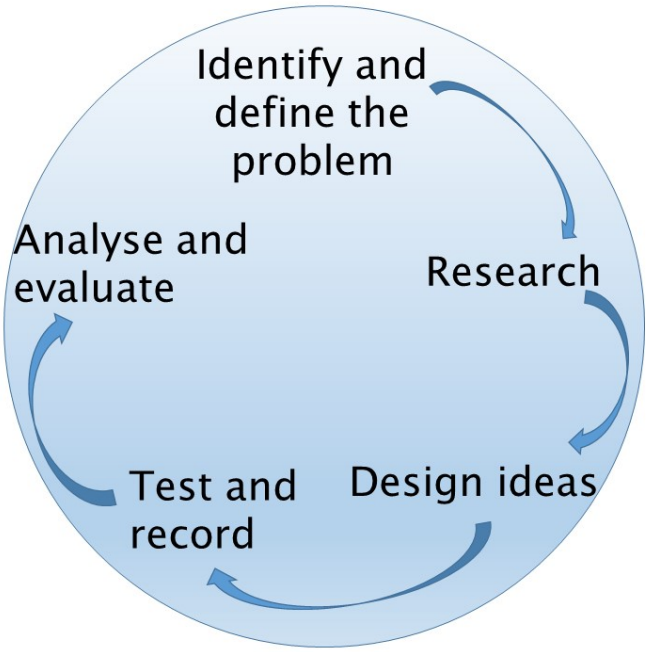
Chopping on Rock – Student Booklet

The Challenge

You are moving house and your parents have decided that they would like some new equipment for the kitchen. They would like to keep it modern and stylish, but also practical. In particular they would like a new chopping board, as they are sick of the flimsy plastic one they have been using. You have decided for their anniversary you would like to have one made for them, and have taken on the challenge of designing it yourself.



Background Information

Some of the earliest tools ever used by humans were those intended for food preparation; chopping, grinding and tenderising have always been important techniques in the kitchen. The simple chopping board, is actually anything but – and can be designed for multi-purpose use, for example a heat mat and chopping board combined. New designs are still entering the market, with developments to make them more user friendly, or convenient for storage and cleaning.

One of the most important aspects of a chopping board is that it is food safe. Chopping boards need to be able to be cleaned easily and effectively, so that they do not harbour any bacteria. It is vital that their surface is not too absorbent. This will also prevent bad smells as well as staining.

Personalised chopping boards have become very popular in the past few years, especially as house warming, wedding and anniversary gifts. Often they are made with engravings including names or dates. For "foodies" they might include words suggesting what to place where on them, such as cheese names.

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There is a wide array of materials that are used for chopping boards, and it is important that they have been tested properly to ensure that they can withstand everyday use, as well as any accidental knocks or bumps that might occur. Chopping boards need to be durable, reliable, cost effective and convenient.

Figure 1. Slate cheese platter. (Acabashi, 2017)

Figure 2. Your new kitchen (pixabay, 2015)

Suggested Background Research Questions

- What are possible materials for a chopping board?
- What dimensions would be practical for a chopping board?
- Which materials are most sustainable?
- What are the most important features and functions of a chopping board?
- What will go well with the kitchen?

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Investigation: Density of Different Materials

Figure 3. Archimedes reportedly cried "Eureka! Eureka!" after he stepped into a bath and noticed the water level rising. He realised that the volume of water displaced must be equal to his volume. (Arlindi, 1999)

Objective

Design an experiment to determine the density of different materials and consider which materials are most suitable for their intended use.

Useful links: video on how to measure the volume of an irregular shape:
https://www.youtube.com/watch?v=e0geXKxeTn4

Method

1. Research how to calculate density
2. Brainstorm methods you could use to find the volume of solids.
3. Create a method for your investigation, including how you will ensure it is conducted safely, add diagrams to show the set up.
4. Create a table to record data collected from your experiments. What data will you need to collect? How will you collect the data?
5. Show your method and data collection table to your teacher before carrying out the investigation.

Extension

Some materials may be buoyant. What does buoyant mean?

Can you think of a way a solid can behave like a fluid (it can be poured and will fill the container it enters)? Hint, think about the size of the solid.

Can you come up with a method to find the volume of an irregular shape that would float in water?

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Results and Analysis

1. Record your data in the table you have prepared.
2. List the samples in order from lowest density to highest density.
3. Estimate what the usual dimensions for a chopping board are? (length, breadth, height)
4. Calculate what the mass of a board that size would be for each sample material, by re-arranging your formula for density and using the densities you previously determined.
5. Will any of the boards be so heavy that they become impractical, if so which ones? Support your answer with data, and an explanation why you feel it would be impractical.

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Investigation: Shaking Up the Style

Objective

A rectangular chopping board might be a bit boring, how about making a chopping board a different shape?

Method

Set up an excel spreadsheet to input formula which will allow you to calculate the **area, volume and mass** of different designs using densities of materials you have previously calculated (or that you have researched).

Suggested shapes to investigate:

- Triangles
- Circles and semi-circles
- Rhombuses
- Parallelograms
- Trapeziums
- Kites

Suggested materials:

- Slate
- Marble
- Granite
- Pumice

Ensure that you draw, either by hand or using CAD software, scale drawings of each of your designs.

Evaluation

1. Which design was the heaviest?
2. Were any of the designs impractical in terms of storage/weight or for some other reason?
3. Which shape and material do you think would be best for your chopping board design? Explain why, using your data and drawings to justify your reasoning.

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Investigation: Durability of Materials

Figure 4. Testing the durability of materials for knocks and blows needn't be this hard! (wikipedia, 2016)

Objective

Design an investigation to determine the durability of different materials, and conclude which materials will be most suitable for use as a chopping board.

Method

Design a method to test the durability of a variety of materials that could be used to produce a chopping board. Consider how the chopping board will be used – including frequency of use. Think about how much force it will be subjected to, including any accidental knocks and bumps.

Brainstorm ideas on how you can test these everyday forces on the materials, ensuring that it will be a fair test. How will you record results?

What will the independent variable be? What is the dependent variable? How will you control all other variables to ensure a fair test?

How will you conduct the investigation safely?

Add diagrams to show the set-up and a table to record your results. Show these to your teacher before carrying out the investigation.

Results and Analysis

1. Present your results in a suitable format.
2. Were there any materials which did not stand up to the test?
3. Did any materials complete the test unaltered?
4. Which materials will be most suitable for the intended design in relation to durability?
5. Evaluate your method of testing, was it fair? What worked well and how could it be improved?

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Investigation: Reactivity of Materials

Objective

Design a test to determine the reactivity of different materials with liquids which it may be subjected to when used as a chopping board.

Method

Consider what type of chemicals and liquids the chopping board might come into contact with? Think of (juicy) things you would chop on it well as liquids you would clean it with.
Brainstorm ideas on how you can test the materials reactivity with these liquids, ensuring that it will be a fair test.
How will you record results and observations?
What will the independent variable be? What is the dependent variable? How will you control all other variables to ensure a fair test?
Create a method for your investigation, including how you will ensure it is conducted safely, add diagrams to show the set-up – show this and your table to your teacher before carrying out the investigation.

Results and Analysis

1. Present your results in a suitable format.
2. Which samples changed/ reacted and what did they react to?
3. Can you think of any means of stopping or slowing the reaction, other than not using the liquids?

You may wish to redo this experiment, testing your idea from part 3 to determine if it works.

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Porosity and Permeability

Objective

To design and carry out an investigation to determine which materials are porous and/or permeable and assess their suitability for use in chopping boards.

Method

Research the difference between porosity and permeability.
Brainstorm ideas on how you can test porosity and permeability of materials, ensuring that it will be a fair test.
How will you record results and observations?
What will the independent variable be? What is the dependent variable? How will you control all other variables to ensure a fair test?
Create a method for your investigation, including how you will ensure it is conducted safely, add diagrams to show the set-up – show this and your table to your teacher before carrying out the investigation.

Results and Analysis

1. Present your results in a suitable format.
2. Which material was the most permeable?
3. Which material was the least permeable?
4. Were any of the samples porous but not permeable?
5. Why is the porosity and permeability important to test for a chopping board? (consider what might be chopped on it, as well as hygiene reasons).
6. Can you think of any ways you could reduce the permeability/ porosity of a material?

You may wish to redo this experiment testing your suggestions above.

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Testing for Bacteria

Objective

To test a range of materials to see which ones host bacteria, even after they have been cleaned, to determine which might be best to use for a chopping board.

Method

Research science experiments to test for bacteria.
Brainstorm ideas on how you can test the amount of bacteria the materials can grow, ensuring that it will be a fair test, and considering how frequently a chopping board might be used, how often it will be cleaned and how it will be dried.
How will you record results and observations?
What will the independent variable be? What is the dependent variable? How will you control all other variables to ensure a fair test?
Create a method for your investigation, including how you will ensure it is conducted safely, add diagrams to show the set-up – show this and your table to your teacher before carrying out the investigation.

Results and Analysis

1. Present your results in a suitable format.
2. Which sample had the largest colonies of bacteria?
3. Which sample had the largest variety of bacteria?
4. Are any of the samples unsafe for use as a chopping board?
5. Can you think of any ways you could make the material safer, decreasing how much bacteria can grow on it?
6. Evaluate your experiment – was it a fair test? Provide some suggestions for improvement.

You may wish to redo the investigation, testing your suggested methods of improvement, and ideas to reduce bacteria growth.

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Cost Analysis

Objective

To determine which material will be the cheapest to make your chopping board out of.

Method

1. Create a table which will allow you to input calculations and data (Excel will do many calculations for you).
2. Decide on the ideal dimensions you will use for your product.
3. Research different merchants to find at least 3 quotes for the price of the materials, ensure you note where you got each quote from.
4. Consider the size that you can buy the material in – will it need to be cut down? If so will there be lots of waste, or would it even be possible to make a few, which you could possibly sell reducing costs, possibly even making profit?
5. Will you have to varnish the product, if so how many times? How much varnish will you use, and how much will that cost?
6. How much time will it take to make the product roughly? Consider that a tougher material may take more time to cut. Adding layers of varnish will also add time. How much is your time worth?
7. Will you have to buy new tools to make the product? If so what is the cost of the tools?

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Designing and Planning the Product

Objective

To create different design ideas to decide on the most suitable design for the intention. To make a clear and safe plan of how the product could be made.

Method

Carry out some background research into products that have already been made into chopping boards, creating a document with images of those which fit into the design brief and highlight the features which make them appropriate.
Analyse existing products or ideas – what are the pros and cons?
Create 3D scale drawings of different design ideas, highlighting the features which make them appropriate for the design brief. You may wish to do this on the computer using SketchUp or CAD.
Write a plan of how you could make your chosen design, ensuring you have completed a risk assessment.