

BIOMECHANICAL ENGINEERING PRIMARY

POWERED BY



Combining design technology,
science, and engineering

HELPING HANDS, MAKING HANDS

A background image showing two children, a girl and a boy, working on a project. The girl is on the left, looking at something, and the boy is on the right, smiling. They are both wearing red safety glasses. The image is overlaid with a large, stylized 'X' shape made of blue and red geometric shapes. The word 'IMAGINE' is written in white, bold, sans-serif capital letters across the 'X' shape.

IMAGINE

AGES
7-11
Lesson plan x2

SKILLS COVERED:

- > Imagining
- > Empathising
- > Designing
- > Making
- > Identifying
- > Evaluating
- > Thinking creatively
- > Technical knowledge
- > Biological knowledge



Taking inspiration directly from the amazing story of **the man who built his baby son an intuitive prosthetic arm**, this lesson combines biology, design technology and engineering to give an insight into the exciting world of biomechanical engineering. With an important life lesson about the difference prosthetics can make to the lives of those who need them, this cross-curricular two-part lesson will awaken pupil's passion for using technical skills to help those in need.

Overview

Helping hands, making hands

Meet Ben and his son Sol. They both feature in the intro video for this lesson, which is included in the presentation – slide 10.



Ben took matters into his own hands when the birth of Sol resulted in complications – and the loss of an arm. He wanted Sol to have as normal a life as possible, but found that prosthetics for babies, toddlers, and small children weren't very good, or very accessible. So, he decided to use his skills as an engineer to build working prosthetics his son could use to develop his muscles and play.

Ben is the RS Hero for these consecutive lessons, as your class takes a journey into the life changing world of prosthetics, picking up some exciting new technical skills and knowledge as they broaden their world view, and explore the unlimited possibilities of an engineering career.



REMEMBER...

While this lesson plan has been timed to run over a two-lesson time frame, it can also be spread out over a longer period. Younger or less advantaged classes may benefit from three or more sessions using the same material.

IMAGINE

LESSON 1 (informative)

- Bones, ligaments, muscles and their roles
- How the body and limbs move
- Examples of prosthetics and their uses
- Why you would need a prosthetic
- What prosthetics are

LESSON 2 (practical)

- What a prosthetic limb would need to do
- The structure of an arm/hand
- Designing and making a prosthetic arm
- The impact of prosthetics

DESIRED PUPIL OUTCOMES (LESSONS 1 & 2)

- Please see teacher notes for Desired pupil outcomes and curriculum links



Lesson 1



REMEMBER...

There are slides accompanying this lesson plan, including activities. Before you run this lesson, make sure you have the **HELPING HANDS, MAKING HANDS** presentation downloaded and set up on a projector at the front of the class. Please see teaching notes for further instructions.



Introduction - 20 mins

1. Open the lesson by asking the class 'what are you made of?' and ask for answers
 - For protection (bones, skin)
 - For movement (bones, muscle, ligaments)
2. Reveal the points gradually, briefly explaining what each one means:
 - Skin
 - Bones
 - Muscle
 - Connective tissue
 - Ligaments
3. Identify the completed diagram in the slide as the human skeletal/muscular system, which is called the musculoskeletal system
4. Explain that each of these components has a specific role within the body. Ask the class to identify which components are:
 - For support (bones, connective tissue)
5. Imagination time

Explain that today, the class is looking at movement, and what it means to lose that ability. Ask the class to:

 - Close their eyes and imagine they have to keep them closed forever
 - Cover their ears and imagine they have to keep them covered forever

Ask how they feel with each, picking pupils at random. If their eyes are covered, say their name. If their ears are covered, point to them and signal them to uncover their ears before asking.

IMAGINE

Stretch & Challenge

Ask the class what they think could happen to their bodies if they didn't have any:

- Skin
- Muscle
- Ligaments
- Bones
- Connective tissue

➤ Main activity - 20 mins

1. Split the class into small groups of three. Ask each group to stand up, move away from their desks, and clear a space which they can move around safely in
2. Ask each group to very carefully take it in turns:
 - Moving around the space as they usually would(include other mini-tasks such as shaking hands with each other, picking up objects, taking jumpers/cardigans on and off, pretending to eat etc.)
3. Ask each group to make a list using A3 paper and markers, of the different tasks they need their dominant arm, or both arms for
 - Moving around, but with only one arm (dominant)
 - Moving around, but with no arms
 - Moving around, but with only one leg
 - Moving around, but with no legs
4. Ask them to share their answers with the class, and note any 'stand out' answers on the whiteboard

HINT: Tie a coloured ribbon or string around the 'missing' limb(s) so they know which one not to move.

Stretch & challenge

Ask each to imagine how they would complete these tasks if they were to lose their dominant arm, or be born without it. Tell them to come up with solutions in their groups and write them on the A3 paper.

If there is time, ask the class to share their solutions, and see if the 'prosthetic' idea surfaces.



Plenary - 10 mins

1. Play the video on slide 10. It explores the idea of prosthetics, as demonstrated by Ben and Sol, as well as an explanation of the tasks ahead from a teacher
2. Ask the class what they thought of the video, and if they have any questions
3. If the information isn't volunteered, ask if they know what a prosthetic is, and what it's for
4. Explain how a prosthetic is made up of mechanical components which mimic the functions of a real body part

HINT: You can ask the class to do the 'homework' task in the following lesson as a warm up, best conducted in pairs or groups of three.

OPTIONAL HOMEWORK

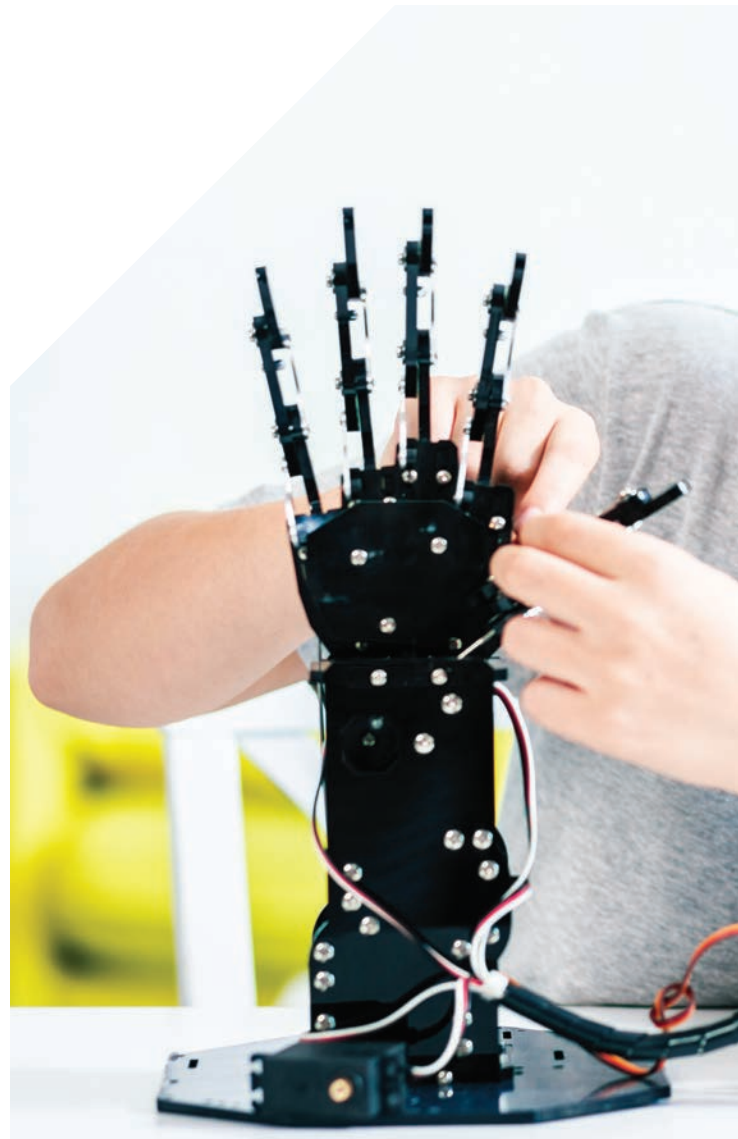
1. Tell the class to pay extra attention to the way their arms and hands move when they're doing different tasks
2. Ask them to make a note of how the joints move, where they are, and what they do depending on the task

IMAGINE

Lesson 2

➤ Introduction - 20 mins

1. Using the slides, briefly recap the main points of Lesson 1
 - The skeletal/muscular system
 - Which components are for support/protection/movement
2. Ask the class to think about 'prosthetics', and see if they can remember what they are. Reveal the definitions gradually on the slide
3. Split the pupils into groups of three (they can be the same groups as in the previous lesson) and ask them to spread themselves around the classroom
4. Instruct the groups to examine each other's arms and hands as they perform tasks
5. Explain the concept of a 'joint', and tell them to:
 - Play close attention to where they are in the arms and hand
 - How they 'work' (single direction like the finger joints, multiple direction like the elbows, 'ball' joint which rolls like the wrists)
 - Count how many joints there are, what type they are, and where they are on the arm/hand
 - Write down their findings on the 'My Joints' worksheet (see teaching notes)



Stretch & challenge

When the groups have finished designing their basic prosthetic arm, ask whether they'd like to 'enhance' it with 'super powers'.

Ask the class:

1. What would the 'super power' be? (e.g. extra fingers for playing guitar, magnets in finger tips for picking up tools)



Main activity - 20 mins

1. In the same groups, explain that they are now going to work together to design a prosthetic arm, which works just like a normal arm
2. Explain that, once the item has been designed, it would theoretically use manmade, resistant materials such as metals, plastics, and foam
3. Run the main activity (see teaching notes for instructions)

Plenary - 10 mins

Use the slides to guide you through answering the following questions:

1. Why prosthetics are important?
2. What would happen if you didn't have access to them?
3. Why are babies and children harder to make prosthetics for?
4. Discuss ways of making it easier for babies and children to get access to prosthetics (cheaper materials, adjustable depending on growth, simpler designs)

2. What would the powers be used for?
3. How would you design them into the prosthetic?

If there is time, ask the class to draw the enhancements on their existing designs, and label them.



TEACHING NOTES

Instructions for teachers

LESSON 1

BEFORE YOU START

Make the classroom ready to show a presentation and download the slides from the resource pack (set to the beginning slide 2 – Lesson 1)

RESOURCES

- HELPING HANDS, MAKING HANDS presentation slides
- Screen and projector
- Coloured ribbons or string
- Marker pens and paper

LESSON 2

BEFORE YOU START

Make the classroom ready to show a presentation and download the slides from the resource pack (set to the slide 14 – Lesson 2)

Main activity (preparation)

1. Print out the 'Main activity items' sheet either:
 - a) Directly onto plain non-glossy A3 card (for best results)
 - b) Onto normal plain A3 paper
2. Cut out each item (made up of fake arm and hand bones, ligaments and muscles) individually, keeping all items from the same sheet together in a pot or tray



Main activity (instructions)

1. In groups of three, the pupils will sort and arrange the items on a blank piece of A3 to 'design a moving prosthetic arm'
2. When they're happy that their design will work, they will then colour in the items according to what they are (bones, ligaments, muscles) and stick them to the A3 sheet
3. When they're finished, instruct them to 'draw the skin' – an outline of the skin around the hand – to finish it off
4. See 'Main activity' section for stretch and challenge options

RESOURCES

- HELPING HANDS, MAKING HANDS presentation slides
- Screen and projector
- A3 card (if available)
- A3 paper
- Colouring in pencils or pens
- Glue stick
- Pots or trays

To print:

- 'My Joints' worksheet (one per pupil)
- Main activity items sheet

Desired pupil outcomes and curriculum links

TEACHING NOTES

DESIRED PUPIL OUTCOMES

- I can now identify and explain the basic components of the human body, including the skeletal/muscular system
- I can now describe how the human body moves
- I can now describe the importance of, and function of, prosthetics
- I can now identify and explain basic joints and how they work
- I can now design/draw and evaluate a basic prosthetic arm and reflect on the main components and their functions
- I can now describe the materials a basic prosthetic could be made out of
- I can now understand why it's harder for babies and children to have access to prosthetics

CURRICULUM LINKS

SCIENCE

- Describe and explain the main body parts and internal organs (skeletal, muscular and digestive system)
- Describe the changes as humans develop through age

DESIGN

- Use research and develop design criteria to inform the design of innovative, functional, appealing products that are fit for purpose, aimed at particular individuals or groups
- Generate, develop, model and communicate their ideas through discussion, annotated sketches, cross-sectional and exploded diagrams, prototypes, pattern pieces and computer-aided-design



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