Build Your Own Robot Arm

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Lesson Focus

Develop a robot arm using common materials. Students will explore design, construction, teamwork, and materials selection and use. Note: This lesson plan is designed for classroom use only, with supervision by a teacher familiar with electrical and electronic concepts.

Lesson Synopsis

Participating teams of three or four students are provided with a bag including the materials listed below. Each team must use the materials to design and build a working robot arm. The robot arm must be at least 45 cm in length and be able to pick up an empty Styrofoam cup. Teams of students must agree on a design for the robot arm and identify what materials will be used. Students will draw a sketch of their agreed upon design prior to construction. Resulting robot arms are then tested and checked for range of motion and satisfaction of the given criteria.

Year Levels

Year 7 – Term 2; Year 8 – Term 2; Year 10 – Term 3

Objectives

- Learn design concepts.
- Learn teamwork.
- Learn problem solving techniques.
- Learn about simple machines.

Anticipated Learner Outcomes

As a result of this activity, students should develop an understanding of:

- design concepts
- teamwork needed in the design process
- impact of technology in manufacturing

Lesson Activities

Students design and build a working robotic arm from a set of everyday items with a goal of having the arm be able to pick up a Styrofoam cup. Working in teams of three or four students, the students explore effective teamwork skills while learning simple robot mechanics.

Alignment to Curriculum Frameworks

See attached curriculum alignment sheet.

Resources / Materials

- 7.5 cm wide and approx. 55 cm long strips of cardboard-- 5 or so
- Binder clips (different sizes)-- 8 or more
- Brads (split pins)-- @10
- Clothes pegs -- 6
- Craft sticks--10-15
- Fishing line—90 – 120 cm feet
- Hangers-- 1 or 2
- Paper clips (diff. Sizes)-- 10-15
- Pencils-- 3-4
- Rubber bands (different sizes)--15
- Tape-- clear and masking (partial rolls should be fine)
- Twine— 90 – 120 cm
- Various size scraps of cardboard--10 assorted

Internet Connections

- TryEngineering (www.tryengineering.org)
- Design Your Own Robot (www.mos.org/robot/robot.html)
- FIRST Robotics Competition (www.usfirst.org)
- Robot Books (www.robotbooks.com)
- Curriculum Links (www.acara.edu.au)

Recommended Reading

- Artificial Intelligence: Robotics and Machine Evolution by David Jefferis (ISBN: 0778700461)
- Robotics, Mechatronics, and Artificial Intelligence: Experimental Circuit Blocks for Designers by Newton C. Braga (ISBN: 0750673893)
- Robot Builder's Sourcebook : Over 2,500 Sources for Robot Parts by Gordon McComb (ISBN: 0071406859)
- Robots (Fast Forward) by Mark Bergin (ISBN: 0531146162)

Optional Writing Activity

- Write an essay (or paragraph depending on age) about how the invention of robots and robotics has impacted manufacturing.

References

Ralph D. Painter and other volunteers - Florida West Coast USA Section of IEEE
URL: http://ewh.ieee.org/r3/floridawc/cms

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For Teachers:
Teacher Resources

Divide your class into teams of three or four students, and provide student handout (attached). Students are then instructed to examine the materials provided (see list below) and to work as a team to design and build a robot arm out of the materials. The robot arm must be at least 45 cm in length and be able to pick up an empty Styrofoam cup. Teams of students must agree on a design for the robot arm and identify what materials will be used. Students should draw a sketch of their agreed upon design prior to construction.

Explain that teamwork, trial, and error are part of the design process. There is no "right" answer to the problem - each team's creativity will likely generate an arm that is unique from the others designed in your class.

Resources/Materials

- 7.5 cm wide and approx. 55 cm long strips of cardboard-- 5 or so
- Binder clips (different sizes)-- 8 or more
- Brads-- @10
- Clothespins-- 6
- Craft sticks--10-15
- Fishing line—90 – 120 cm feet
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- Paper clips (diff. Sizes)-- 10-15
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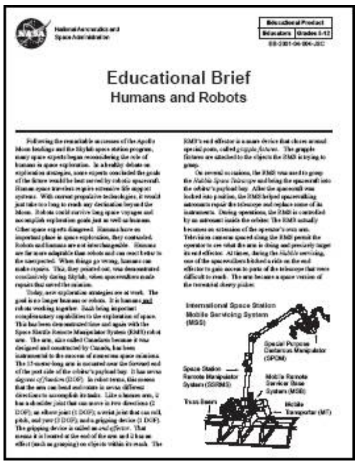
- Various size scraps of cardboard--10 assorted

Extension Ideas

"Humans and Robots," a NASA educational brief which is attached, describes the robotics features on the International Space Station. The brief's classroom activity is about making and using an ISS grapple fixture known as an end effector. The PDF file is also available at http://spacelink.nasa.gov.



Educational Brief
Humans and Robots

Build Your Own Robot Arm

Student Worksheet:

How To Build Your Own Robot Arm

You are a member of a team of three or four students, all working together to design and build a robot arm out of the following materials which are provided to you. The robot arm must be at least 45 cm in length and be able to pick up an empty Styrofoam cup. Your team must agree on a design for the robot arm and identify what materials will be used. Your team should draw a sketch of their agreed upon design prior to construction.

Part of the teamwork process is sharing ideas and determining which design your team will go with. Trial and error are part of the design process. There is no "right" answer to the problem - your team's creativity will likely generate an arm that is unique from the others designed in your class.

Resources/Materials

- 7.5 cm wide and approx. 55 cm long strips of cardboard-- 5 or so
- Binder clips (different sizes)-- 8 or more
- Brads-- @10
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Student Worksheet:
Robot Arm Exercise Questions

- Did you use all the materials provided to you? Why, or why not?

- Which item was most critical to your robot arm design?

- How did working as a team help in the design process?

- Were there any drawbacks to designing as a team?

- What did you learn from the designs developed by other teams?

- Name three industries that make use of robots in manufacturing:

For Teachers:
Alignment to Curriculum Frameworks

Note: All Lesson Plans in this series are aligned to the Australian Curriculum for both Science and Mathematics.

	Year Level					
	5	**6**	**7**	**8**	**9**	**10**
Science Understandings			Change to an object's motion is caused by unbalanced forces acting on the object **(ACSSU117)** *Investigating the effects of applying different forces to familiar objects*	Energy appears in different forms including movement, heat and potential energy, and causes changes within systems **(ACSSU155)** *Using flow diagrams to illustrate changes between different forms of energy*		Energy conservation in a system can be explained be describing energy transfers and transformations **(ACSSU190)** *Using models to describe how energy is transferred and transformed within systems* The motion of objects can be described and predicted using the laws of Physics **(ACSSU229)**

Science as a human endeavour			Scientific knowledge changes as new evidence becomes available **(ACSHE119 – Yr 7; ACSHE134 – Yr 8)** Science knowledge can be developed through collaboration and connecting ideas across the disciplines of Science **(ACSHE223 – Yr 7; ACSHE226 – Yr 8)**	Advances in scientific understandings often rely on developments in technology and technological advances are often linked to scientific discoveries **(ACSHE192 – Yr 10)**
Science Inquiry Skills			Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge **(ACSIS124 - Yr 7; ACSIS139 – Yr 8)** Summarise data and use scientific understanding to identify relationships and draw conclusions **(ACSIS 130 - Yr 7; ACSIS145 – Yr 8)** Reflect on the method used to investigate a question or solve a problem, evaluate quality of data collected and identify improvements to the method **(ACSIS131 - Yr 7; ACSIS145 – Yr 8)** Use scientific knowledge and findings from investigations to evaluate claims **(ACSIS132 - Yr 7; ACSIS234 – Yr 8)** Communicate scientific ideas and information for a particular purpose **(ACSIS133 - Yr 7; ACSIS148 – Yr 8)**	Formulate questions or hypothesis that can be investigated scientifically **(ACSIS198 – Yr 10)** Use knowledge of scientific concepts to draw conclusions that are consistent with evidence **(ACSIS204 – Yr 10)** Evaluate conclusions and describe specific ways to improve **(ACSIS205 – Yr 10)** Communicate scientific ideas and information for a particular purpose **(ACSIS208 – Yr 10)**

MATHEMATICS LINKS

Activity	**Concept / Year Level**							
	Number and place value	**Real numbers**	**Money and financial maths**	**Linear and non-linear relationships**	**Using units of measurement**	**Geometric reasoning**	**Data and representation and interpretation**	**Shape**
Build your own robot arm		**Yr 7 – 10**			**Yr 5 – 10**			

Mathematics Links with Science Curriculum (Skills used in this activity)	General Capabilities	Cross-Curriculum Priorities
• Process data using simple tables • Data analysis skills (graphs) • Analysis of patterns and trends • Use of metric units	• Literacy • Numeracy • Critical and creative thinking • Personal and social capacity • ICT capability	• Sustainability

Science Achievement Standards

Year 7

By the end of Year 7, students describe techniques to separate pure substances from mixtures. They ***represent and predict the effects of unbalanced forces, including Earth's gravity, on motion.*** They explain how the relative positions of the Earth, sun and moon affect phenomena on Earth. They analyse how the sustainable use of resources depends on the way they are formed and cycled through Earth systems. They predict the effect of environmental changes on feeding relationships and classify and organise diverse organisms based on observable differences. Students describe situations where scientific knowledge from different science disciplines has been used to solve a real-world problem. They explain how the solution was viewed by, and impacted on, different groups in society.

Students identify questions that can be investigated scientifically. They ***plan fair experimental methods, identify variables to be changed and measured***. They select equipment that improves fairness and accuracy and describe how they considered safety. Students ***draw on evidence to support their conclusions***. They summarise data from different sources, describe trends and refer to the quality of their data when suggesting improvements to their methods. They ***communicate their ideas, methods and findings using scientific language and appropriate representations***.

Year 8

By the end of Year 8, students compare physical and chemical changes and use the particle model to explain and predict the properties and behaviours of substances. ***They identify different forms of energy and describe how energy transfers and transformations cause change in simple systems***. They compare processes of rock formation, including the time scales involved. They analyse the relationship between structure and function at cell, organ and body system levels. Students examine the different science knowledge used in occupations. They explain how evidence has led to an improved understanding of a scientific idea and describe situations in which scientists collaborate to generate solutions to contemporary problems.

Students identify and construct questions and problems that they can investigate scientifically. They consider safety and ethics when planning investigations, including designing field or experimental methods. They identify variables to be changed, measured and controlled. ***Students construct representations of their data to reveal and analyse patterns and trends, and use these when justifying their conclusions***. They explain how modifications to methods could improve the quality of their data and apply their own scientific knowledge and investigation findings to evaluate claims made by others. They ***use appropriate language and representations to communicate science ideas, methods and findings in a range of texts types***.

Year 10

By the end of Year 10, students analyse how the periodic table organises elements and use it to make predictions about the properties of elements. They explain how chemical reactions are used to produce particular products and how different factors influence the rate of reactions. They ***explain the concept of energy conservation and represent energy transfer and transformation within systems. They apply relationships between force, mass and acceleration to predict changes in the motions of objects***. Students describe and analyse interactions and cycles within and between Earth's spheres. They evaluate the evidence for scientific theories that explain the origin of the universe and the diversity of life on Earth. They explain the processes that underpin heredity and evolution. Students analyse how the models and theories they use have developed over time and discuss the factors that prompted their view.

Students develop questions and hypotheses and independently design and improve appropriate methods of investigation, including field work and laboratory experimentation. They explain how they have considered reliability, safety, fairness and ethical actions in their methods and identify where digital technologies can be used to enhance the quality of their data. When ***analysing data, selecting evidence and developing and justifying conclusions***, they identify alternative explanations for findings and explain any sources of uncertainty. Students evaluate the validity and reliability of claims made in secondary sources with reference to currently held scientific views, the quality of methodology and the evidence cited. They construct evidence-based arguments and select appropriate representations and text types to communicate science ideas for specific purposes.