also be carried out by heating building materials and putting them in water and seeing how long it takes the temperature to rise a certain amount. However, this is a bit trickier to conduct as it would require small samples of building material and heating them up could be dangerous. Scientifically thermal mass is the same as specific heat capacity, if your school has a range of materials which it uses to test specific heat capacity (this is covered in Year 11 WACE Physics) you could test those materials.

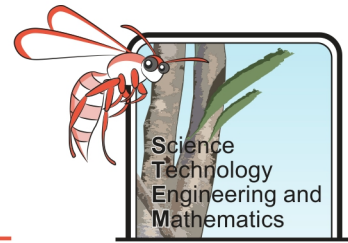
Australian Syllabus Links	
Science	<p>AC SIS125 Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed</p> <p>AC SIS126 Measure and control variables, select equipment appropriate to the task and collect data with accuracy</p> <p>AC SIS130 Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence.</p> <p>AC SIS131 Reflect on Scientific investigations including evaluating the quality of the data collected, and identifying improvements</p>
Technologies	<p>WATPPS41 Design, develop, review and communicate design ideas, plans and processes within a given context, using a range of techniques, appropriate technical terms and technology.</p> <p>WATPPS42 Follow a plan designed to solve a problem, using a sequence of steps</p> <p>WATPPS44 Independently apply given contextual criteria to evaluate design processes and solutions.</p> <p>ACTDEK034 Material and technology decisions and processes influence the selection and combination of materials, systems, components, tools and equipment.</p>

Designing a Passive Building - Teacher Resource



Useful websites

- Explanation of thermal mass and how different materials vary along with a table of thermal mass for building materials:
<http://yourhome.gov.au/passive-design/thermal-mass>



Investigating Colour

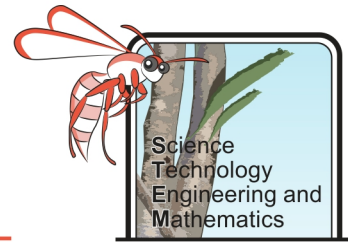
Objective

Students carry out an investigation to determine the effect of colour on temperature increase of a material. This investigation can be completed using very basic equipment (just three tin cans and thermometers) or can be made more accurate by using closed top thermometers and temperature probes. Students can graph their results to look at the changes in temperature over time and to gain experience drawing line graphs with more than one piece of information on it.

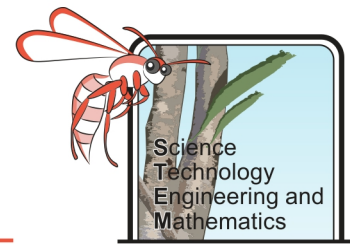
The time suggested is a recommendation so that enough data points are given to plot a graph, however if very little change has been observed the students can spend more time collecting data. Students should find that the black can/test tube has the largest temperature change and the silver has the smallest temperature change. Other colours can be tested as well – students might want to test colours that are more commonly used for bricks, for example.

	Australian Syllabus Links
Science	<p>AC SIS125 Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed</p> <p>AC SIS126 Measure and control variables, select equipment appropriate to the task and collect data with accuracy</p> <p>AC SIS130 Summarise data, from students’ own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence.</p> <p>AC SIS131 Reflect on Scientific investigations including evaluating the quality of the data collected, and identifying improvements</p>
Technologies	<p>WAT PPS41 Design, develop, review and communicate design ideas, plans and processes within a given context, using a range of techniques, appropriate technical terms and technology.</p> <p>WAT PPS42 Follow a plan designed to solve a problem, using a sequence of steps</p> <p>WAT PPS44 Independently apply given contextual criteria to evaluate design processes and solutions.</p> <p>ACT DEK034 Material and technology decisions and processes influence the selection and combination of materials, systems, components, tools and equipment.</p>

Designing a Passive Building - Teacher Resource



Australian Syllabus Links	
Mathematics	ACMSP169 Identify and investigate issues involving numerical data collected from primary and secondary sources.



Open Plan Investigation

Objective

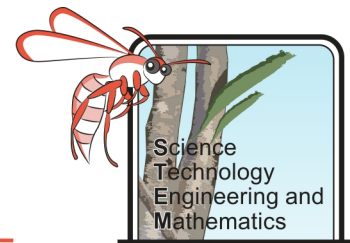
Students will determine if open plan living design affects heat flow through a house and discuss which house design is preferable for a passive house.

In this investigation students use model houses to test the difference in heat in an open plan space compared to the temperature in a house with 4 rooms. They should find that the house with four rooms has two extremes where the rooms close to the heat source get much hotter than the rooms further from the heat source. Whereas with open plan design the whole area gets quite hot as the air can circulate through.

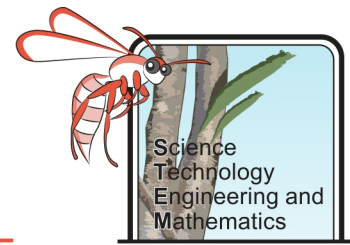
This highlights the importance of orientation for a passively designed house. In the southern hemisphere it is recommended that houses are north facing, meaning that the main living areas are on the north side of the property. This will mean that in winter they are heated by the Sun but in summer they will not get as much direct light.

However, it is important to note that having smaller rooms instead of open plan allows more control of heating within a house. It means if the front rooms are hot and the back rooms are not, only the smaller front rooms will need air-conditioning to cool them, as opposed to an open plan design, where the entire space will need to be cooled.

Designing a Passive Building - Teacher Resource



Australian Syllabus Links	
Science	<p>ACSIS125 Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed</p> <p>ACSIS126 Measure and control variables, select equipment appropriate to the task and collect data with accuracy</p> <p>ACSIS130 Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence.</p> <p>ACSIS131 Reflect on Scientific investigations including evaluating the quality of the data collected, and identifying improvements</p>
Technologies	<p>WATPPS41 Design, develop, review and communicate design ideas, plans and processes within a given context, using a range of techniques, appropriate technical terms and technology.</p> <p>WATPPS42 Follow a plan designed to solve a problem, using a sequence of steps</p> <p>WATPPS44 Independently apply given contextual criteria to evaluate design processes and solutions.</p> <p>ACTDEK034 Material and technology decisions and processes influence the selection and combination of materials, systems, components, tools and equipment.</p>
Mathematics	<p>ACMSP169 Identify and investigate issues involving numerical data collected from primary and secondary sources.</p>



Investigating the Effectiveness of Eaves

Objective

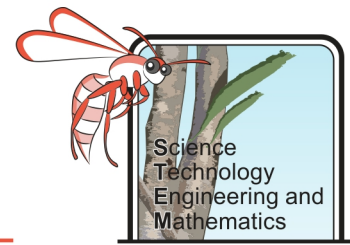
Students will investigate how effective eaves are at shading windows from the Sun.

Students use a model house (they may have to build one first) and use a light meter to measure how much light enters the house in the summer when the Sun is high in the sky, compared to how much light enters the house when the Sun is low in the sky.

Students should find that the lower the Sun is in the sky, the more light the windows receive. This is useful to passive design as the Sun is lower in the sky in winter, so receiving that sunlight helps to warm up the house. The Sun is high in the sky in summer, this is when the eaves block more sunlight, thus helping to keep the house cool.

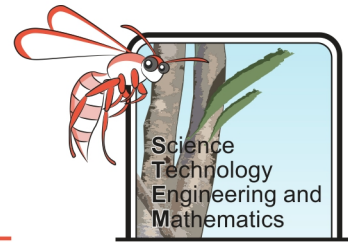
Students can further this investigation by changing the length and slope of the eaves, as well as testing different material types, such as shade sail material etc.

Designing a Passive Building - Teacher Resource



Australian Syllabus Links	
Science	<p>AC SIS125 Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed</p> <p>AC SIS126 Measure and control variables, select equipment appropriate to the task and collect data with accuracy</p> <p>AC SIS130 Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence.</p> <p>AC SIS131 Reflect on Scientific investigations including evaluating the quality of the data collected, and identifying improvements</p> <p>AC SSU115 Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and moon.</p>
Technologies	<p>WATPPS41 Design, develop, review and communicate design ideas, plans and processes within a given context, using a range of techniques, appropriate technical terms and technology.</p> <p>WATPPS42 Follow a plan designed to solve a problem, using a sequence of steps</p>
Mathematics	<p>AC MSP169 Identify and investigate issues involving numerical data collected from primary and secondary sources.</p>

Designing a Passive Building - Teacher Resource



Critique of a Building

Objective

Students will review the school buildings and discuss how well designed they are as passive buildings, they will give recommendations on how they may be made more passive.

Students may critique one or many buildings, using their knowledge from previous investigations. They should use a checklist to make notes on a particular building in the school or the school as a whole.

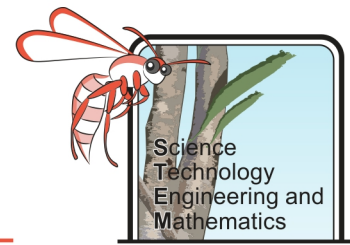
This activity can be carried out in groups or individually and will require the students to go outside to look at the building design.

By completing this activity, they will understand the key features of a passive building and will be much more prepared to design their own passive house.

Students may want to use equipment such as light meters and temperature probes to get some accurate readings.

	Australian Syllabus Links
Science	ACSIS133 Communicate ideas, findings and evidence-based solutions to problems using scientific language, and representations, using digital technologies as appropriate.
Technologies	WATPPS40 Consider components/ resources to develop solutions, identifying constraints. WATPPS41 Design, develop, review and communicate design ideas, plans and processes within a given context, using a range of techniques, appropriate technical terms and technology. WATPPS44 Independently apply given contextual criteria to evaluate design processes and solutions. ACTDEK034 Material and technology decisions and processes influence the selection and combination of materials, systems, components, tools and equipment.

Designing a Passive Building - Teacher Resource



Design a Passive Building

Objective

Students use their findings from previous investigations to design a passive building. They may use their suggestions for improvement from the critique of a building investigation to ensure their building is well designed.

This activity can be done in a number of ways, students could build model houses with a range of materials, they could design a building using Computer Aided Design (CAD) or draw their designs by hand and add annotations to explain features.

	Australian Syllabus Links
Science	<p>AC SIS131 Reflect on Scientific investigations including evaluating the quality of the data collected, and identifying improvements</p> <p>AC SIS132 Use scientific knowledge and findings from investigations to evaluate claims based on evidence.</p> <p>AC TDEK029 Competing factors, including social, ethical and sustainability considerations, in the development of technologies.</p>
Technologies	<p>WATPPS41 Design, develop, review and communicate design ideas, plans and processes within a given context, using a range of techniques, appropriate technical terms and technology.</p> <p>WATPPS44 Independently apply given contextual criteria to evaluate design processes and solutions.</p> <p>AC TDEK034 Material and technology decisions and processes influence the selection and combination of materials, systems, components, tools and equipment.</p>
Mathematics	<p>AC M MG16 Draw different views of prisms and solids formed from combinations of prisms.</p>