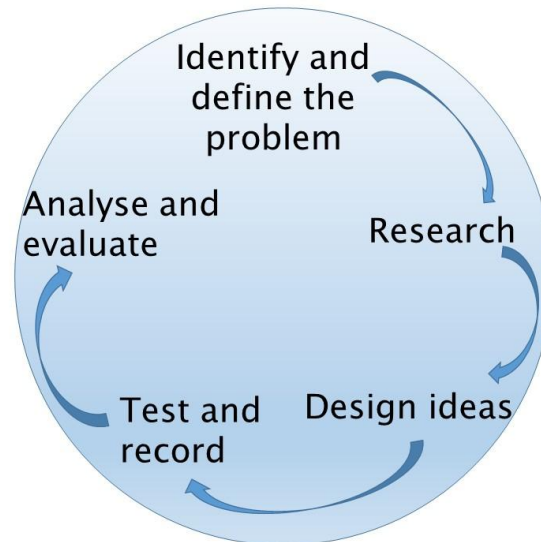


The Challenge

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.

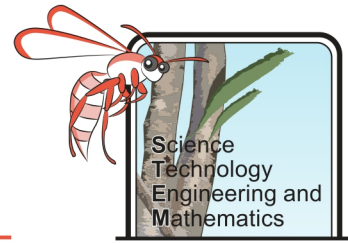


Background Information

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.

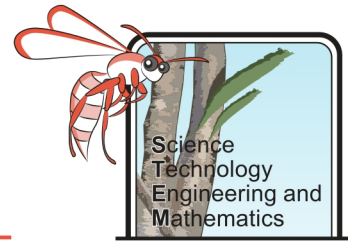
The more passive the building the more energy efficient it is, this means that less energy is needed for heating, cooling and lighting. A passive design is desirable as, not only does it greatly reduce electricity and gas bills, it is better for the environment.

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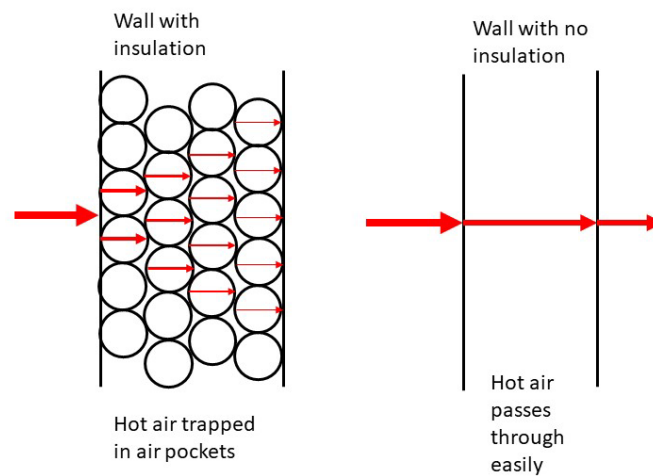
Background Research

1. Draw a labelled diagram to show how the orientation of a building might be different in the northern hemisphere as compared to the southern hemisphere.
2. Explain the difference between a material with high thermal mass and a material with low thermal mass, using examples.
3. Outline various ways of shading a building. Draw diagrams to show how they work.
4. Draw a diagram to explain why deciduous trees are favourable in passive design.
5. What are the advantages and disadvantages of having lots of windows on a building?
6. Use diagrams to compare double glazing to single glazing and add notes to explain how double-glazing works.
7. Summarise the major principles of passive design.



Investigating Insulation

Most buildings have insulation in their roofs, and some will even have insulation in their walls. Insulation traps hot air which means less heat is lost to the outside in winter, and heat cannot enter in the summer. This helps to keep the building at a desirable temperature all year round, without having to use heating or air conditioning. There are many different types of insulation, natural and man-made, such as sheep's wool, polystyrene, expansion foam and wool fibre.



Objective:

To design and investigate the efficiency of different types of insulation.

Equipment and Method

Detail how you will conduct this investigation, outlining an equipment list and method. Ensure you have stated your independent, dependant and controlled variables and explained how you will take measurements. Show this to your teacher before conducting your investigation.

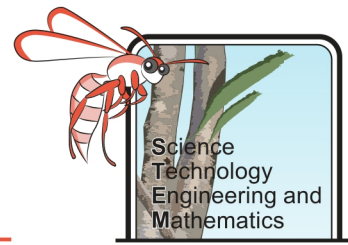
Results and Analysis

1. Display your results in an appropriate manner.
2. Which material was the most efficient insulator?
3. Which material was the least efficient at insulating?

Evaluation

1. What steps did you take to ensure you conducted fair test?
2. What improvements could be made to the test? (Explain why these improvements would make the investigation better).
3. What kind of jobs might require you to know about different types of insulation and who might find this information important?

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Investigating Thermal Mass

Objective:

To plan and conduct an investigation to determine which building material has the highest thermal mass.

Materials

- A range of building materials e.g. brick, tiles, concrete, slate, glass, wood
- Ice cubes
- Stopwatch
- 1 x 500ml beaker for each material
- Hot water source

Method

Using the equipment listed above, and/or other equipment, write a step-by-step method to determine which material has the highest thermal mass. Ensure you take into consideration any safety precautions. Ensure you state what your dependant, independent and controlled variables are. Show your method to your teachers and gain their approval before conducting the investigation.

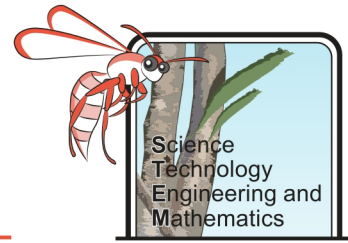
Results and Analysis

1. Create a table with your results.
2. Use a graph to represent your results.
3. Which material had the highest thermal mass? Explain your answer.
4. Which material had the lowest thermal mass? Explain your answer.
5. Which material would be best to use to ensure passive design?

Evaluation

1. What steps did you take to ensure you conducted a fair test?
2. What changes could you make to your investigation to improve it?
3. What kind of jobs might require you to know about thermal mass and why would this information be useful?

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Investigating Colour

The colour of a building can impact how much warmth it absorbs. In Australia, because it is generally so hot, it is more desirable for a building to reflect solar radiation.

Objective

To plan and conduct an investigation to investigate the impact of colour on how quickly a material heats up.

Materials

- Test tubes/tin cans painted different colours (black, white and silver)
- Test tube rack
- Thermometers or temperature probes
- Bungs/can lids with holes in them
- Heat lamp/Sun

Method

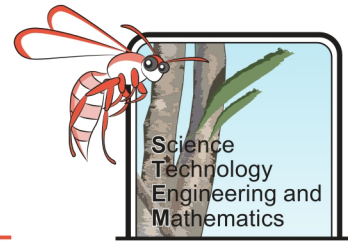
Using the equipment listed above, and/or other equipment, write a step-by-step method for an investigation to determine which colour absorbs the most heat. Ensure you take into consideration any safety precautions. Make sure you state what your dependent, independent and controlled variables will be. Show your method to your teacher and gain their approval before conducting the investigation.

Results and analysis

1. Which test tube had the largest change in temperature?
2. Which test tube showed the smallest change in temperature?
3. What colour would you recommend painting your house to ensure a passive design – explain your answer?

Evaluation

1. Was your experiment a fair test? Explain your answer.
2. What improvements would you make to your investigation?
3. Other than in the building trade, who else could find this information useful for their job? Explain your answer.



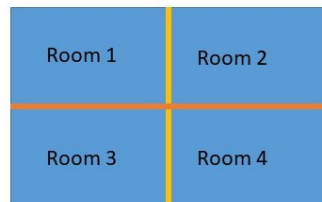
Open Plan Investigation

Objective

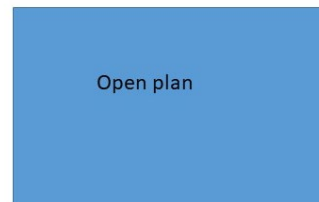
To design and conduct an investigation to determine if having an open plan design affects how passive a building is.

Equipment

- 2 x cardboard boxes the same size
- 5 x thermometers
- Heat lamp
- Extra cardboard
- Scissors



Heat lamp



Heat lamp

Method

Using the equipment listed above, and/or other equipment, write a step-by-step method for an investigation to determine if open plan design affects how passive a house is. Ensure you take into consideration any safety precautions you will take. Show your method to your teacher and gain their approval before conducting the investigation.

What is the independent variable for this investigation?

What is the dependent variable for this investigation?

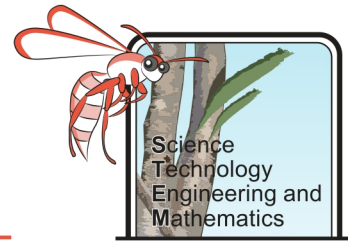
What variables do you have to keep the same for this investigation?

Results and analysis

Record your results in a table.

1. Which room(s) had the smallest change in temperature, and how much was the change?
2. Which room(s) had the largest change in temperature and how much was the change?

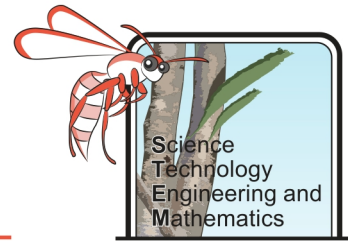
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3. Overall would you recommend more open plan spaces or smaller rooms if you were designing a passive building? You should consider the need for heating and cooling, as well as think about lighting.

Evaluation

1. Was this a fair test? Explain your answer.
2. What improvements could you make to this investigation?



Investigating the Effectiveness of Eaves

On most buildings the roofs continue past the edge of the walls of the house. The area of roof from the perimeter of the house to its edge is called an eave. Eaves create shaded areas below them and provide some protection from rain.

Objective

Design an investigation to examine the effectiveness of eaves as a means of shading of a building.

Suggested equipment

- Model house with eaves and window and one without eaves (Can be made from cardboard, lego etc)
- Light meter
- Bright bulb/torch
- Meter rule
- Retort stand, clamp and boss head

Method

Write a step-by- step method which will allow you to compare the effect of eaves versus no eaves on a building in both summer and winter. Ensure you take into consideration any safety precautions you will take. Show your method to your teacher and gain their approval before conducting the investigation.

What is the independent variable for this investigation?

What is the dependant variable for this investigation?

What variables do you have to keep the same for this investigation?

Results and Analysis

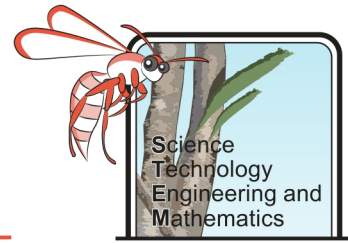
Record your results in a table.

1. Were the eaves effective at blocking out sunlight? Use your data to back up your answer.
2. What was the difference between the amount of light that was received in the winter compared to the summer?

Evaluation

1. What were the strengths and weaknesses of this investigation?
2. How could you improve the investigation to make it truer to the real world?
3. Who might find this information useful for their work?

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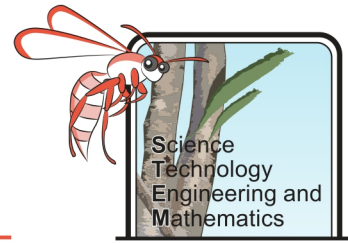
Critique of a Building

Objective

To critique the design of an existing building and suggest areas for improvement to make it a more passive design.

1. Chose a building in your school which you can complete an environmental assessment of. Create a “critique table” to discuss the strengths and weaknesses of all the main design areas used in a passive building.
2. Take photos which will help support your report, for example of the eaves, showing the colour of the building, which way the windows are facing etc.
3. Make recommendations on how the building could be changed to make it more passive.

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Design a Passive Building

Objective:

To design a passive building, explaining how each design feature enables it to be energy efficient.

You can complete this as a report with sketches and photos or create a model. It is vital that you can **explain** your design features to the design panel to assist with the design of the new STEM building.