TEACHER NOTES

STEM LEARNING

BORN TO ENGINEER

BIONIC BOY

Subject focus: Engineering, with links to Design and Technology

This lesson plan – which could be adapted and split across more than one lesson – takes inspiration from the Born to Engineer video from Ben Ryan, who is working to develop low-cost 3D-printed prosthetic limbs for young children and babies. Through discussion and activity, this resource supports students to increase their understanding of engineering through designing a prosthetic arm.

This resource has been designed for students aged between 10 and 14. However, you may wish to alter the activities for a different age range. (Note: The timings for each part of the activity are to be used as a guide.)

STARTER

10 MIN

- Play the Born to Engineer video featuring Ben Ryan as an introduction to the activity.
- Ask students what prosthetics they are aware of and where they have seen prosthetics (ie sport, TV, newspapers).
- Using the slides and the teacher handout as a prompt, review a selection of prosthetic technologies. Ask students if they have any other suggestions.

Resources https://www.stem.org.uk/rxexno Teacher handout

DISCUSSION

5 MIN

Ask students how long prosthetics have been used for. Use the slides to show students how prosthetics have changed over the years. You may wish to discuss the specific materials used and the potential drawbacks of these materials (ie wood, animal teeth, gold).

ACTIVITY

15 MIN

Show students the Born to Engineer video again, this time asking them to answer the questions on the student handout. Use the slides to prompt discussion and check students' comprehension of the video. This sets the scene for the design activity.

Resources https://www.stem.org.uk/rxexno Student worksheet

DISCUSSION

5 MIN

Discuss with students how nature inspires engineers (biomimicry). Ben Ryan used nature to inspire his prosthetic hand's mechanism through studying the movement of spiders' legs.

You may find it useful to show this video clip (https://www.youtube.com/watch?v=Dk7dhtW5deE) to further explain how movement is achieved through hydraulics.

Resources https://www.youtube.com/watch?v=2eUkT1HngW0

ACTIVITY

30 MIN+

Introduce the design challenge to the class. Students must design a new prosthetic arm for Sol (or a similar child) that will enable him to play once he starts school. The arm can use technology to give Sol superhuman abilities (ie Wi-Fi, wearable technology, etc). This challenge works well when students are encouraged to incorporate technology into their design, enabling a child to have a fully bionic hand.

Research:
We are looking for students to explore the needs of a child of school age.
We have suggested the following as research prompts, however, you may wish to add further areas:

- What kind of activities might Sol (and other similar aged children) do when they get to primary school?
- How big will the prosthetic need to be to fit a school-age child?
- What materials will it need to be made from to withstand use over time?
- What might a child want it to look like (eg colour, shape)?
- What are the safety considerations for making something to be used by a child?
- Does it need to replicate a hand exactly or could it have some additional 'superhuman' ability?
- What technology will your hand need to function?

Further resources on how to create a scaled product for children using anthropometric data are available here:
https://www.stem.org.uk/rxyer
https://www.stem.org.uk/rxfgr9

Guidance on how to run a simulation workshop for students, enabling them to experience the challenges of interacting with everyday objects with a physical restriction can be found here: https://www.stem.org.uk/rxeuoe

Design, prototype, evaluate, improve:

The design process can be followed for the development of student ideas. We would suggest that students go through a process of making a prototype, either physically or virtually, and improve their ideas as they go.

The final result for this activity is dependent on the time available for design, prototyping and testing. You may wish students to present their ideas to the class, or pursue creating a functional, scale or aesthetic prototype.

EXTENSION ACTIVITY 1

30 MIN

This activity asks students to investigate the performance of hook and loop material (ie Velcro), creating their own tests for the four performance areas:

- peel strength
- shear strength
- tensile strength
- cycle life

Further information about each of the performance areas can be found in the teacher handout.

We suggest that this activity is delivered as an investigation, with students working as material engineers on behalf of Ben Ryan's company, Ambionics. Students must design their own tests and provide guidance for Ben as to which hook and loop system is the most appropriate for Sol's needs.

Resources Teacher handout

EXTENSION ACTIVITY 2

30 MIN+

This activity provides students with an inclusive design context to work in. Students are introduced to the organisation Adaptoys and asked to develop a range of adapted toys that can be used by people who have additional needs.

We suggest that this forms an additional design challenge or could be extended into a larger design and make project.

Resources https://www.youtube.com/watch?v=tny6D-pvw_I

EXTENSION ACTIVITY 3

15 MIN

This research activity gives students the opportunity to learn about quantum tunneling composite (QTC), a smart material that reduces its electrical resistance when compressed.

QTC is used as a force sensor and may be a useful technology for future bionic limbs.

Further information about QTC can be found here: https://www.stem.org.uk/rxupf

FURTHER RESOURCES

Further information on Ben Ryan's progress can be found here: https://www.ambionics.co.uk/

Further information on engineering and engineering careers can be found via the following websites:

https://www.borntoengineer.com/
https://www.stem.org.uk/year-of-engineering
http://www.tomorrowsengineers.org.uk/

HEALTH AND SAFETY

Each activity includes details about significant health and safety considerations, such as appropriate eye protection, gloves, etc. Ensure that all equipment is handled with care, particularly sharp instruments. Advice and guidelines are available from CLEAPPS and SSERC. We recommend that practical activities are risk assessed before commencing and always follow your employer policies.