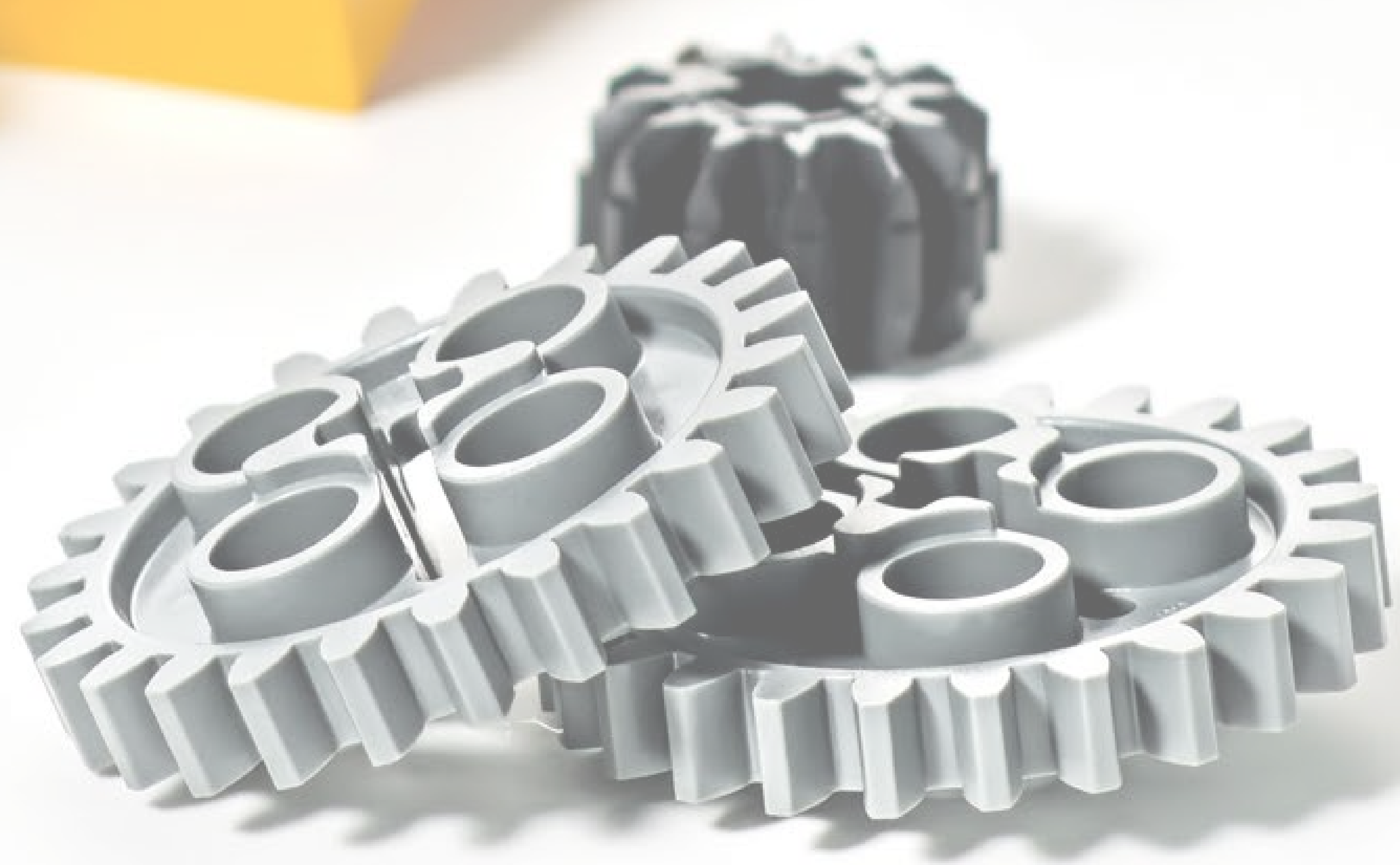
LEGO® Education WeDo 2.0
Curriculum Pack

WeDo 2.0
2045300

LEGO education

Table of Contents



The LEGO® Education Community is an online community where teachers, administrators, and other education professionals can connect and share ideas, engage in discussions, and share lesson plans and projects.

The LEGO Education Community site is only available in English.

Introduction to WeDo 2.0

Welcome to the LEGO® Education WeDo 2.0 Curriculum Pack.

In this chapter, you will discover the fundamental steps required for the journey you are about to experience.

LEGO® Education WeDo 2.0 Curriculum Pack

LEGO® Education WeDo 2.0 is developed to engage and motivate primary school pupils' interest in learning science and engineering related subjects. This is done through the use of motorised LEGO models and simple programming.

WeDo 2.0 supports a hands-on, "minds on" learning solution that gives pupils the confidence to ask questions, and the tools to find answers and solve real-life problems.

Pupils learn by asking questions and solving problems. This material does not tell pupils everything they need to know. Instead it makes them question what they know and explore what they do not yet understand.

Learn science and engineering through projects

WeDo 2.0 has a range of different projects. The projects are divided into the following types:

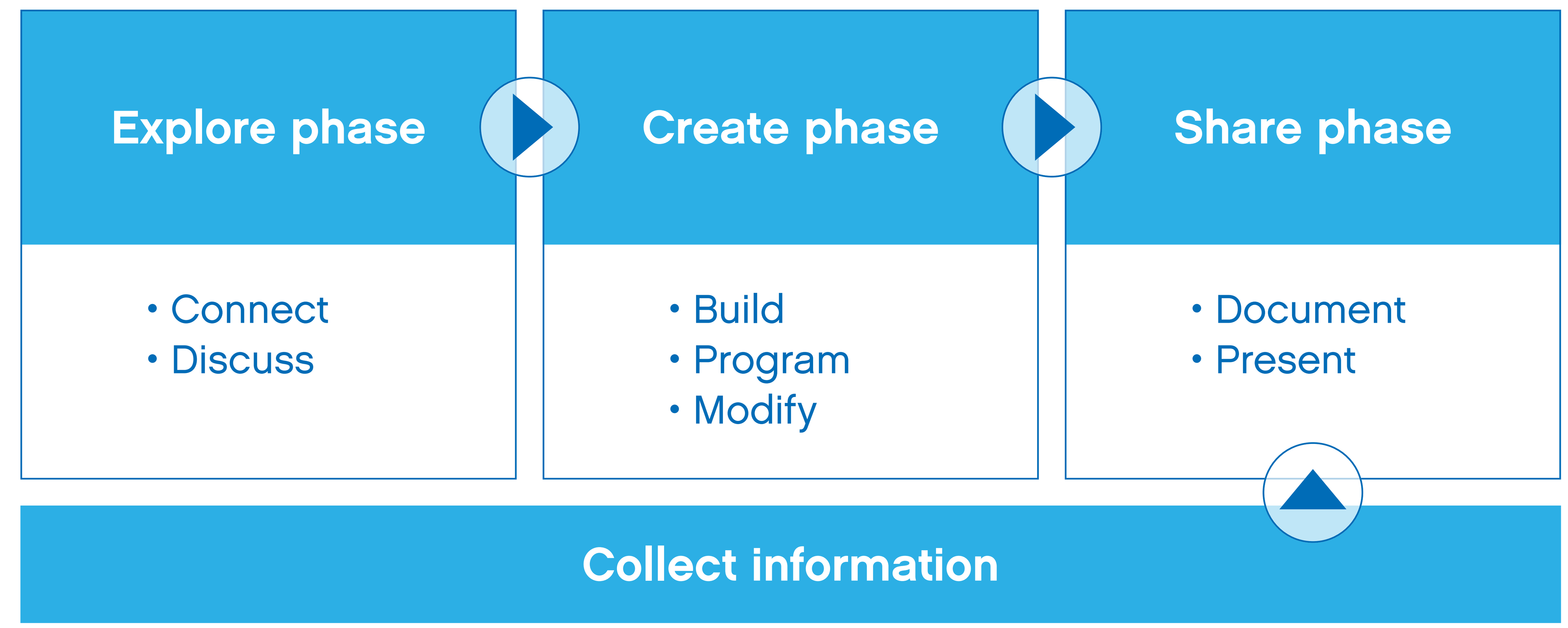
- A Getting Started Project divided into four parts, where you can learn the basic functions of WeDo 2.0
- Eight Guided Projects linked to National Curriculum requirements, with step-by-step instructions for the complete project
- Eight Open Projects linked to National Curriculum requirements, with a more open experience

The Guided Projects and the Open Projects are divided into three phases: the Explore phase, to connect pupils to the task; the Create phase, to allow them to build and program; and the Share phase, where they document and present their projects.

Each project should last approximately three hours. Each phase has an equal importance in the project flow and an estimated completion time of around 45 minutes, but you can modify the time spent on each phase to suit your teaching.

How to teach science with WeDo 2.0

WeDo 2.0 uses a project progression defined by three phases.



Explore phase
Pupils connect to a scientific question or an engineering problem, establish a line of inquiry, and consider possible solutions.

The steps of the Explore phase are: connect and discuss.

Create phase
Pupils build, program, and modify a LEGO® model. Projects can be one of three types: investigate, design solutions, and use models. Depending on the type of project, the Create phase will differ from one project to another.

The steps of the Create phase are: build, program, and modify.

Share phase
Pupils present and explain their solutions and findings using their LEGO models and the documents they have created with the integrated Documentation tool.

The steps of the Share phase are: document and present.

Important
During each of these phases, pupils will document their findings, the answers, and the process, using various methods. This document can be exported and used for assessment, display, or sharing with parents.

Use the Guided Projects

The Guided Projects will help you to set the scene and facilitate the learning experience. They are designed to build your pupils' confidence and provide the foundations necessary for success.

All Guided Projects follow the Explore, Create, and Share sequence to ensure that pupils progress step-by-step through the learning experience.

Teacher's notes have been provided for every project, and include:

- Curriculum links
- Detailed preparation
- Assessment grids
- Differentiation techniques and notes on possible pupil misconceptions.
- Explore, Create, and Share Help panel

See the "Guided Projects" chapter for information about all Guided Projects.

Suggestions

It is recommended that you start with the Getting Started Project followed by one or two Guided Projects to make sure pupils understand the approach and methodology. "Pulling" is a good Guided Project to start with.

Using Open Projects

The Open Projects also follow the Explore, Create, and Share sequence, but intentionally do not offer the same step-by-step guidance as the Guided Projects. They provide an initial brief and starting points to build on.

The key to using the Open Projects is to make them your own; offer opportunities for projects that are locally relevant and challenging in the areas you want them to be. Use your creativity to adapt these project ideas to suit your pupils. You will find teacher support about Open Projects in the "Open Projects" chapter.

With every Open Projects brief, pupils will be given three suggested base models to look at in the Design Library.

The Design Library, located in the software, will provide inspiration for pupils to build their own solutions. The goal is not to replicate the model, but to get help on how to build a function, such as to lift or walk. Pupils will find building instructions for the 15 base models in the Design Library, as well as pictures of inspirational models.

Suggestion

The Design Library and Open Projects can be found in the WeDo 2.0 Software.

Document projects

Asking your pupils to document their work will help you to keep track, identify where they need more help, and evaluate their progress.

Pupils can use many different methods to express their ideas. During the ongoing documentation process, they can:

1. Take photographs of important steps of their prototypes and their final models.
2. Take photographs of their team working on important stages of the process.
3. Record a video explaining a problem they are facing.
4. Record a video explaining their investigation.
5. Make notes using the Documentation tool.
6. Find supporting pictures on the Internet.
7. Take screenshots of their programs.
8. Write, draw, or sketch on paper and then take photographs to record the information.

Suggestion

A combination of paper and digital documentation can be the most effective, depending on the age group you are working with.

Share projects

At the end of the project, pupils will be eager to share their solutions and findings. This is a great opportunity to develop their communication abilities.

Here are a few examples of how your pupils can share their work:

1. Ask the pupils to create the display where the LEGO® model will be used.
2. Ask the pupils to describe their investigations or dioramas.
3. Ask a team of pupils to present their best solution to you, another team, or to the class.
4. Invite an expert or a group of parents to your classroom for a pupil presentation.
5. Organise a science fair at your school.
6. Ask the pupils to record videos explaining their projects, and post them online.
7. Create and display posters of the projects around your school.
8. E-mail the project documents to parents, or publish them in pupils' portfolios.

Suggestion

To make this experience even more upbeat, ask each pupil to make a positive comment or to pose a question about another pupil's work during the sharing session.

The Science Lab

Max and Mia's virtual WeDo 2.0 Science Lab is a great place for pupils to get connected to real-life questions or problems. You can meet them in every Guided Project.

Max is always ready for a new project. He loves to discover fresh topics, and he's very creative when it's time to invent something new.

Mia is thrilled by any discoveries. She's very curious about the world around her, and she always wants to know more.

In the Getting Started Project, Max and Mia are joined by Milo the Science Rover, who is capable of great discoveries.

Max and Mia have great projects to propose, and they are excited to **welcome you to the LEGO® Education WeDo 2.0 Science Lab!**

WeDo 2.0 in the Curriculum

The LEGO® Education WeDo 2.0 solution combines LEGO bricks with the expectations of the National Curriculum Science programmes of study. The projects are designed to develop pupils' science practices.

In this chapter, you will be introduced to three innovative ways to use the bricks in your classroom:

- Model reality.
- Conduct investigations.
- Use design skills alongside the development of science practices.

Experience overview

The WeDo 2.0 projects are developed with the National Curriculum requirements for science at Key Stage 2 in mind.

These practices represent the expectations of the Curriculum, in that pupils develop scientific knowledge and conceptual understanding, as well as practical skills. The practices are not to be seen as separate, rather as an interconnected set of expectations for pupils.

Cross-curricular themes are also important, and teachers are encouraged to explore the connections to other subject areas.

Elements of the National Curriculum for Computing, Geography and Design & Technology are interwoven throughout the document and are used within the WeDo 2.0 curriculum.

The “habits of mind,” as outlined in *Engineering Habits of Mind* (EHoM) and defined by the National Academy of Engineering (NAE) and the National Research Council (NRC), are an important part of project-based learning.

The habits of mind are centred on the fact that science is about the attitudes, values, and skills that determine how people learn and acquire knowledge about the world.

According to both the NAE and NRC, there are six habits of mind that are essential for science and engineering growth:
1. Systems thinking
2. Creativity
3. Optimism
4. Collaboration
5. Communication
6. Ethical considerations

The WeDo 2.0 curriculum projects are built around the habits of mind and interconnected throughout the curriculum.

Develop science and engineering practices with WeDo 2.0

WeDo 2.0 projects will develop science practices. They provide opportunities for pupils to work with and develop ideas and knowledge, and to gain an understanding of the world around them.

The progression and difficulty level of the projects allows pupils to develop competency while exploring and learning about key science topics. The projects have been carefully chosen to cover a wide variety of topics and issues.

WeDo 2.0 projects develop eight science and engineering practices:

1. Ask questions and solve problems.
2. Use models.
3. Design prototypes.
4. Investigate.
5. Analyse and interpret data.
6. Use computational thinking.
7. Engage in argument from evidence.
8. Obtain, evaluate, and communicate information.

The guiding principle is that every pupil should engage in all of these practices across the projects in each year group.

Science practices and the engineering habits of mind

The science and engineering practices serve as the common thread throughout the curriculum, and all requirements should, in essence, be taught through them. While the academic definition of each process is important, it is probably a good habit to verbalise the practices in a way that is understandable to pupils at that level.

The following points identify the basic principles of these practices and give examples of how they are used in WeDo 2.0 projects.

1. Ask questions and define problems.
This practice focuses on simplistic problems and questions based on observational skills.

2. Develop and use models.
This practice focuses on pupils' prior experiences and the use of concrete events in modelling solutions to problems. It also includes improving models and new ideas about a real-world problem and solution.

3. Plan and carry out investigations.
This practice is about how pupils learn and follow directions for an investigation to formulate probable solution ideas.

4. Analyse and interpret data.
The focus of this practice is to learn how to gather information from experiences, document discoveries, and share ideas from the learning process.

Science practices and the engineering habits of mind

5. Use mathematics and computational thinking.
The purpose of this practice is to realise the role of numbers in data-gathering processes. Pupils read and gather data about investigations, make charts, and draw diagrams resulting from the numerical data. They add simple data sets to come up with conclusions. They understand or create simple algorithms.

6. Construct explanations and design solutions.
This practice is about ways they might go about constructing an explanation or designing a solution for a problem.

7. Engage in argument from evidence.
Constructively sharing ideas based on evidence is an important feature of science and engineering. This practice is about how pupils begin to share their ideas and demonstrate proof to others in a group.

8. Obtain, evaluate, and communicate information.
Teaching children about what real scientists do is key to this practice. The way in which they set up and complete investigations to gather information, how they evaluate their findings, and how they document, are all important elements. It is important that teachers explore a plethora of ways to have pupils gather, record, evaluate, and communicate their findings. Ideas include digital presentations, portfolios, drawings, discussion, video, and interactive notebooks.

Important

The WeDo 2.0 projects will engage your pupils in all science and engineering practices. Refer to the practices grid of this chapter to get an overview.

Use the LEGO® bricks in a scientific context

LEGO® bricks have been used in three different ways in the WeDo 2.0 projects:
1. To model reality
2. To investigate
3. To design

These three ways will give you the opportunity to develop a different set of practices, as the outcome of the project is different in each case.

1. Use models
Pupils represent and describe their ideas using the bricks.

Pupils can build a model to gather evidence or provide a simulation. Although only representations of reality, models enhance understanding and explain natural phenomena.

When implementing a modelling project, encourage pupils to focus their creativity on representing the reality as accurately as possible. By doing that, they will need to identify and explain the limitations of their models.

Examples of modelling Guided Projects are:
- Frog's Metamorphosis
- Plants and Pollinators

2. Investigate
Planning and carrying out investigations is an ideal framework for a science project. Pupils' learning is enhanced by active engagement with the problem. Pupils are encouraged to make predictions, carry out tests, collect data, and draw conclusions.

When implementing an investigation project, you should encourage pupils to pay special attention to ensure fair testing. Ask them to search for cause and effect in their tests, ensuring they change only one variable at a time.

Examples of investigating Guided Projects are:
- Pulling
- Speed
- Robust Structures

Use the LEGO® bricks in an engineering context

3. Design
Pupils design solutions for a problem for which there is no single answer. The problem may require pupils to design a combination of plans, models, simulations, programs, and presentations. Going through the design process will require pupils to constantly adjust and modify their solutions to meet criteria.

While designing a solution, it will be important to recognise that the idea of "failure" in engineering is a sign of growth in the cognitive process. Therefore, pupils may not reach a viable solution on their first attempt or within the provided time constraints. In that case, encourage them to reflect on their process and to identify what they have learned.

When you implement a design project, encourage pupils to focus their creativity on designing multiple solutions. Ask them to select the prototype they think is the best according to the criteria you have set.

Examples of designing Guided Projects are:
- Prevent Flooding
- Drop and Rescue
- Sort to Recycle

Important

Documents produced by pupils following the completion of these three types of projects may contain different types of information.

Use LEGO® bricks in a computational thinking context

Computational thinking is a set of problem-solving skills that are applied to working with computers and other digital devices. In WeDo 2.0, computational thinking is handled in a developmentally appropriate manner through the use of icons and programming blocks.

Computational thinking characteristics include:
- Logical reasoning
- Looking for patterns
- Organising and analysing data
- Modelling and simulations
- Using computers to assist in testing models and ideas
- Using algorithms to sequence actions

Its application in science and engineering projects enables pupils to use powerful digital tools to carry out investigations and build and program models, which might otherwise be tricky to do. Pupils use programs to activate motors, lights, sounds, or displays, or to react to sounds, tilt, or movement to implement functionalities to their models or prototypes.

Visual overview of Guided Projects

1. Pulling
Investigate the effects of balanced and unbalanced forces on the movement of an object.

2. Speed
Investigate the factors that make a car accelerate to help predict future motion.

3. Robust Structures
Investigate the characteristics that make a building earthquake resistant, using an earthquake simulator constructed from LEGO® bricks.

4. Frog's Metamorphosis
Model a frog's metamorphosis using a LEGO representation, and identify the characteristics of the organism at each stage.

5. Plants and Pollinators
Model a LEGO representation of the relationship between a pollinator and flower during the reproduction phase.

6. Prevent Flooding
Design an automatic LEGO floodgate to control water according to various precipitation patterns.

7. Drop and Rescue
Design a device to reduce the impacts on humans, animals, and the environment after an area has been damaged by extreme weather.

8. Sort to Recycle
Design a device that uses the physical properties of objects, including their shape and size, to sort them.

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Visual overview of Open Projects

9. Predator and Prey
Model a LEGO® representation of the behaviours of different predators and their prey.

10. Animal Expression
Model a LEGO representation of different communication methods used in the animal kingdom.

11. Extreme Habitats
Model a LEGO representation of how habitat influences the survival of certain species.

12. Space Exploration
Design a LEGO prototype of a rover that would be ideal for exploring distant planets.

13. Hazard Alarm
Design a LEGO prototype of a weather alarm device to reduce the impact of severe storms.

14. Cleaning the Ocean
Design a LEGO prototype to help people remove plastic waste from the ocean.

15. Wildlife Crossing
Design a LEGO prototype to allow an endangered species to safely cross a road or other hazardous area.

16. Moving Materials
Design a LEGO prototype of a device that can move specific objects in a safe and efficient way.

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National Curriculum for Science at Key Stage 2 Numbering

The National Curriculum for Science does not have a numbered system.
We created our own for WeDo 2.0 for ease of use when referencing the curriculum grid and assessment tools.

The system works as follows:

LKS2	Lower Key Stage 2
UKS2	Upper Key Stage 2
WS	Working Scientifically
P	Plants
A	Animals, Including Humans
R	Rocks
L	Light
FM	Forces & Magnets
LTH	Living Things & Their Habitats
SM	States of Matter
S	Sound
E	Electricity
PCM	Properties and Changes of Materials
ES	Earth & Space
F	Forces
EI	Evolution & Inheritance
s	Statutory Requirement
ns	Non-Statutory requirements

Examples of how these codes are used are:

- 3.FM.s1 = Year 3. Forces & Magnets. Statutory Requirement 1.
- 6.LTH.ns1 = Year 6. Living Things & Their Habitats. Non-statutory Requirement 1.

Our advice to teachers would be to write the codes next to the statements in your copy of the National Curriculum to enable easy reference.

Curriculum Overview (Science) of Guided Projects, Organised by Year Group

NB: Addressed Computing, Geography and Design & Technology Curriculum requirements are referenced in the teacher's notes for each project.

<table>
<tr><th></th><th>Lower KS 2 Working Scientifically</th><th>Year 3</th><th>Year 4</th><th>Upper KS 2 Working Scientifically</th><th>Year 5</th><th>Year 6</th></tr>
<tr><td>1. Pulling</td><td rowspan="8">LKS2.WS.s1
LKS2.WS.s2
LKS2.WS.s4
LKS2.WS.s5
LKS2.WS.s6
LKS2.WS.s7
LKS2.WS.s8
LKS2.WS.s9</td><td>3.FM.s1
3.FM.ns2</td><td></td><td rowspan="8">UKS2.WS.s1
UKS2.WS.s4
UKS2.WS.s5
UKS2.WS.s6</td><td>5.F.s2
5.F.s3
5.F.ns1</td><td></td></tr>
<tr><td>2. Speed</td><td></td><td></td><td>5.F.s3</td><td></td></tr>
<tr><td>3. Robust Structures</td><td></td><td></td><td>5.F.s3</td><td></td></tr>
<tr><td>4. Frog's Metamorphosis</td><td>3.A.s1
3.A.ns1</td><td>4.LTH.s3
4.LTH.ns1
4.LTHns2
4.A.s3</td><td>5.LTH.s1
5.LTH.s2
5.LTH.ns1
5.LTH.ns3
5.F.s3</td><td>6.LTH.s1
6.LTH.s2
6.LTH.ns1
6.EI.s2
6.EI.s3</td></tr>
<tr><td>5. Plants and Pollinators</td><td>3.P.s1</td><td>4.LTH.ns1</td><td>5.LTHs1
5.LTH.s2
5.LTH.ns2
5.F.s3</td><td></td></tr>
<tr><td>6. Prevent Flooding</td><td></td><td>4.SM.s3</td><td>5.F.s2
5.F.s3</td><td></td></tr>
<tr><td>7. Drop and Rescue</td><td></td><td></td><td>5.F.s3
5.F.ns1</td><td></td></tr>
<tr><td>8. Sort to Recycle</td><td></td><td>4.LTH.ns2</td><td>5.F.s3</td><td></td></tr>
</table>

Curriculum Overview of Open Projects, Organised by Year Group

NB: Addressed Computing, Geography and Design & Technology Curriculum requirements are referenced in the teacher's notes for each project.

	Lower KS 2 Working Scientifically	Year 3	Year 4	Upper KS 2 Working Scientifically	Year 5	Year 6
9. Predator and Prey	LKS2.WS.s1 LKS2.WS.s2 LKS2.WS.s4 LKS2.WS.s5 LKS2.WS.s6 LKS2.WS.s7 LKS2.WS.s8 LKS2.WS.s9	3.A.s2		UKS2.WS.s1 UKS2.WS.s4 UKS2.WS.s5 UKS2.WS.s6	5.F.s3	6.El.s3
10. Animal Expression					5.LTH.s1 5.LTH.s2 5.F.s3	6.LTH.s1 6.El.s2
11. Extreme Habitats			4.LTH.s3 4.LTH.ns2		5.F.s3	6.El.s3
12. Space Exploration					5.ES.s1 5.ES.s2 5.ES.s3 5.F.s3	
13. Hazard Alarm					5.F.s3	
14. Cleaning the Ocean			4.LTH.s3 4.LTH.ns2		5.F.s3	
15. Wildlife Crossing					5.F.s3	6.El.s3
16. Moving Materials					5.F.s3	

National Curriculum for Science Requirements – Lower Key Stage 2 Programme of Study

Working Scientifically Lower Key Stage 2 (LKS2.WS)		
During Years 3 and 4, pupils should be taught to use the following practical scientific methods, processes, and skills through the teaching of the programme of study content:		
Statutory Requirements (S)	**Code**	*Pupils should be taught to:*
	LKS2.WS.s1	asking relevant questions and using different types of scientific enquiries to answer them.
	LKS2.WS.s2	setting up simple practical enquiries, comparative and fair tests.
	LKS2.WS.s3	making systematic and careful observations and, where appropriate, taking accurate measurements using standard units, using a range of equipment, including thermometers and data loggers.
	LKS2.WS.s4	gathering, recording, classifying and presenting data in a variety of ways to help in answering questions.
	LKS2.WS.s5	recording findings using simple scientific language, drawings, labelled diagrams, keys, bar charts, and tables.
	LKS2.WS.s6	reporting on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions.
	LKS2.WS.s7	using results to draw simple conclusions, make predictions for new values, suggest improvements and raise further questions.
	LKS2.WS.s8	identifying differences, similarities or changes related to simple scientific ideas and processes.
	LKS2.WS.s9	using straightforward scientific evidence to answer questions or to support their findings.

National Curriculum for Science Requirements – Lower Key Stage 2 Programme of Study

Year 3 Plants (3.P)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	3.P.s1	Identify and describe the functions of different parts of flowering plants: roots, stem/trunk, leaves, and flowers.
	3.P.s2	Explore the requirements of plants for life and growth (air, light, water, nutrients from soil, and room to grow) and how they vary from plant to plant.
	3.P.s3	Investigate the way in which water is transported within plants.
	3.P.s4	Explore the part that flowers play in the life cycle of flowering plants, including pollination, seed formation, and seed dispersal.
NS	3.P.ns1	Pupils should be introduced to the relationship between structure and function: the idea that every part has a job to do. They should explore questions that focus on the role of the roots and stem in nutrition and support, leaves for nutrition and flowers for reproduction.
	3.P.ns2	Pupils might work scientifically by: comparing the effect of different factors on plant growth, for example, the amount of light, the amount of fertiliser; discovering how seeds are formed by observing the different stages of plant life cycles over a period of time; looking for patterns in the structure of fruits that relate to how the seeds are dispersed.
	3.P.ns3	They might observe how water is transported in plants, for example, by putting cut, white carnations into coloured water and observing how water travels up the stem to the flowers.

Year 3 Animals, Including Humans (3.A)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	3.A.s1	Identify that animals, including humans, need the right types and amount of nutrition, and that they cannot make their own food; they get nutrition from what they eat.
		Identify that humans and some other animals have skeletons and muscles for support, protection, and movement.
NS	3.A.ns1	Pupils should continue to learn about the importance of nutrition and should be introduced to the main body parts associated with the skeleton and muscles, finding out how different parts of the body have special functions.
	3.A.ns2	Pupils might work scientifically by: identifying and grouping animals with and without skeletons and observing and comparing their movement; exploring ideas about what would happen if humans did not have skeletons. They might compare and contrast the diets of different animals (including their pets) and decide ways of grouping them according to what they eat. They might research different food groups and how they keep us healthy, and design meals based on what they find out.

National Curriculum for Science Requirements – Lower Key Stage 2 Programme of Study

Year 3 Rocks (3.R)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	3.R.s1	Compare and group together different kinds of rocks on the basis of their appearance and simple physical properties.
	3.R.s2	Describe in simple terms how fossils are formed when things that have lived are trapped within rock.
	3.R.s3	Recognise that soils are made from rocks and organic matter.
NS	3.R.ns1	Linked with work in geography, pupils should explore different kinds of rocks and soils, including those in the local environment.
	3.R.ns2	Pupils might work scientifically by: observing rocks, including those used in buildings and gravestones, and exploring how and why they might have changed over time; using a hand lens or microscope to help them to identify and classify rocks according to whether they have grains or crystals, and whether they have fossils in them. Pupils might research and discuss the different kinds of living things whose fossils are found in sedimentary rock and explore how fossils are formed. Pupils could explore different soils and identify similarities and differences between them and investigate what happens when rocks are rubbed together or what changes occur when they are in water. They can raise and answer questions about the way soils are formed.

Year 3 Light (3.L)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	3.L.s1	Recognise that they need light in order to see things, and that dark is the absence of light.
	3.L.s2	Notice that light is reflected from surfaces.
	3.L.s3	Recognise that light from the sun can be dangerous and that there are ways to protect their eyes.
	3.L.s4	Recognise that shadows are formed when the light from a light source is blocked by an opaque object.
	3.L.s5	Find patterns in the way that shadows change in size.
NS	3.L.ns1	Pupils should explore what happens when light reflects off a mirror or other reflective surfaces, including playing mirror games to help them to answer questions about the behaviour of light. They should think about why it is important to protect their eyes from bright lights. They should look for, and measure, shadows, and find out how they are formed and what might cause the shadows to change.
	3.L.ns2	Pupils might work scientifically by: looking for patterns in what happens to shadows when the light source moves or the distance between the light source and the object changes.

National Curriculum for Science Requirements – Lower Key Stage 2 Programme of Study

Year 3 Forces and Magnets (3.FM)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	3.FM.s1	Compare how things move on different surfaces.
	3.FM.s2	Notice that some forces need contact between two objects, but magnetic forces can act at a distance.
	3.FM.s3	Observe how magnets attract or repel each other and attract some materials and not others.
	3.FM.s4	Compare and group together a variety of everyday materials on the basis of whether they are attracted to a magnet, and identify some magnetic materials.
	3.FM.s5	Describe magnets as having two poles.
	3.FM.s6	Predict whether two magnets will attract or repel each other, depending on which poles are facing.
NS	3.FM.ns1	Pupils should observe that magnetic forces can act without direct contact, unlike most forces, where direct contact is necessary (for example, opening a door, pushing a swing). They should explore the behaviour and everyday uses of different magnets (for example, bar, ring, button, and horseshoe).
	3.FM.ns2	Pupils might work scientifically by: comparing how different things move and grouping them; raising questions and carrying out tests to find out how far things move on different surfaces and gathering and recording data to find answers their questions; exploring the strengths of different magnets and finding a fair way to compare them; sorting materials into those that are magnetic and those that are not; looking for patterns in the way that magnets behave in relation to each other and what might affect this, for example, the strength of the magnet or which pole faces another; identifying how these properties make magnets useful in everyday items and suggesting creative uses for different magnets.

National Curriculum for Science Requirements – Lower Key Stage 2 Programme of Study

Year 4 Living Things and their Habitats (4.LTH)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	4.LTH.s1	Recognise that living things can be grouped in a variety of ways.
	4.LTH.s2	Explore and use classification keys to help group, identify, and name a variety of living things in their local and wider environment.
	4.LTH.s3	Recognise that environments can change and that this can sometimes pose dangers to living things.
NS	4.LTH.ns1	Pupils should use the local environment throughout the year to raise and answer questions that help them to identify and study plants and animals in their habitats. They should identify how habitats change throughout the year. Pupils should explore possible ways of grouping a wide selection of living things that include animals, flowering plants, and non-flowering plants. Pupils could begin to put vertebrate animals such as fish, amphibians, reptiles, birds, and mammals; and invertebrates such as snails, slugs, worms, spiders, and insects into groups.
	4.LTH.ns2	Pupils should explore examples of human impact (both positive and negative) on environments, for example, the positive effects of nature reserves, ecologically planned parks, or garden ponds, and the negative effects of population and development, litter, or deforestation.
	4.LTH.ns3	Pupils might work scientifically by: using and making simple guides or keys to explore and identify local plants and animals; making a guide to local living things; raising and answering questions based on their observations of animals and what they have found out about other animals that they have researched.

Year 4 Animals, Including Humans (4.A)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	4.A.s1	Describe the simple functions of the basic parts of the digestive system in humans.
	4.A.s2	Identify the different types of teeth in humans and their simple functions.
	4.A.s3	Construct and interpret a variety of food chains, identifying producers, predators and prey.
NS	4.A.ns1	Pupils should be introduced to the main body parts associated with the digestive system, for example, mouth, tongue, teeth, oesophagus, stomach, and small and large intestine, and explore questions that help them to understand their special functions.
	4.A.ns2	Pupils might work scientifically by: comparing the teeth of carnivores and herbivores, and suggesting reasons for differences; finding out what damages teeth and how to look after them. They might draw and discuss their ideas about the digestive system and compare them with models or images.

National Curriculum for Science Requirements – Lower Key Stage 2 Programme of Study

Year 4 States of Matter (4.SM)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	4.SM.s1	Compare and group materials together, according to whether they are solids, liquids, or gases.
	4.SM.s2	Observe that some materials change state when they are heated or cooled, and measure or research the temperature at which this happens in degrees Celsius (°C).
	4.SM.s3	Identify the part played by evaporation and condensation in the water cycle and associate the rate of evaporation with temperature.
NS	4.SM.ns1	Pupils should explore a variety of everyday materials and develop simple descriptions of the states of matter (solids hold their shape; liquids form a pool not a pile; gases escape from an unsealed container). Pupils should observe water as a solid, a liquid, and a gas, and should note the changes to water when it is heated or cooled.
	4.SM.ns2	Pupils might work scientifically by: grouping and classifying a variety of different materials; exploring the effect of temperature on substances such as chocolate, butter, and cream (for example, to make food such as chocolate crispy cakes and ice-cream for a party). They could research the temperature at which materials change state, for example, when iron melts or when oxygen condenses into a liquid. They might observe and record evaporation over a period of time, for example, a puddle in the playground or washing on a line, and investigate the effect of temperature on washing drying or snowmen melting.

National Curriculum for Science Requirements – Lower Key Stage 2 Programme of Study

Year 4 Sound (4.S)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	4.S.s1	Identify how sounds are made, associating some of them with something vibrating.
	4.S.s2	Recognise that vibrations from sounds travel through a medium to the ear.
	4.S.s3	Find patterns between the pitch of a sound and the features of the object that produced it.
	4.S.s4	Find patterns between the volume of a sound and the strength of the vibrations that produced it.
	4.S.s5	Recognise that sounds get fainter as the distance from the sound source increases.
NS	4.S.ns1	Pupils should explore and identify the way sound is made through vibration in a range of different musical instruments from around the world; and find out how the pitch and volume of sounds can be changed in a variety of ways.
	4.S.ns2	Pupils might work scientifically by: finding patterns in the sounds that are made by different objects such as saucepan lids of different sizes or elastic bands of different thicknesses. They might make earmuffs from a variety of different materials to investigate which provides the best insulation against sound. They could make and play their own instruments by using what they have found out about pitch and volume.

Year 4 Electricity (4.E)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	4.E.s1	Identify common appliances that run on electricity.
	4.E.s2	Construct a simple series electrical circuit, identifying and naming its basic parts, including cells, wires, bulbs, switches, and buzzers.
	4.E.s3	Identify whether or not a lamp will light in a simple series circuit, based on whether or not the lamp is part of a complete loop with a battery.
	4.E.s4	Recognise that a switch opens and closes a circuit and associate this with whether or not a lamp lights in a simple series circuit.
	4.E.s5	Recognise some common conductors and insulators, and associate metals with being good conductors.
NS	4.E.ns1	Pupils should construct simple series circuits, trying different components, for example, bulbs, buzzers, and motors, and including switches, and use their circuits to create simple devices. Pupils should draw the circuit as a pictorial representation, not necessarily using conventional circuit symbols at this stage.
	4.E.ns2	Pupils might work scientifically by: observing patterns, for example, that bulbs get brighter if more cells are added, that metals tend to be conductors of electricity, and that some materials can and some cannot be used to connect across a gap in a circuit.

National Curriculum for Science Requirements – Upper Key Stage 2 Programme of Study

Working Scientifically Upper Key Stage 2 (UKS2.WS)		
During Years 5 and 6, pupils should be taught to use the following practical scientific methods, processes, and skills through the teaching of the programme of study content:		
Statutory Requirements	**Code**	**National Curriculum Statement**
	UKS2.WS.s1	Planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.
	UKS2.WS.s2	Taking measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate.
	UKS2.WS.s3	Recording data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, and bar and line graphs.
	UKS2.WS.s4	Using test results to make predictions to set up further comparative and fair tests.
	UKS2.WS.s5	Reporting and presenting findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.
	UKS2.WS.s6	Identifying scientific evidence that has been used to support or refute ideas or arguments.

National Curriculum for Science Requirements – Upper Key Stage 2 Programme of Study

Year 5 Living Things and their Habitats (5.LTH)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	5.LTH.s1	Describe the differences in the life cycles of a mammal, an amphibian, an insect, and a bird.
	5.LTH.s2	Describe the life process of reproduction in some plants and animals.
NS	5.LTH.ns1	Pupils should study and raise questions about their local environment throughout the year. They should observe life-cycle changes in a variety of living things, for example, plants in a vegetable garden or flower border, and animals in the local environment. They should find out about the work of naturalists and animal behaviourists, for example, David Attenborough and Jane Goodall.
	5.LTH.ns2	Pupils should find out about different types of reproduction, including sexual and asexual reproduction in plants, and sexual reproduction in animals.
	5.LTH.ns3	Pupils might work scientifically by: observing and comparing the life cycles of plants and animals in their local environment with other plants and animals around the world (in rainforests, oceans, desert areas, and in prehistoric times), asking pertinent questions and suggesting reasons for similarities and differences. They might try to grow new plants from different parts of the parent plant, for example, seeds, stem and root cuttings, tubers or bulbs. They might observe changes in an animal over a period of time (for example, by hatching and rearing chicks), comparing how different animals reproduce and grow.

Year 5 Animals, Including Humans (4.A)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	5.A.s1	Describe the changes as humans develop to old age.
NS	5.A.ns1	Pupils should draw a timeline to indicate stages in the growth and development of humans. They should learn about the changes experienced in puberty.
	5.A.ns2	Pupils could work scientifically by researching the gestation periods of other animals and comparing them with humans; by finding out and recording the length and mass of a baby as it grows.

National Curriculum for Science Requirements – Upper Key Stage 2 Programme of Study

Year 5 Properties and Changes of Materials (5.PCM)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	5.PCM.s1	Compare and group together everyday materials on the basis of their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal), and response to magnets.
	5.PCM.s2	Know that some materials will dissolve in liquid to form a solution, and describe how to recover a substance from a solution.
	5.PCM.s3	Use knowledge of solids, liquids, and gases to decide how mixtures might be separated, including through filtering, sieving, and evaporating.
	5.PCM.s4	Give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood, and plastic.
	5.PCM.s5	Demonstate that dissolving, mixing and changes of state are reversible changes.
	5.PCM.s6	Explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda.
NS	5.PCM.ns1	Pupils should build a more systematic understanding of materials by exploring and comparing the properties of a broad range of materials, including relating these to what they learnt about magnetism in Year 3 and about electricity in Year 4. They should explore reversible changes, including, evaporating, filtering, sieving, melting, and dissolving, recognising that melting and dissolving are different processes. Pupils should explore changes that are difficult to reverse, for example, burning, rusting, and other reactions, for example, vinegar with bicarbonate of soda. They should find out about how chemists create new materials, for example, Spencer Silver, who invented the glue for sticky notes or Ruth Benerito, who invented wrinkle-free cotton.
	5.PCM.ns2	Pupils might work scientifically by: carrying out tests to answer questions, for example, 'Which materials would be the most effective for making a warm jacket, for wrapping ice cream to stop it melting, or for making blackout curtains?' They might compare materials in order to make a switch in a circuit. They could observe and compare the changes that take place, for example, when burning different materials or baking bread or cakes. They might research and discuss how chemical changes have an impact on our lives, for example, cooking, and discuss the creative use of new materials such as polymers, super-sticky and super-thin materials.

National Curriculum for Science Requirements – Upper Key Stage 2 Programme of Study

Year 5 Earth and Space (5.ES)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	5.ES.s1	Describe the movement of the Earth, and other planets, relative to the Sun in the solar system.
	5.ES.s2	Describe the movement of the Moon relative to the Earth.
	5.ES.s3	Describe the Sun, Earth, and Moon as approximately spherical bodies.
	5.ES.s4	Use the idea of the Earth's rotation to explain day and night and the apparent movement of the sun across the sky.
NS	5.ES.ns1	Pupils should be introduced to a model of the Sun and Earth that enables them to explain day and night. Pupils should learn that the Sun is a star at the centre of our solar system and that it has eight planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune (Pluto was reclassified as a 'dwarf planet' in 2006). They should understand that a moon is a celestial body that orbits a planet (Earth has one moon; Jupiter has four large moons and numerous smaller ones).
	5.ES.ns2	Pupils should learn how ideas about the solar system have developed, understanding how the geocentric model of the solar system gave way to the heliocentric model by considering the work of scientists such as Ptolemy, Alhazen, and Copernicus.
	5.ES.ns3	Pupils might work scientifically by: comparing the time of day at different places on the Earth through Internet links and direct communication; creating simple models of the solar system; constructing simple shadow clocks and sundials, calibrated to show midday and the start and end of the school day; finding out why some people think that structures such as Stonehenge might have been used as astronomical clocks.

National Curriculum for Science Requirements – Upper Key Stage 2 Programme of Study

Year 5 Forces (5.F)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	5.F.s1	Explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object.
	5.F.s2	Identify the effects of air resistance, water resistance, and friction, that act between moving surfaces.
	5.F.s3	Recognise that some mechanisms, including levers, pulleys, and gears, allow a smaller force to have a greater effect.
NS	5.F.ns1	Pupils should explore falling objects and raise questions about the effects of air resistance. They should explore the effects of air resistance by observing how different objects such as parachutes and sycamore seeds fall. They should experience forces that make things begin to move, accelerate, or slow down. Pupils should explore the effects of friction on movement and find out how it slows or stops moving objects, for example, by observing the effects of a brake on a bicycle wheel. Pupils should explore the effects of levers, pulleys, and simple machines on movement. Pupils might find out how scientists, for example, Galileo Galilei and Isaac Newton helped to develop the theory of gravitation.
	5.F.ns2	Pupils might work scientifically by: exploring falling paper cones or cupcake cases, designing and making a variety of parachutes, and carrying out fair tests to determine which designs are the most effective. They might explore resistance in water by making and testing boats of different shapes. They might design and make products that use levers, pulleys, gears, and/or springs, and explore their effects.

National Curriculum for Science Requirements – Upper Key Stage 2 Programme of Study

Year 6 Living Things and their Habitats (6.LTH)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	6.LTH.s1	Identify and describe the functions of different parts of flowering plants: roots, stem/trunk, leaves, and flowers.
	6.LTH.s2	Explore the requirements of plants for life and growth (air, light, water, nutrients from soil, and room to grow) and how they vary from plant to plant.
NS	6.LTH.ns1	Pupils should build on their learning about grouping living things in Year 4, by looking at the classification system in more detail. They should be introduced to the idea that broad groupings, such as micro-organisms, plants, and animals can be subdivided. Through direct observations where possible, they should classify animals into commonly found invertebrates (such as insects, spiders, snails, worms) and vertebrates (fish, amphibians, reptiles, birds and mammals). They should discuss reasons why living things are placed in one group and not another.
	6.LTH.ns2	Pupils might find out about the significance of the work of scientists such as Carl Linnaeus, a pioneer of classification.
	6.LTH.ns3	Pupils might work scientifically by: using classification systems and keys to identify some animals and plants in the immediate environment. They could research unfamiliar animals and plants from a broad range of other habitats and decide where they belong in the classification system.

Year 6 Animals, Including Humans (6.A)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	6.A.s1	Identify and name the main parts of the human circulatory system, and describe the functions of the heart, blood vessels, and blood.
	6.A.s2	Recognise the impact of diet, exercise, drugs, and lifestyle on the way their bodies function.
	6.A.s3	Describe the ways in which nutrients and water are transported within animals, including humans.
NS	6.A.ns1	Pupils should build on their learning from Years 3 and 4, about the main body parts and internal organs (skeletal, muscular, and digestive system) to explore and answer questions that help them to understand how the circulatory system enables the body to function.
	6.A.ns2	Pupils should learn how to keep their bodies healthy and how their bodies might be damaged – including how some drugs and other substances can be harmful to the human body.
	6.A.ns3	Pupils might work scientifically by: exploring the work of scientists and scientific research about the relationship between diet, exercise, drugs, lifestyle, and health.

National Curriculum for Science Requirements – Upper Key Stage 2 Programme of Study

Year 6 Evolution and Inheritance (6.EI)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	6.EI.s1	Recognise that living things have changed over time and that fossils provide information about living things that inhabited the Earth millions of years ago.
	6.EI.s2	Recognise that living things produce offspring of the same kind, but normally offspring vary and are not identical to their parents.
	6.EI.s3	Identify how animals and plants are adapted to suit their environment in different ways and that adaptation may lead to evolution.
NS	6.EI.ns1	Building on what they learned about fossils in the topic on rocks in Year 3, pupils should find out more about how living things on earth have changed over time. They should be introduced to the idea that characteristics are passed from parents to their offspring, for instance by considering different breeds of dogs, and what happens when, for example, labradors are crossed with poodles. They should also appreciate that variation in offspring over time can make animals more or less able to survive in particular environments, for example, by exploring how giraffes' necks became longer, or the development of insulating fur on the arctic fox. Pupils might find out about the work of palaeontologists such as Mary Anning and about how Charles Darwin and Alfred Wallace developed their ideas on evolution.
	6.EI.ns2	Pupils might work scientifically by: observing and raising questions about local animals and how they are adapted to their environment; comparing how some living things are adapted to survive in extreme conditions, for example, cactuses, penguins, and camels. They might analyse the advantages and disadvantages of specific adaptations, such as being on two feet rather than four, having a long or a short beak, having gills or lungs, tendrils on climbing plants, or brightly coloured and scented flowers.

National Curriculum for Science Requirements – Upper Key Stage 2 Programme of Study

Year 6 Light (6.L)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	6.L.s1	Recognise that light appears to travel in straight lines.
	6.L.s2	Use the idea that light travels in straight lines to explain that objects are seen because they give out or reflect light into the eye.
	6.L.s3	Explain that we see things because light travels from light sources to our eyes or from light sources to objects and then to our eyes.
NS	6.L.ns1	Pupils should build on the work on light from Year 3, exploring the way that light behaves, including light sources, reflection, and shadows. They should talk about what happens and make predictions.
	6.L.ns2	Pupils might work scientifically by: deciding where to place rear-view mirrors on cars; designing and making a periscope, and using the idea that light appears to travel in straight lines to explain how it works. They might investigate the relationship between light sources, objects, and shadows by using shadow puppets. They could extend their experience of light by looking at a range of phenomena including rainbows, colours on soap bubbles, objects appearing to bend when viewed through water, and coloured filters (they do not need to explain why these phenomena occur).

Year 6 Electricity (6.E)		
	Code	**National Curriculum Statement** *Pupils should be taught to:*
S	6.E.s1	Associate the brightness of a lamp or the volume of a buzzer with the number and voltage of cells used in the circuit.
	6.E.s2	Compare and give reasons for variations in how components function, including the brightness of bulbs, the loudness of buzzers, and the on/off position of switches.
	6.E.s3	Use recognised symbols when representing a simple circuit in a diagram.
NS	6.E.ns1	Building on their work in Year 4, pupils should construct simple series circuits, to help them to answer questions about what happens when they try different components, for example, switches, bulbs, buzzers, and motors. They should learn how to represent a simple circuit in a diagram using recognised symbols.
	6.E.ns2	Pupils might work scientifically by: systematically identifying the effect of changing one component at a time in a circuit; designing and making a set of traffic lights, a burglar alarm, or some other useful circuit.

Assess with WeDo 2.0

There are many ways to monitor and assess your pupils' progress through a WeDo 2.0 project. Here are some useful assessment tools:

- Anecdotal record grid
- Observation rubrics grid
- Documentation pages
- Self-assessment statements

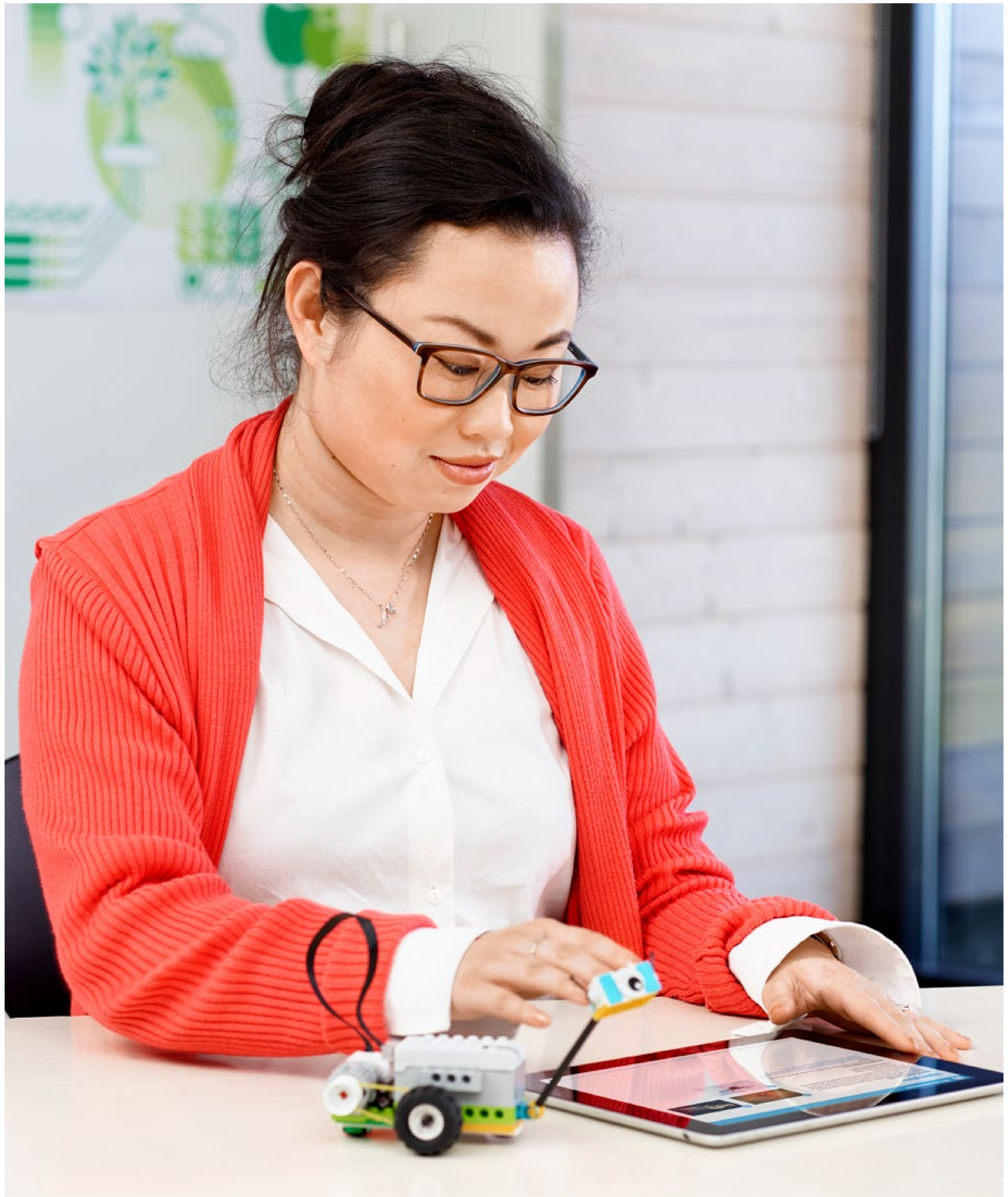
Teacher-led assessment

Developing pupils' science and engineering practices takes time and feedback. Just as in the design cycle, in which pupils should know that failure is part of the process, assessment should provide feedback to pupils in terms of what they did well and where they can improve.

Problem-based learning is not about succeeding or failing. It is about being an active learner and continually testing and building upon ideas.

Anecdotal record grid

The anecdotal record grid lets you record any type of observation you believe is important about each pupil. Use the template on the next page to provide feedback to pupils about their learning progress as required.



Anecdotal record grid

Name: Class: Project:

Emerging	Developing	Proficient	Accomplished

Notes:

Teacher-led assessment

Observation rubrics
An example rubrics has been provided for every Guided Project. You can use the observation rubrics grid to:
- Evaluate pupil/team performance at each step of the process.
- Provide constructive feedback to help the pupil/team to progress.

Observation rubrics provided in the Guided Projects can be adapted to fit your needs. The rubrics are based on these progressive stages:

1. Emerging
The pupil is at the beginning stages of development in terms of content knowledge, ability to understand and apply content, and/or demonstration of coherent thoughts about a given topic.

2. Developing
The pupil is able to present basic knowledge only (vocabulary, for example), and cannot yet apply content knowledge or demonstrate comprehension of concepts being presented.

3. Proficient
The pupil has concrete levels of comprehension of content and concepts and can demonstrate adequately the topics, content, or concepts being taught. The ability to discuss and apply outside the required assignment is lacking.

4. Accomplished
The pupil can take concepts and ideas to the next level, apply concepts to other situations, and synthesise, apply, and extend knowledge to discussions that include extensions of ideas.

Suggestion

You can use the observation rubrics grid on the next page to keep track of your pupils' progress.

Observation rubrics grid

Class:		Project																	
Pupils' names		Scientific understanding			English, presentation & problem-solving														
		Explore	Create	Share	Explore	Create	Share												
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11																			
12																			
13																			
14																			
15																			

To be used with the rubrics description in the “Guided Projects” chapter (1. Emerging, 2. Developing, 3. Proficient, 4. Accomplished).

Pupil-led assessment

Documentation pages

Each project will ask pupils to create documents to summarise their work.
To have a complete science report, it is essential that pupils:

- Document with various types of media.
- Document every step of the process.
- Take the time to organise and complete their documents.

It is most likely that the first document your pupils complete will not be as good as the next one:

- Allow them time and feedback to see where and how they can improve it.
- Ask your pupils to share their documents with each other. By communicating their scientific findings, pupils are engaged in the work of scientists.

Self-assessment statements

After each project, pupils can reflect on the work they have done. Use the following page to encourage reflection and set goals for the next project.

Pupil self-assessment rubric

Name: Class: Project:

	Explore	Create	Share
	I documented and used my best reasoning in connection with the question or problem.	I did my best work to solve the problem or question by building and programming my model and making changes when needed.	I documented important ideas and evidence throughout my project and did my very best when presenting to others.
1			
2			
3			
4			

Project reflection

One thing I did really well was:

One thing I want to improve on for next time is:

Classroom Management

In this chapter, you will find information and guidance to help with the implementation of WeDo 2.0 in your classroom.

The secret for success resides in these key elements:

- Good material preparation
- Good classroom disposition
- Good WeDo 2.0 project preparation
- Good guidance of pupils

Prepare the material

1. Install the software on the computers or tablets.
2. Open each LEGO® Education WeDo 2.0 Core Set and sort the elements.
3. Attach the labels to the relevant sorting tray compartments.
4. It is a good idea to label the box, Smarthub, motor, and sensors with a number. That way, you can assign a numbered kit to each pupil or team. You may find it helpful to also display the parts list in the classroom.
5. Put two AA batteries in the Smarthub or use the supplementary Smarthub rechargeable battery.

Suggestion

To improve your classroom experience, it is recommended that you allocate a name, from the list in the Connection Centre, to each Smarthub.

When you access the Connection Centre:
1. Press on the button on the Smarthub.
2. Locate the Smarthub name in the list.
3. Long Press on the name you wish to change.
4. At this point, you will be able to enter a name of your choice.

You can insert names following a code, such as:
- WeDo-001,
- WeDo-002,
- etc.

This will make it easier for the pupils to locate and connect with the right Smarthub.

Before you start a project

Classroom disposition

1. Designate a cabinet, trolley cart, or other space for storing the sets between sessions.
2. If not already available in your classroom, prepare a box of measuring tools, such as rulers or tape measures, and paper for collecting data and making charts.
3. Ensure that there is enough space in the classroom for the project to take place.
4. When planning the projects, ensure that there is enough time for the pupils to put their models and parts away at the end of each session.

Teacher preparation

1. Spend some time exploring the bricks in the WeDo 2.0 set, and determine key expectations for classroom use.
2. Set aside an hour to try the Getting Started Project, as if you were one of the pupils.
3. Read the overview and projects description in the “Open Projects” chapter and select the project you wish to complete.
4. Review the planning of the project you have selected.

Now you’re ready to go!

Pupil guidance

It is important to establish good classroom management habits when working with the WeDo 2.0 sets and digital devices.

It may be helpful to establish clear expectations for team roles:

- WeDo 2.0 projects are optimal for a team of two pupils working together.
- Ask the pupils to work to their strengths within their groups.
- Make adjustments to suit teams who are ready to develop new skills and improve further.
- Assign, or ask the pupils to determine, specific roles for each team member.

Suggestion

Assign a role to each pupil so that the team can foster collaboration and cooperation skills. Here are a few ideas/examples:

- Selector – chooses the bricks
- Builder – assembles the bricks
- Programmer – creates the program strings
- Documenter – takes photographs and videos
- Presenter – explains the project
- Team captain

It is also a good idea to rotate roles. This allows the pupils to experience all of the components involved in each project, and will help them to develop a wider range of skills.

Getting Started Projects

Milo the Science Rover
52-56

Milo's Motion Sensor
57-58

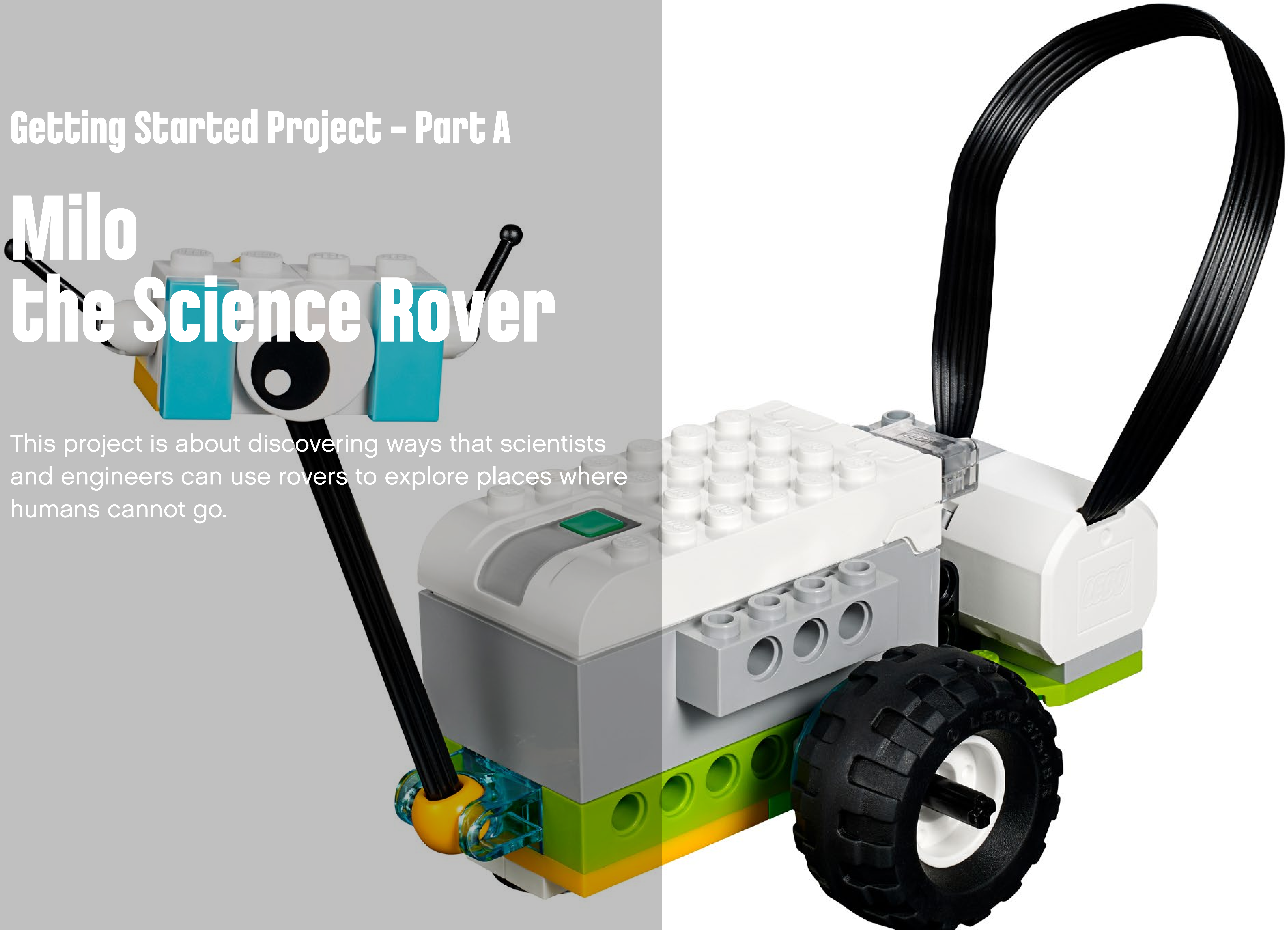
Milo's Tilt Sensor
59-60

Collaborate
61-62

Getting Started Project – Part A

Milo
the Science Rover

This project is about discovering ways that scientists and engineers can use rovers to explore places where humans cannot go.



Quick glance: Getting Started Project, part A

Preparation: 30 min.

- For information regarding general preparation, please see the “Classroom Management” chapter.
- Read through this project so you have a good idea of what to do.
- Prepare to introduce this project to your pupils.
- Define your expectations and theirs.
- Determine the end result of this project: Everyone should have a chance to build, program, and document.
- Make sure that timing allows for expectations to be met.

Explore phase: 10 min.

- Start the project using the introductory video.
- Have a group discussion.

Create phase: 20 min.

- Ask the pupils to build the first model from the provided building instructions.
- Ask them to program the model using the sample program.
- Allow pupils time so they can make their own experiments and change the parameters of the program.
- Challenge them to discover new programming blocks on their own.

Share phase: 10 min.

Some suggestions for sharing include:

- Make sure your pupils take photographs of their models.
- Make sure they write their names and comments in the Documentation tool.
- Ask the pupils to export the results of their projects and share them with their parents.

Important

It is recommended that you complete the four Getting Started Projects in a single sequence. If not, it is recommended that you complete these before moving on to other projects. This will give the pupils ample time to explore the materials.

Approximate timing for the four Getting Started Projects is:

- Part A: Milo the Science Rover: 40 min.
- Part B: Milo’s Motion Sensor: 15 min.
- Part C: Milo’s Tilt Sensor: 15 min.
- Part D: Collaborate: 15 min.

Explore phase

Use the introductory video

Scientists and engineers have always challenged themselves to explore remote places and make new discoveries. To make this possible, they have designed spacecraft, rovers, satellites, and robots that enable them to collect data and make visual observations of previously inaccessible places. They have succeeded many times, but have also failed many times. Remember that failure presents a chance to learn. Use the following ideas to start thinking like a scientist:

1. Scientists send rovers to Mars.
2. They use submarines in water.
3. They fly drones into volcanoes.

Questions for discussion

1. What do scientists and engineers do when they cannot go where they want to explore?

   Scientists and engineers see these situations as challenges that need to be overcome. With proper resources and commitment, they will develop prototypes of possible solutions and ultimately choose the best option.

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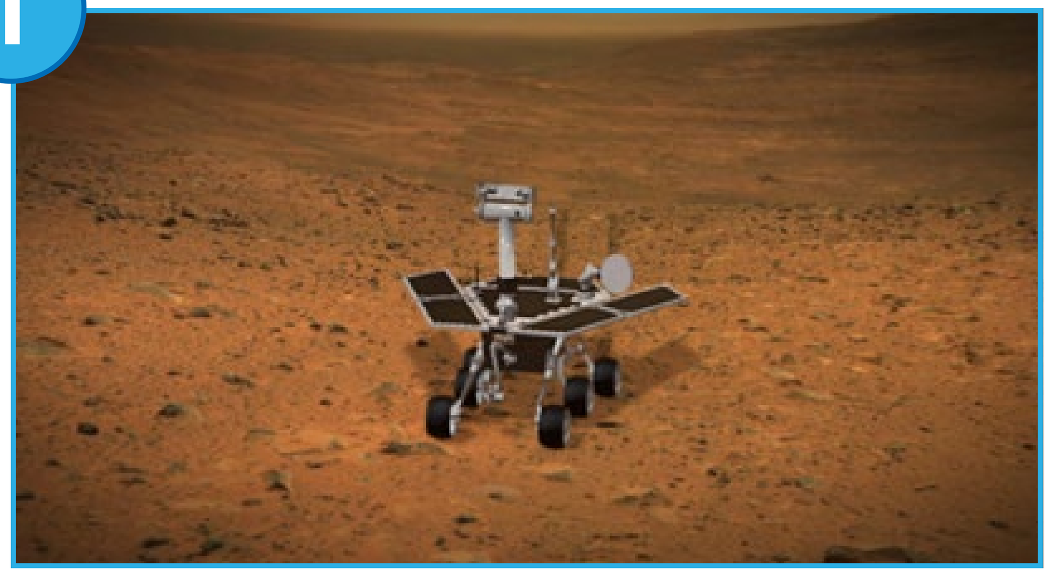

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Create phase

Build and program Milo

Pupils should follow the building instructions to build Milo the Science Rover.

1. Build Milo the Science Rover.

This model will give pupils a “first build” experience with WeDo 2.0.

Important

Make sure everyone can connect the motor to the Smarthub, and the Smarthub to the device.

2. Program Milo.

This program will start the motor at power eight, travel in one direction for two seconds, and then stop.

The motor can be started in both directions, stopped and turned at different speeds, and activated for a specific amount of time (specified in seconds).

Suggestion

Give pupils time to change the parameters of this program string. Let them discover new features, such as adding sound.

Use this opportunity to guide pupils to the Design Library, where they can find inspiration to explore other program strings.

Share phase

Present

Before you move on to the next part of the Getting Started Project, allow the pupils to express themselves:

- Have a short discussion with your pupils about scientific and engineering instruments.
- Ask your pupils to describe how science rovers are helpful to humans.

Document

- Introduce the pupils to the Documentation tool.
- Ask them to take photographs of themselves together with their models.

Getting Started Project – Part B

Milo's Motion Sensor

In this section, pupils will be introduced to the use of the Motion Sensor to detect the presence of a special plant specimen.

Using a Motion Sensor

Explore phase

Rovers sent to remote locations need to have sensors so that they can complete tasks without the need for constant human attention.

Questions for discussion

1. How are science instruments important to the tasks that scientists have to complete?
   Rovers are fitted with sensors that tell them when to move and when to stop. This makes them suitable for carrying out research In remote locations.

Create phase

Your pupils will follow the provided building instructions to create a robotic arm that incorporates the Motion Sensor, making it possible for Milo to detect the plant sample. They will also build a plant sample on a LEGO® round plate.

The provided program string will make the rover move forward until it detects the presence of the sample object. It will then stop and make a sound.

Ask the pupils to record a sound that will signify the rover's discovery.

Share phase

Ask your pupils to record a video of their mission. They will practice using the camera and recording themselves, which will be useful for future projects.

Getting Started Project – Part C

Milo's Tilt Sensor

In this section, pupils will be introduced to the use of the Tilt Sensor to help Milo send a message to the base.

Introduce the use of a Tilt Sensor

Explore phase
When rovers locate what they are looking for, they send a message back to the base.

Questions for discussion
1. Why is communication between a rover and its base so important?
   If a rover successfully completes a series of tasks, but fails to send back the results, the mission will be deemed a failure. A communication link between the remote rover and the base is essential.
2. How do we communicate with rovers?
   Currently, satellites are used to transmit radio signals between the base and the rover.

Create phase
Using the Tilt Sensor and the provided building instructions, your pupils will build a device that can send a message back to the base.

The program string will trigger two actions, depending on the angle detected by the Tilt Sensor:
- If tilted down, the red LED will light up.
- If tilted up, a text message will appear on the device.

Share phase
Make sure that each pupil takes a screenshot of their final program. Ask them to practise documenting the program strings they used in their project.

Getting Started Project – Part D

Collaborate

In this section, pupils will be introduced to the importance of collaborating during projects.

Collaborate with other rovers

Explore phase

Now that your rover has found the plant sample, it is time to carry it back. But wait. It might be too heavy! Let's see if you can collaborate with another rover to move the sample forward together.

Create phase

Pair up the teams to complete this final part of the mission:

1. Ask them to build the transportation device, physically connecting the two rovers together.
2. Let pupils create their own program strings to move the specimen from a point A to a point B.
   Pupils could use the following program strings.
3. When everyone is ready, ask the teams to carefully move their plant samples.

Suggestion

Note that you can connect up to three Smarthubs to the same tablet; for teams working on their own. See the "Toolbox" chapter for instructions.

Share phase

Ask the pupils to discuss their experiences:

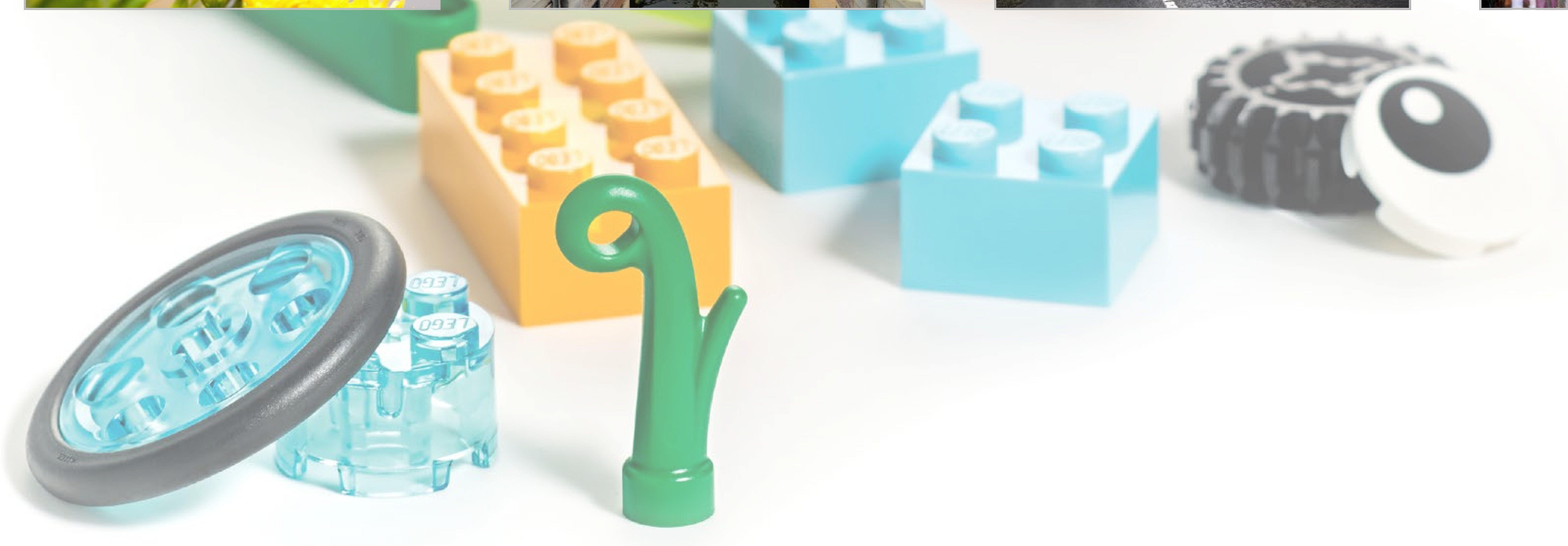
- Why is it important to collaborate when solving a problem?
- Give an example of good communication among teams.

Finally, ask the pupils to complete their document with the Documentation tool while collecting and organising important information.

Important

Because not all the WeDo motors are the same, teams will have to collaborate in order to succeed.

Guided Projects overview



Project 1

Pulling

This project is about investigating the effects of balanced and unbalanced forces on the movement of an object.

Curriculum links

National Curriculum for science
(See page 23 for how this project addresses non-statutory requirements, and requirements for working scientifically)

3.FM.s1: Compare how things move on different surfaces.

5.F.s2: Identify the effects of air resistance, water resistance and friction, that act between moving surfaces.
5.F.s3: Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

Other National Curriculum links
Design and technology
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.
Evaluate:
Evaluate their ideas and products against their own design criteria and consider the views of others to improve their work.
Technical knowledge:
Apply their understanding of how to strengthen, stiffen, and reinforce more complex structures.
Understand and use mechanical systems in their products [for example, gears, pulleys, cams, levers, and linkages].
Understand and use electrical systems in their products [for example, series circuits incorporating switches, bulbs, buzzers, and motors].
Apply their understanding of computing to program, monitor, and control their products.

Computing
Design, write, and debug programs that accomplish specific goals, including controlling or simulating physical systems.
Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs.
Select, use, and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems, and content that accomplish given goals, including collecting, analysing, evaluating, and presenting data and information.

Quick glance: Plan this WeDo 2.0 project

Preparation: 30 min.
- Read about general preparation in the “Classroom Management” chapter.
- Read about the project so you have a good idea of what to do.
- Define how you want to introduce this project: Use the video provided for the project in the WeDo 2.0 Software, or use material of your own choice.
- Determine the end result of this project: the parameters to present and produce the document.
- Make sure that timing allows for expectations to be met.

Important

This project is an investigation; please refer to the “WeDo 2.0 in Curriculum” chapter for further explanations of investigative practices.

Explore phase: 30-60 min.
- Start the project using the introductory video.
- Have a group discussion.
- Allow the pupils to document their ideas for Max and Mia’s questions using the Documentation tool.

Create phase: 45-60 min.
- Ask the pupils to build the first model using the provided building instructions.
- Allow them to program the model using the sample program.
- Allow them time to test different combinations with different objects. Explain what is happening in terms of balanced and unbalanced forces.

Create more phase (optional): 45-60 min.
- You can use this extension of the project for differentiation or for older pupils.

Share phase: 45 min. or more
- Make sure your pupils document the results of each test.
- Ask the pupils to share their findings based on the information gathered during their investigations.
- Ask them to predict the outcome resulting from the addition of weight.
- Ask the pupils to create their final presentations.
- Find different ways to let the pupils share their results.
- Ask the pupils to present their projects.

Suggestion

Have a look at the following “Open Projects” when you have completed this project:
- Cleaning the Oceans
- Space Exploration

Differentiation

It is recommended that you start with this project.

To ensure success, consider giving more guidance on building and programming, such as:

- Explain the use of motors.
- Explain simple program strings.
- Explain how to conduct an investigation.
- Define factors to focus on, such as pull and friction forces.

Be specific about how you would like them to present and document their findings. For example, a team sharing session.

Investigate more

For an additional challenge, allow extra time for experimentation with pupil-created design, building, and programming. This will allow them to explore the additional laws of push and pull.

To extend the investigation, ask your pupils to compare the strength of their robots by pairing them in a tug-of-war contest. Prepare for the excitement!

Pupils' misconceptions

Pupils are likely to believe that if something is not moving, there are no forces acting upon it. A good example to demonstrate this is trying to move a car when the handbrake is on. Because the car is not moving, pupils tend to believe that there are no forces involved, yet there is. Scientifically, it's understood that several balanced forces are at work.

Vocabulary

Force
Push or pull upon an object
Net force
Overall force acting on an object
Friction
The resisting force when two objects are in contact
Static friction
Force that occurs when two objects are not moving relative to one another (example: a desk on a floor)
Rolling friction
Force that occurs when one object rolls on another (example: car wheels on a road)
Kinetic friction or sliding friction
Force that occurs when two objects are moving relative to one other and rub together (example: a sledge on snow)
Equilibrium
The condition in which all forces are balanced or cancelled by equal opposing forces. In other words, when net force equals 0.

Scientific understanding assessment rubrics

You can use these assessment rubrics with the observation rubrics grid, which you can find in the “Assess with WeDo 2.0” chapter.

Explore phase

During the Explore phase, make sure each pupil is actively involved in the discussion, asks and answers questions, and correctly uses the terms push and pull, forces, and friction.

1. The pupil is unable to provide answers to questions, participate in discussions, or adequately describe the ideas of “push and pull” and relate to them as forces.
2. The pupil is able, with prompting, to adequately provide answers to questions or participate in discussions, or with help, describe “push and pull” as an example of force.
3. The pupil is able to provide adequate answers to questions, participate in class discussions, or describe push and pull as an example of force.
4. The pupil is able to extend explanations in discussion or describe in detail the concept of force with push and pull.

Create phase

During the Create phase, make sure that each pupil is working as part of a team, can make predictions about events, and can use the information gathered during the Explore phase.

1. The pupil is unable to work as part of a team, make predictions about events, or use gathered information.
2. The pupil is able to work as part of a team and predict, with help, what might happen during the investigation.
3. The pupil is able, with guidance, to gather and use information, work as part of a team, contribute to team discussions, make predictions, and gather information to use in a presentation.
4. The pupil is able to work as part of a team, serve as the leader, and use gathered information to justify predictions that explain the forces of push and pull.

Share phase

During the Share phase, make sure that each pupil can explain what is happening with their model in terms of force, has tested different combinations and can predict others, and can use important information from the project to create a final report.

1. The pupil is unable to engage in the discussion about the investigation, explain the model using the concept of force, or use information to create a final project.
2. The pupil is able, with prompting, to engage in the discussion about forces, complete multiple testing scenarios in order to make predictions, and use limited information to create a final project.
3. The pupil is able to engage in discussions about the investigation of forces and use the information gathered during testing to produce a final project.
4. The pupil is able to engage extensively in class discussions about the topic, and use the information gathered to create a final project that includes additional elements.

English, presentation and problem-solving assessment rubrics

You can use these assessment rubrics with the observation rubrics grid, which you can find in the “Assess with WeDo 2.0” chapter.

Explore phase

During the Explore phase, make sure that each pupil can effectively explain their own ideas and comprehension in relation to the questions posed.

1. The pupil is unable to share his/her ideas in relation to the questions posed during the Explore phase.
2. The pupil is able, with prompting, to share his/her ideas in relation to the questions posed during the Explore phase.
3. The pupil adequately expresses his/her ideas in relation to the questions posed during the Explore phase.
4. The pupil uses details to extend explanations of his/her ideas in relation to the questions posed during the Explore phase.

Create phase

During the Create phase, make sure that each pupil makes appropriate choices (i.e., screenshot, image, video, text) and follows the established expectations for documenting their findings.

1. The pupil fails to document findings throughout the investigation.
2. The pupil documents his/her findings, but the documentation is incomplete or does not comply with all of the established expectations.
3. The pupil adequately documents findings for each part of the investigation and makes appropriate choices and selections.
4. The pupil uses a variety of appropriate methods for documentation and exceeds the established expectations.

Share phase

During the Share phase, make sure that each pupil uses the evidence that they gathered during their investigations to justify their reasoning, and that they adhere to established guidelines when presenting their findings to an audience.

1. The pupil does not use evidence from his/her findings during the presentation or does not follow established guidelines.
2. The pupil uses some evidence from his/her findings, but the justification is limited. In general, established guidelines are followed, but may be lacking in one or more areas.
3. The pupil adequately provides evidence to justify his/her findings and follows established guidelines for presenting.
4. The pupil fully discusses his/her findings and thoroughly utilises appropriate evidence to justify his/her reasoning, while following all established guidelines.

Explore phase

The introductory video may set the stage for the following ideas to be reviewed and discussed with pupils.

Introductory video

It has been a long time since humans first attempted to move large objects around. From ancient civilisations to the modern age, various tools have been used to push or pull objects.

1. When you do not succeed in pulling something, it is because it is being pulled in the opposite direction with the same or a greater amount of force.
2. When an object starts to move, the force is greater in the direction of the movement.
3. On earth, friction has a role to play.
4. It is easier to pull a weight along a smooth surface than it is along a rough surface, due to the reduction in friction.

The topic of force and motion was explored and explained in detail by Sir Isaac Newton in the 17th century. You experience the laws of physics, that Newton defined, on a daily basis.

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Explore phase

Questions for discussion

1. Name different ways in which an object can be moved.
   To make it move, pull or push it, or, more generally, apply a force to it.
2. Can you explain friction? Is it easier to pull something on a normal surface than on a slippery one?
   This question refers to friction. It is easier to move an object on a slippery surface than on a rough one.
   Depending on the mass of an object, it can also be more difficult to move the object on a slippery surface, because there is less grip to push or pull it.
3. Predict what will happen if the pull force is greater in one direction than the other.
   This answer should be based on pupils' predictions. This means that at this point, your pupils' answers may be incorrect. After the lesson, pupils should be able to discuss the fact that the motion of an object depends on the direction of the greater force.

Ask your pupils to collect their answers with text or pictures in the Documentation tool.

Other questions to explore

1. Can you describe the relationship between balanced forces and an object's ability to move?
   Unbalanced forces can cause a change in an object's motion (speeding up, slowing down, etc.)

Create phase

Build and program a Pull-robot
Pupils will follow the building instructions to create a Pull-robot. The Pull-robot will pull various objects that are placed in its basket. This investigation can be carried out on various types of surfaces, such as wood or carpet. Use the same surface for the entire project.

1. Build a Pull-robot.
The wobble module featured in this project uses a bevel gear. This bevel gear changes the axis of rotation, from vertical to horizontal, bringing the motion from the motor to the wheels.

The basket has sliding bricks to reduce friction.

2. Program the robot to pull an object.
This program will display a 3, 2, 1 countdown before the motor turns on for two seconds at motor power 10.

Suggestion

Before your pupils begin their investigations, ask them to adjust the parameters of the program so that they fully understand it.

Create phase

Test the Pull-robot
Using this model, pupils should be able to conduct an investigation about pull forces.

1. Investigate by adding light objects and then heavy objects to the basket until the device stops moving.
It will take around 300 grams on a regular surface to stop the Pull-robot from moving. Pupils can use any object, but nothing too heavy, as the goal is to reach equilibrium. At that point, pupils have balanced forces in front of them. You can use an arrow to symbolise the direction of the force.

You can also use the small tyres as objects to place in the basket. They will increase the friction on the basket side.

2. With the same amount of bricks in the basket, put the large tyres on the model and carry out tests.
Ask the pupils to put the tyres on the Pull-robot. This will cause the friction between the wheels and the surface to be greater on the Pull-robot side, increasing the force pulling in that direction. The system will suddenly become unbalanced.

This evidence supports the idea that when a pull force is greater than opposing forces, objects should move.

3. Find the heaviest object you can pull with your model when it is fitted with tyres.
This final step will depend on the friction of the surface.

Create phase

Use the “Investigate more” section of the pupil project as an optional extension. Keep in mind that these tasks are an extension of the “Investigate” section and are designed for older or more advanced pupils.

Investigate more

The Pull-robot that pupils are working with uses a bevel gear mechanism to change the direction of the motor rotation. It does not greatly increase the strength of the movement.

1. Build a different Pull-robot.

Ask the pupils to explore new designs for a pull machine. Ask them to build their own models, carry out the same tests as with their original Pull-robot, and compare the results of the two investigations. The pupils can refer to the Design Library for inspiration.

Collaboration suggestion

Find the most powerful machine in the classroom

When the pupils have finished their tests, organise a tug-of-war contest:

- Pair up two teams.
- Attach the robots back-to-back with the LEGO® chain.
- Ask the teams to place equal amounts of weight and mass in the baskets before starting the contest.
- Tell them to start their motors at your signal, so that they pull away from each other. Which is the strongest?

Share phase

Complete the document

Ask the pupils to document their projects in different ways:

- Ask them to take screenshots of their results.
- Ask them to compare images of their models with real-life images.
- Ask them to record project presentation videos.

Suggestions

Pupils may collect data in a chart format or on a spreadsheet.
Pupils may also graph the results of their tests.

Present results

At the end of this project, pupils should present the results of their investigations.

To enhance your pupils' presentation:

- Make sure pupils use words like balanced force, unbalanced force, push, pull, friction, and weight.
- Ask them to use arrows to represent force.
- Ask them to put their explanations into context.
- Ask them to analyse their projects in terms of real-life situations in which they have observed balanced and unbalanced forces.
- Discuss the connection between their findings and these particular situations.

Pulling

A possible way of sharing

Pupils explain the maximum weight that they could pull and whether the force is balanced or unbalanced.

Project 2

Speed

This project is about investigating the factors that make a car go faster and predicting future motion.

Curriculum links

National Curriculum for science

(See page 23 for how this project addresses non-statutory requirements, and requirements for working scientifically)

5.F.s3: Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

Other National Curriculum links

Design and technology

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.

Evaluate:

Evaluate their ideas and products against their own design criteria and consider the views of others to improve their work.

Technical knowledge:

Understand and use mechanical systems in their products [for example, gears, pulleys, cams, levers, and linkages].

Understand and use electrical systems in their products [for example, series circuits incorporating switches, bulbs, buzzers, and motors].

Apply their understanding of computing to program, monitor, and control their products.

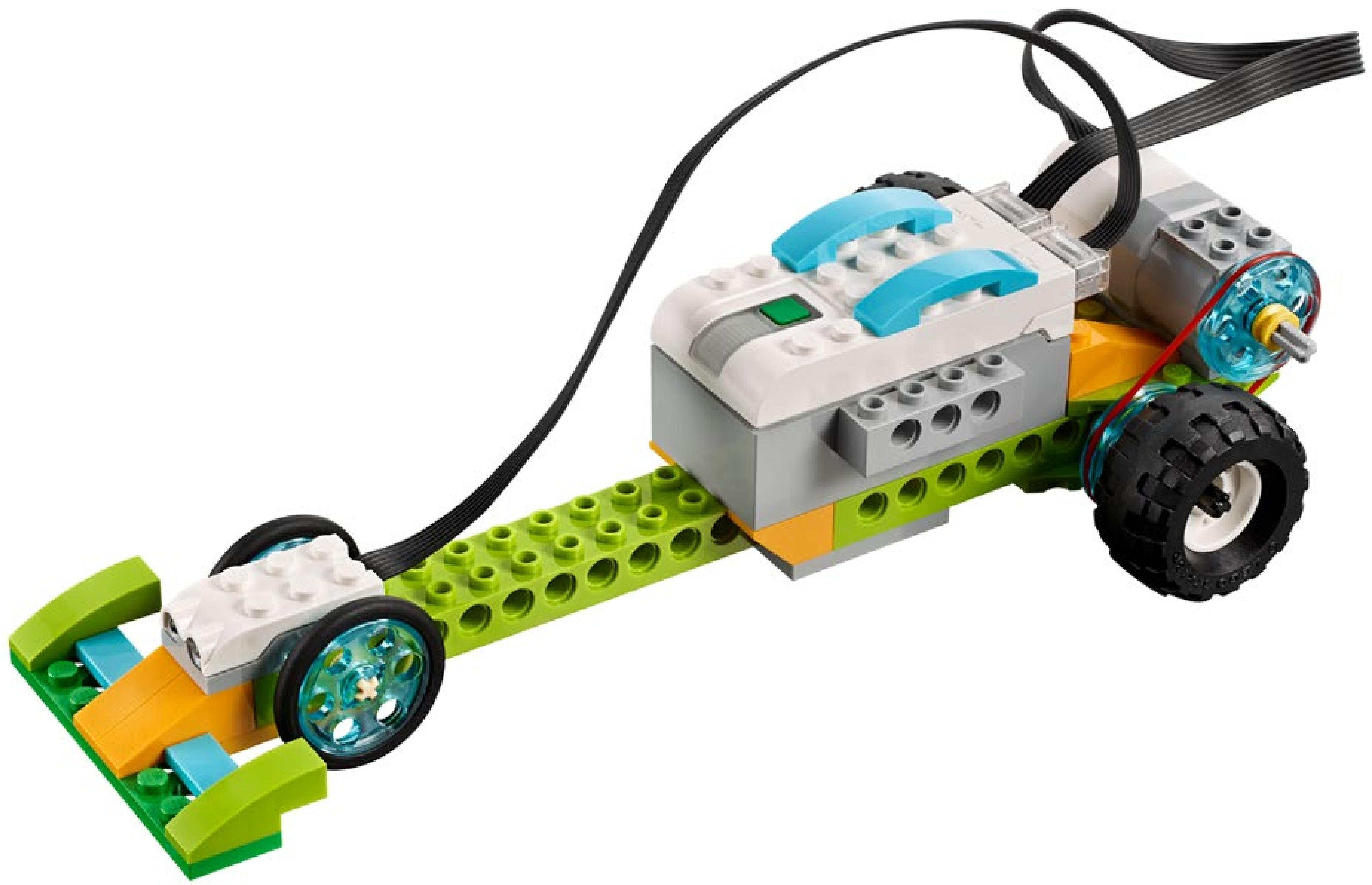
Computing

Design, write, and debug programs that accomplish specific goals, including controlling or simulating physical systems.

Use sequence, selection, and repetition in programs; work with variables and various forms of input and output.

Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs.

Select, use, and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems, and content that accomplish given goals, including collecting, analysing, evaluating, and presenting data and information.



Quick glance: Plan this WeDo 2.0 project

Preparation: 30 min.
- Read the general preparation in the “Classroom Management” chapter.
- Read about the project so you have a good idea of what to do.
- Define how you want to introduce this project: Use the video provided in the project in the WeDo 2.0 Software, or use material of your own choice.
- Determine the end result of this project: the parameters to present and produce the document.
- Make sure that timing allows for expectations to be met.

Important

This project is an investigation; please refer to the “WeDo 2.0 in Curriculum” chapter for further explanation of investigative practices.

Explore phase: 30-60 min.
- Start the project using the introductory video.
- Hold a group discussion.
- Allow pupils to document their ideas for Max and Mia’s questions, using the Documentation tool.

Create phase: 45-60 min.
- Ask the pupils to build the first model from the provided building instructions.
- Ask the pupils to use a minimum distance of 2m or more. Ask the pupils to mark a starting point and set up a barrier that will cause the car to stop.
- Allow them to program the model using the sample program.
- Allow time for them to test the different combinations to make the car go faster.

Create more phase (optional): 45-60 min.
- You can use this extension of the project for differentiation or for older pupils.

Share phase: 45 min. or more
- Make sure your pupils document the results of each test.
- Ask the pupils to share their findings based on the information gathered during their investigations.
- Ask them to predict the pattern resulting from doubling the distance.
- Ask the pupils to create their final presentations.
- Find different ways to let the pupils share their results.
- Ask the pupils to present their projects.

Suggestion

Have a look at the following “Open Projects” when you have completed this project:
- Space Exploration
- Moving materials

Differentiation

To ensure success, consider giving more guidance on building and programming, such as:
- Explain how to conduct an investigation.
- Define the factors your pupils will focus on, such as the size of the wheels, motor power, or type of pulley setting.

Also, be specific in establishing expectations for pupils to present and document their findings.

Investigate more
As an added challenge, allow extra time to investigate with pupil-created designs and programs. This will allow them to explore additional factors that influence speed.

Pupils' misconceptions
Pupils often have trouble distinguishing between speed and acceleration.
A common misconception held by learners is the idea that if speed is constant, then acceleration is also constant. Speed and acceleration are two different concepts that are linked to each other, but if there is no change in the speed, then there is no acceleration or deceleration.

Vocabulary
Speed
Speed is the measurement of how fast an object moves in relation to a point of reference. Speed is calculated by dividing distance over time.
Acceleration
Measurement of the change of speed

Scientific understanding assessment rubrics

You can use these assessment rubrics with the observation rubrics grid, which you will find in the “Assess with WeDo 2.0” chapter.

Explore phase

During the Explore phase, make sure each pupil is actively involved in the discussion, asks and answers questions, and can describe factors that affect speed in cars.

1. The pupil is unable to adequately provide answers to questions, participate in discussions, or describe factors that affect speed.
2. The pupil is able, with prompting, to adequately provide answers to questions, participate in discussions, or, with help, describe factors that affect speed.
3. The pupil is able to provide adequate answers to questions, participate in class discussions, or describe the factors that affect speed, though not in detail.
4. The pupil is able to extend explanations in discussion or describe in detail the factors that affect speed.

Create phase

During the Create phase, make sure each pupil is able to work as part of a team, test one factor at a time to determine its influence on speed, and use the information collected in the Explore phase.

1. The pupil is unable to work as part of a team and complete the testing of each factor affecting speed in order to gather information.
2. The pupil is able to work as part of a team and complete the testing, with help, of each factor affecting speed in order to gather information.
3. The pupil is able to work as part of a team, contribute to the team discussions, and complete the testing of each factor in order to gather information.
4. The pupil is able to work as part of a team, serve as the leader, and extend the testing of factors affecting speed beyond the required expectations.

Share phase

During the Share phase, make sure that each pupil can engage in discussions about the investigation, explain their findings, and use important information from their project to create a final report.

1. The pupil is unable to engage in discussions about the investigation and use the information to create a final project.
2. The pupil is able, with prompting, to engage in discussions about the investigation, and use limited information to create a basic final project.
3. The pupil is able to engage in discussions about the investigation and use the information gathered to produce a final project.
4. The pupil is able to engage extensively in class discussions about the topic, and use the gathered information to create a final project that includes additional required elements.

English, presentation and problem-solving assessment rubrics

You can use these assessment rubrics with the observation rubrics grid, which you will find in the "Assess with WeDo 2.0" chapter.

Explore phase

During the Explore phase, make sure that each pupil can effectively explain their own ideas and comprehension in relation to the questions posed.

1. The pupil is unable to share his/her ideas in relation to the questions posed during the Explore phase.
2. The pupil is able, with prompting, to share his/her ideas related to the questions posed during the Explore phase.
3. The pupil adequately expresses his/her ideas related to the questions posed during the Explore phase.
4. The pupil uses details to extend explanations of his/her ideas in relation to the questions posed during the Explore phase.

Create phase

During the Create phase, make sure that each pupil makes appropriate choices (i.e., screenshot, image, video, text) and follows the established expectations for documenting their findings.

1. The pupil fails to document findings throughout the investigation.
2. The pupil gathers documentation of his/her findings, but the documentation is incomplete or does not follow all of the established expectations.
3. The pupil adequately documents findings for each part of the investigation and makes appropriate choices and selections.
4. The pupil uses a variety of appropriate methods for documentation and exceeds the established expectations.

Share phase

During the Share phase, make sure that each pupil uses the evidence that they gathered during their investigations to justify their reasoning, and that they adhere to established guidelines when presenting their findings to an audience.

1. The pupil does not use evidence from his/her findings when sharing ideas during the presentation. The pupil does not follow established guidelines.
2. The pupil uses some evidence from his/her findings, but the justification is limited. In general, established guidelines are followed, but may be lacking in one or more areas.
3. The pupil adequately provides evidence to justify his/her findings and follows established guidelines for presenting.
4. The pupil fully discusses his/her findings and thoroughly utilises appropriate evidence to justify his/her reasoning, while following all established guidelines.

Explore phase

The introductory video may set the stage for the following ideas to be reviewed and discussed with pupils.

Introductory video

Here are some suggested talking points for the video:

1. Cars allow us to move from one point to another, faster. But there was once a time when cars were slower than horses.
2. In a quest for improvement, car engineers searched for elements that could increase the car's speed.
3. Engineers looked at all parts of the car to design stronger engines and mechanisms.
4. Engineers improved the wheels and tyres by changing the size and materials.
5. Today, cars can travel at speeds of up to 250 mph (400 km/h).

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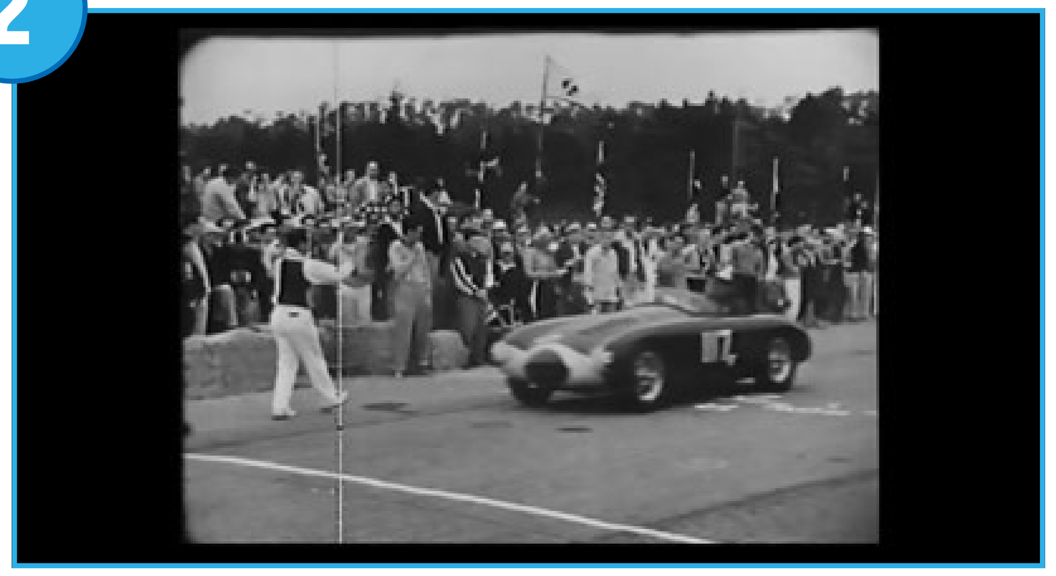

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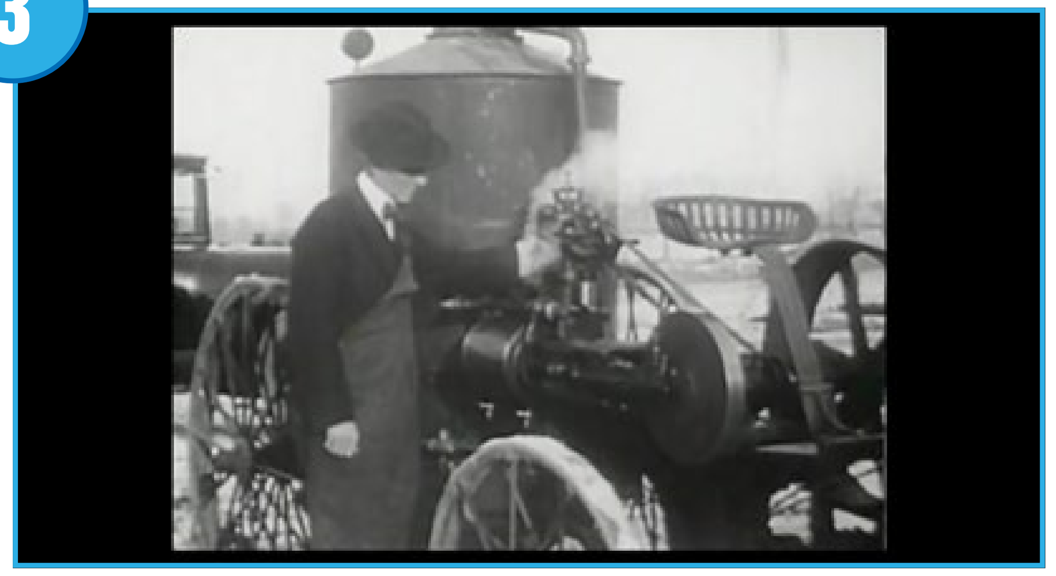

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Explore phase

Questions for discussion

Use these questions prior to, and following the lesson.

1. In what ways have cars have been improved to increase their speed?
   There are many factors that can influence the speed of a car. The size of the wheels, engine power, gears, aerodynamics, and weight play an important role. The colour of the car, brand, or driver experience should not be considered as potential elements for study.
2. What elements can influence the time required for a car to travel a certain distance as quickly as possible?
   This answer should provide prior knowledge regarding comprehension of the content. This means that at the beginning of the lesson, pupils' answers can be incorrect. However, by the end of the lesson, pupils should be able to provide an accurate answer to the question.

Additionally, following the lesson, you may want the pupils to respond to these questions with text or pictures, using the Documentation tool.

Other questions to explore

1. What can you infer about the relationship between wheel size and the time it takes the car to move a set distance?
   The larger the wheels, the faster the car will travel, if all other parameters are kept constant.
2. What did you notice about the configuration of the pulley and its effect of the car's speed?
   One of the pulley configurations makes the car go faster and the other reduces the speed of the car.
3. How can you measure the speed of an object?
   Speed is measured by dividing the time required to travel a distance by the measure of that distance. A unit of speed is always distance divided by time.

Create phase

Build and program a race car
Pupils will follow the building instructions to create a race car. These types of vehicles are optimised to go as fast as possible.

1. Build a race car.
The drive module used in this project utilises a pulley. This pulley system can be assembled in two different positions: the reduced speed position (small pulley and large pulley), or the normal speed position (large pulley to large pulley).

2. Program the race car to calculate time.
Pupils need to have a hand in front of the race car before the program is started. This program will start by displaying No. 0 and wait for the start signal. When your pupils remove their hands, the program will turn the motor on, go to maximum power, and repeat, adding No. 1 to the display. The loop will repeat until it reaches the end of the race. The motor will then turn off.

Important

For this program, pupils need to put their hands in front of the car before they execute the program string. When they remove their hands, the car will start its race.

Important

For this investigation, it is crucial that you have the same set up throughout the test. It is the only way pupils can isolate one element at a time:

- The start line should always be at the same distance from the finish line, this could be a wall or a box.
- The distance between the start and finish line is greater than 2m.

Create phase

Investigate speed factors
With this model, pupils should be able to test different factors, one at a time. They should test at a distance greater than 2m to see results.

1. Run the race with SMALL wheels at motor power 10.
When running this test, pupils should record the number on the display.
They should repeat the test three times to make sure it is consistent.

If the value in one of the three tests is disproportionate, repeat the test for a fourth time. This value is the approximate number of seconds it took for the race car to travel the distance.

2. Run the race with BIG wheels at motor power 10.
By changing the wheels, the race car should take less time to travel the same distance, and therefore, have a greater speed. Repeating the test three times will make sure it is consistent. If the value of one of the three tests is disproportionate, repeat the test for a fourth time.

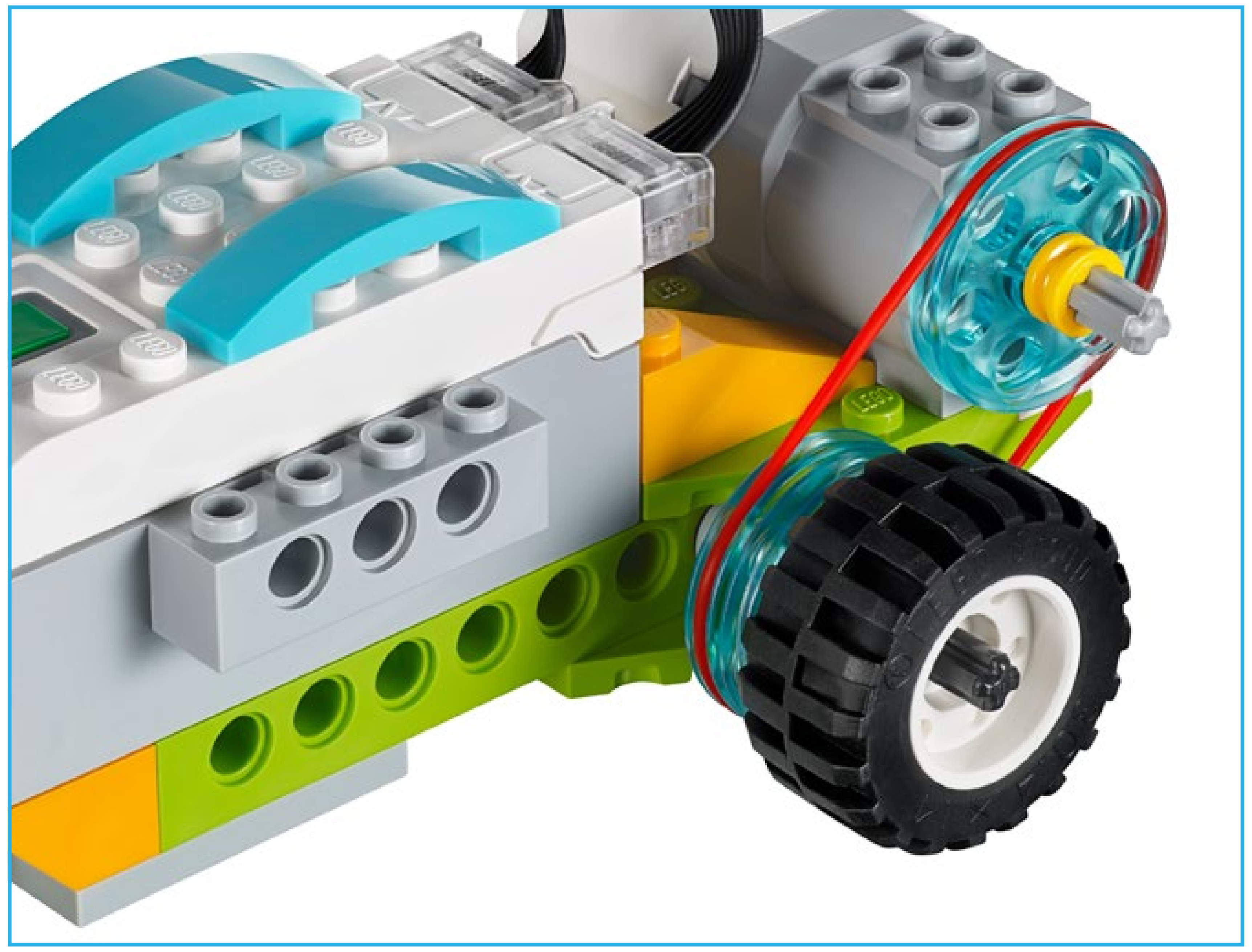
Suggestion

Other options could be considered to reach a more precise result, including increasing the number of trials or finding the average result.

3. Predict the time it will take to travel twice the distance.
When the distance is doubled and the motor power level and size of tyres are the same as the previous test, the number of seconds should also double.

Create phase

Use the “Investigate more” section of the pupil project as an optional extension. Keep in mind that these tasks are an extension of the “Investigate” section and are designed for older or more advanced pupils.

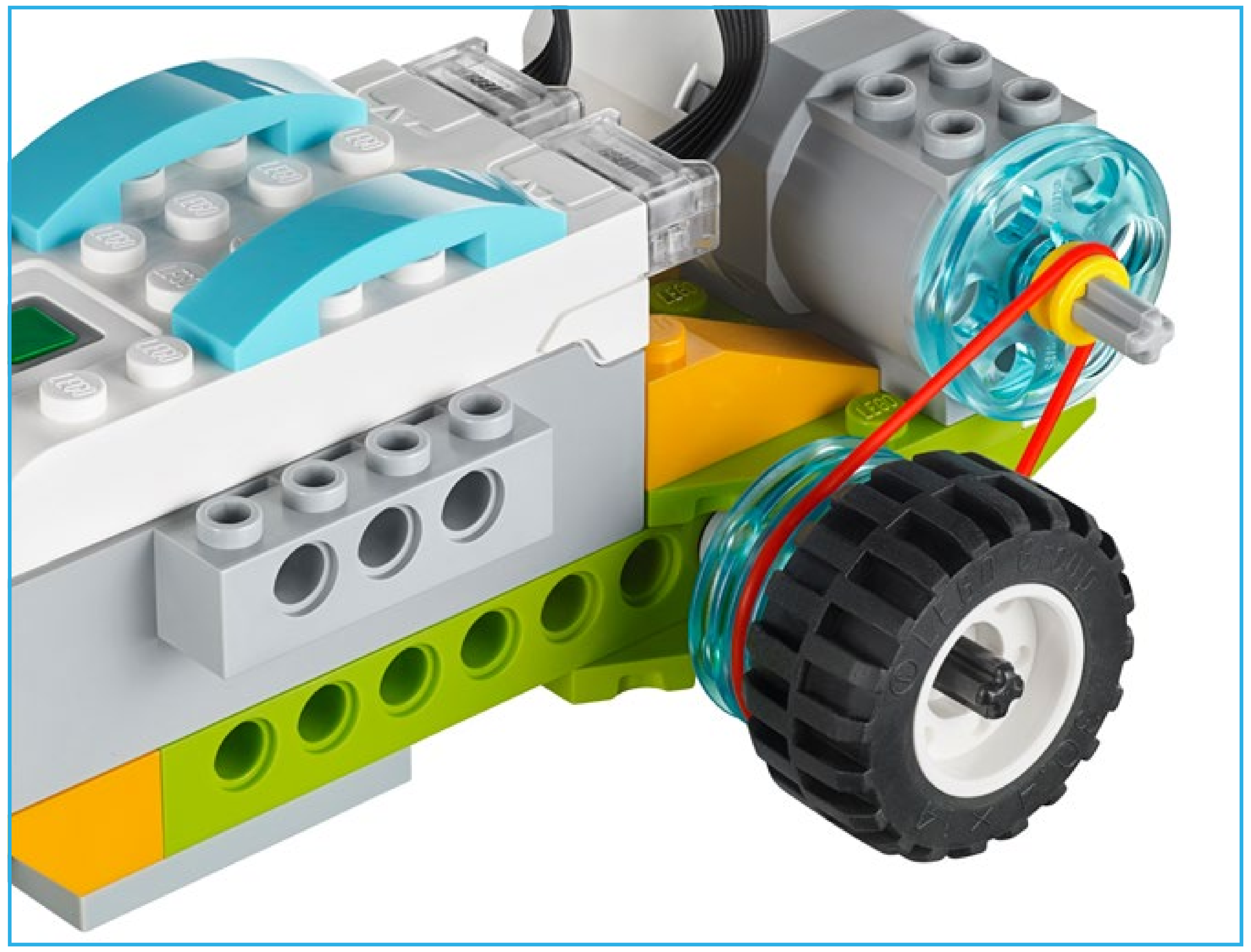


Investigate more speed factors

With the same race car model and the same set up, pupils can hypothesise and test other factors that may influence the speed of the car.

1. Change the motor power.
Changing the motor power level from No. 10 to No. 5 will result in the race car taking more time to travel the same distance.

2. Change the drive mechanism (pulley configuration).
Changing the drive mechanism from the normal position to the reduced speed position will result in the race car taking more time to travel the same distance.



3. Investigate another element.
Ask the pupils to carry out the test based on another factor that they think could influence the speed of the race car. This could be its width, length, height, or weight, or another factor of their own choosing.

Collaboration suggestion

Allow your pupils ample time to design and build their own ultimate race cars. Encourage them to apply their findings to make them as fast as possible. Then organise a race to see whose car is the fastest.

Share phase

Complete the document

Ask the pupils to document their projects in different ways:
- Ask them to take screenshots of their results.
- Ask them to compare images of their models with real-life images.
- Ask them to record project presentation videos.

Suggestions

Pupils may collect data in a chart format or on a spreadsheet.
Pupils may also graph the results of their tests.

Present results

At the end of this project, pupils should present the elements that influence a car's speed. Conclusions should reflect the fact that larger tyres, stronger motors, and greater motor power, generate higher speeds.

To enhance pupils' presentations:
- Ask them to put their explanations into context.
- Ask them to analyse real-life situations where they have observed speed as an element.
- Discuss the connection among their findings and these particular situations.

Speed

One possible way of sharing

Pupils in this class investigate the fastest race car by organising a race.

Project 3

Robust Structures

This project is about investigating the characteristics that make a building earthquake resistant, using an earthquake simulator constructed from LEGO® bricks.

Curriculum links

National Curriculum for science

(See page 23 for how this project addresses non-statutory requirements, and requirements for working scientifically)

5.F.s3: Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

Other National Curriculum links

Design and technology

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.

Evaluate:

Evaluate their ideas and products against their own design criteria and consider the views of others to improve their work.

Technical knowledge:

Apply their understanding of how to strengthen, stiffen, and reinforce more complex structures.

Understand and use mechanical systems in their products [for example, gears, pulleys, cams, levers, and linkages].

Understand and use electrical systems in their products [for example, series circuits incorporating switches, bulbs, buzzers, and motors].

Apply their understanding of computing to program, monitor, and control their products.

Computing

Design, write, and debug programs that accomplish specific goals, including controlling or simulating physical systems.

Use sequence, selection, and repetition in programs; work with variables and various forms of input and output.

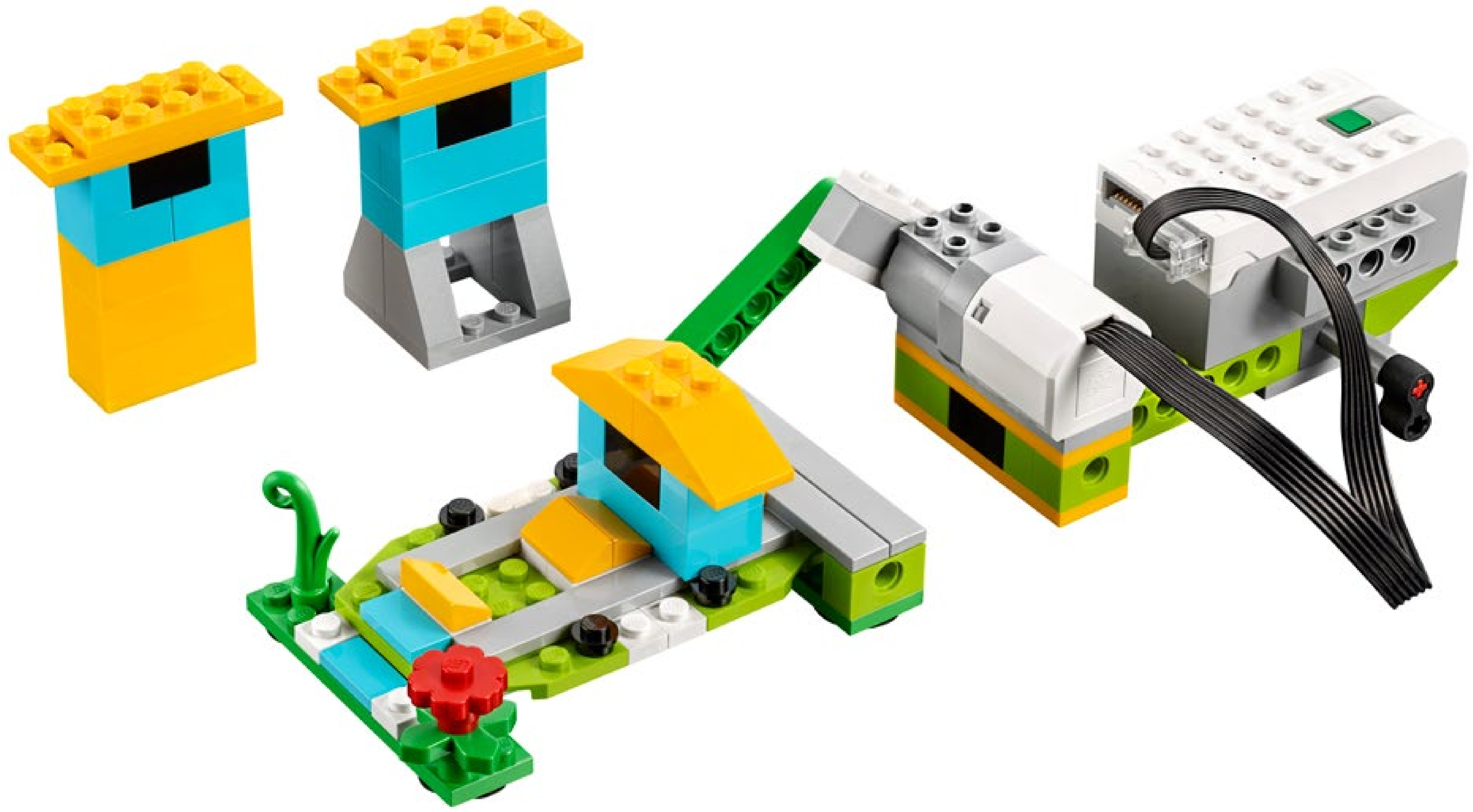
Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs.

Select, use, and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems, and content that accomplish given goals, including collecting, analysing, evaluating, and presenting data and information.

Geography

Human and physical geography:

Describe and understand key aspects of physical geography, including: climate zones, biomes and vegetation belts, rivers, mountains, volcanoes and earthquakes, and the water cycle.



Quick glance: Plan this WeDo 2.0 project

Preparation: 30 min.

- For information regarding general preparation, please see the “Classroom Management” chapter.
- Read about the project so you have a good idea of what to do.
- Define how you want to introduce this project: Use the video provided in the WeDo 2.0 Software, or use material of your own choice.
- Determine the end result of this project: the parameters to present and produce the document.
- Make sure timing allows for expectations to be met.

Important

This project is an investigation; please refer to the “WeDo 2.0 in Curriculum” chapter for further explanation of investigative practices.

Explore phase: 30-60 min.

- Start the project using the introductory video.
- Hold a group discussion.
- Allow pupils to document their ideas for Max and Mia’s questions, using the Documentation tool.

Create phase: 45-60 min.

- Ask the pupils to build the earthquake simulator and three buildings using the provided building instructions.
- Allow them to program the model using the sample program.
- Allow time so that pupils understand how the program works, and give them time to modify the parameters and carry out further tests.

Create more phase (optional): 45-60 min.

- You can use this extension of the project for differentiation or for older pupils.

Share phase: 45 min. or more

- Make sure your pupils document their work as they test different structures.
- Allow the pupils to share their experiences in different ways.
- Ask the pupils to create their final reports and present their projects.

Suggestion

Have a look at the following “Open Projects” when you have completed this project:

- Hazard Alarm
- Moving Materials

Differentiation

To ensure success, consider giving more guidance on building and programming, such as:

- Explain how to conduct an investigation.
- Utilise evidence to construct explanations.
- Offer them additional experiences with isolated variables to test hypotheses.

Also, be specific in establishing expectations for pupils to present and document their findings.

Suggestion

For more experienced pupils, allow extra time for building and programming so they can use their own inquiries to design their own investigations. Pupils could change parameters, such as the level of the earthquake simulator, the materials used to construct the buildings, or the surface on which they test their buildings.

Investigate more

Pupils will design the tallest building, resisting a grade 8 earthquake. They will apply learnings from the previous investigation.

Possible pupil misconceptions

Pupils may believe that earthquakes happen in random locations across the earth. Most of the world's seismic activity is associated with tectonic plate boundaries. While shallow crevasses may form during an earthquake, due to landslides or ground failures, the ground does not "open up" along a fault line.

Vocabulary

Earthquake
Ground vibrations produced when earth's tectonic plates slip past each other
Tectonic plates
Large parts of the earth's crust that move relative to each other due to convection currents in the underlying mantle
Richter scale
Logarithmic scale that classifies the level of the energy released during an earthquake
Variable
In a scientific experiment, an element that can be manipulated, controlled, or measured
Prototype
Early sample or model that is used to test a concept

Scientific understanding assessment rubrics

You can use these assessment rubrics with the observation rubrics grid, which you will find in the "Assess with WeDo 2.0" chapter.

Explore phase

During the Explore phase, make sure each pupil is actively involved in the discussion, asks and answers questions, and can answer questions about earthquakes in their own words.

1. The pupil is unable to provide answers to questions or participate in discussions adequately.
2. The pupil is able, with prompting, to provide answers to questions, participate in discussions, or describe elements that may influence a structure's resistance to earthquakes.
3. The pupil is able to provide adequate answers to questions, participate in class discussions, and describe elements that may influence a structure's resistance to an earthquake.
4. The pupil is able to extend the explanations in discussion and describe in detail the factors that may influence a structure's resistance to an earthquake.

Create phase

During the Create phase, make sure that the pupils use documentation to record predictions and findings, and change only one variable at a time when conducting investigations.

1. The pupil does not complete the necessary documentation during the investigations and rarely exhibits accuracy in changing only one variable at a time.
2. The pupil documents his/her findings, but some critical elements are missing, and the pupil is inconsistent in changing only one variable at a time during the investigations.
3. The pupil uses adequate documentation to record predictions and findings, or generally exhibits accuracy in changing only one variable at a time during the investigations.
4. The pupil uses excellent documentation to record predictions and findings or consistently exhibits accuracy in changing only one variable at a time during the investigations.

Share phase

During the Share phase, make sure that each pupil can effectively utilise documents and verbal communication to explain what is happening with the earthquake simulator, and what can be concluded from the results of the tests.

1. The pupil offers no explanation, neither in his/her document nor through verbal communication.
2. The pupil ineffectively utilises documents and verbal communication to explain what is happening and what can be concluded. The explanation may be incomplete or inaccurate.
3. The pupil ineffectively utilises documents and verbal communication to explain what is happening and what can be concluded.
4. The pupil effectively utilises documents and verbal communication to offer a sophisticated and accurate explanation of what is happening and what can be concluded.

English, presentation and problem-solving assessment rubrics

You can use these assessment rubrics with the observation rubrics grid, which you will find in the "Assess with WeDo 2.0" chapter.

Explore phase

During the Explore phase, make sure that each pupil can effectively explain their own ideas and comprehension related to the questions posed.

1. The pupil is unable to share his/her ideas related to the questions posed during the Explore phase.
2. The pupil is able, with prompting, to share his/her ideas related to the questions posed during the Explore phase.
3. The pupil adequately expresses his/her ideas related to the questions posed during the Explore phase.
4. The pupil uses details to extend explanations of his/her ideas related to the questions posed during the Explore phase.

Create phase

During the Create phase, make sure that each pupil makes appropriate choices (i.e., screenshot, image, video, text) and follows the established expectations for documenting their findings.

1. The pupil fails to document findings throughout the investigation.
2. The pupil gathers documentation of his/her findings, but the documentation is incomplete or does not follow all of the established expectations.
3. The pupil adequately documents findings for each part of the investigation and makes appropriate choices and selections.
4. The pupil uses a variety of appropriate methods for documentation and exceeds the established expectations.

Share phase

During the Share phase, make sure that each pupil uses evidence from their own document text and video to explain ideas, including what happened and why.

1. The pupil does not use evidence from his/her own document text and video and cannot explain ideas, including what happened and why.
2. The pupil uses some evidence from his/her own document text and video but cannot completely explain ideas, including what happened and why.
3. The pupil uses evidence from his/her own document text and video to explain ideas, including what happened and why.
4. The pupil uses a variety of evidence from his/her own document text and video to thoroughly explain ideas, including what happened and why.

Explore phase

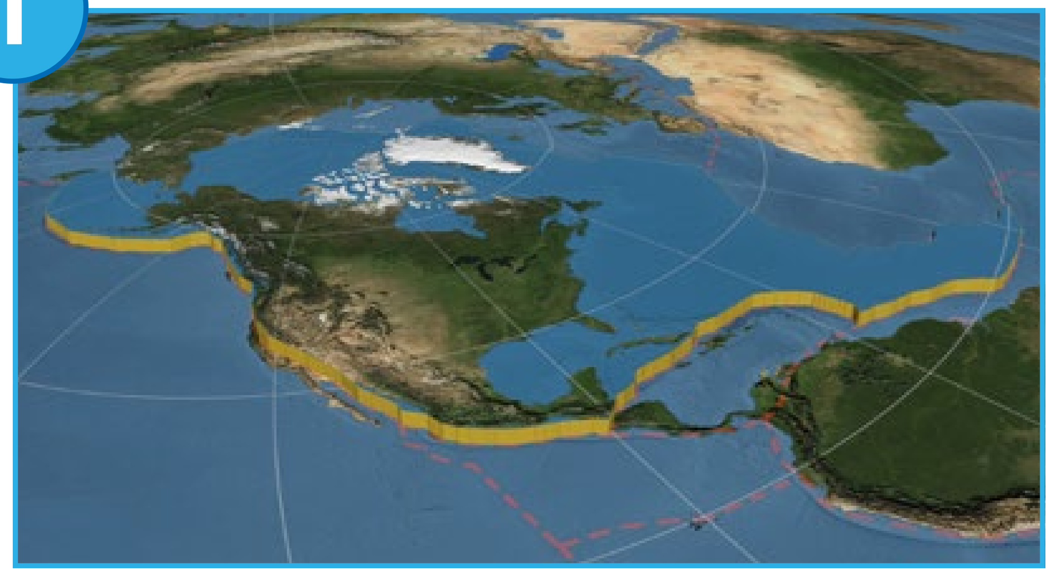
The introductory video may set the stage for the following ideas to be reviewed and discussed with pupils.

Introductory video

Here are some suggested talking points for the video:

1. Since it was formed, the earth has been changing shape. Like pieces of biscuit being pushed around on top of a layer of honey, the tectonic plates that compose the earth slide, rub together, and collide.
2. When doing so, the friction creates vibrations on the surface of the earth.
3. During an earthquake, depending on the strength of the vibrations and a variety of other factors, buildings and other structures may be damaged or destroyed.
4. Today buildings are more resistant to earthquakes, thanks to recent scientific discoveries that have led to improvements in design.

1



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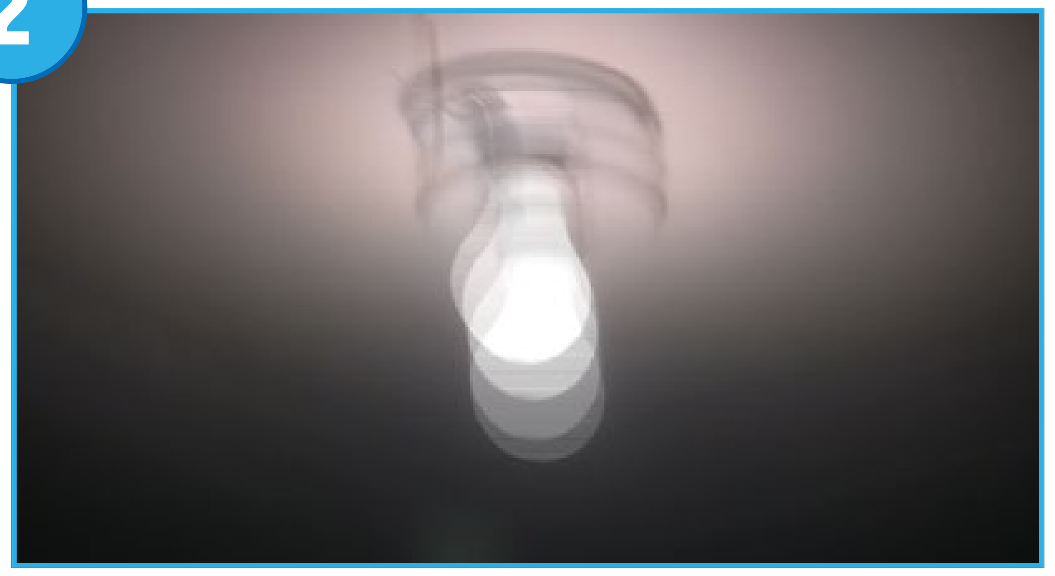


3

4

Explore phase

Questions for discussion

During the Explore phase, these questions are intended to elicit pupils' initial ideas and/or summarise prior learning to evaluate the performance expectation for this project.

Ask the pupils to document their comprehension, and refer back to these questions again during and after the Create phase.

1. What causes earthquakes and what are the hazards they create?
   Earthquakes are vibrations of the earth's crust caused by the movement of the tectonic plates.
2. How do scientists rate the strength of an earthquake?
   Scientists rate earthquakes on a scale they call the Richter scale. The higher the number, on a scale of 1 to 10, the stronger the earthquake.
3. What elements can influence the resistance of buildings during earthquakes?
   This answer should serve as the pupils' hypothesis. This means that at this point, your pupils' answer may be incorrect.

Ask your pupils to answer with text or pictures using the Documentation tool.

Other questions to explore

1. What did you notice about the relationship between the size of a building's footprint and height, and its ability to withstand the impact of an earthquake?
   Structures that are tall or slim are generally less stable and are more likely to fall when submitted to lateral forces.
2. How did you ensure that the tests were kept fair?
   Changing only one parameter at a time.
3. What other factors would be important to investigate?
   Structural design and materials also have to be considered when testing a building's resistance to earthquakes.
4. How are modern buildings designed to withstand earthquakes?
   Architects and engineers use structures, principles, and simulations to test prototypes for weaknesses.
5. Does "resistant" mean the same thing as "strong"?
   It depends on a variety of factors. Sometimes flexible structures or materials are more resistant than rigid or strong structures.

Create phase

Build and program an earthquake simulator and model buildings
Pupils will follow the building instructions to create an earthquake simulator. With this device, they will gather evidence to decide which building would pass the earthquake test.

1. Build an earthquake simulator.
The shake model used in this project uses a piston to push and pull the test plate. The motor power level of the program determines the amplitude of the generated earthquake.

2. Program the simulator.
This program will start by displaying No. 0 on the screen. It will then repeat a series of actions, five times. It will add No. 1 to the display, representing the shake magnitude, turn the motor on to that magnitude for two seconds, and then wait for one second.

Important

With this program, if pupils want to test a stronger or weaker earthquake, they will need to change the number of loops. Allow them to use a program of their own.

Create phase

Investigate your building design
Now that pupils understand the way the earthquake simulator works, let them investigate different factors by isolating one variable at a time.

1. Change the height.
Pupils should use the short and the tall buildings, both with narrow bases (buildings A and B).

With the tall building on the shaking base, pupils should find the minimum magnitude that causes the structure to fall. Then, with that same program, they should test if the narrow or short building is more resistant.

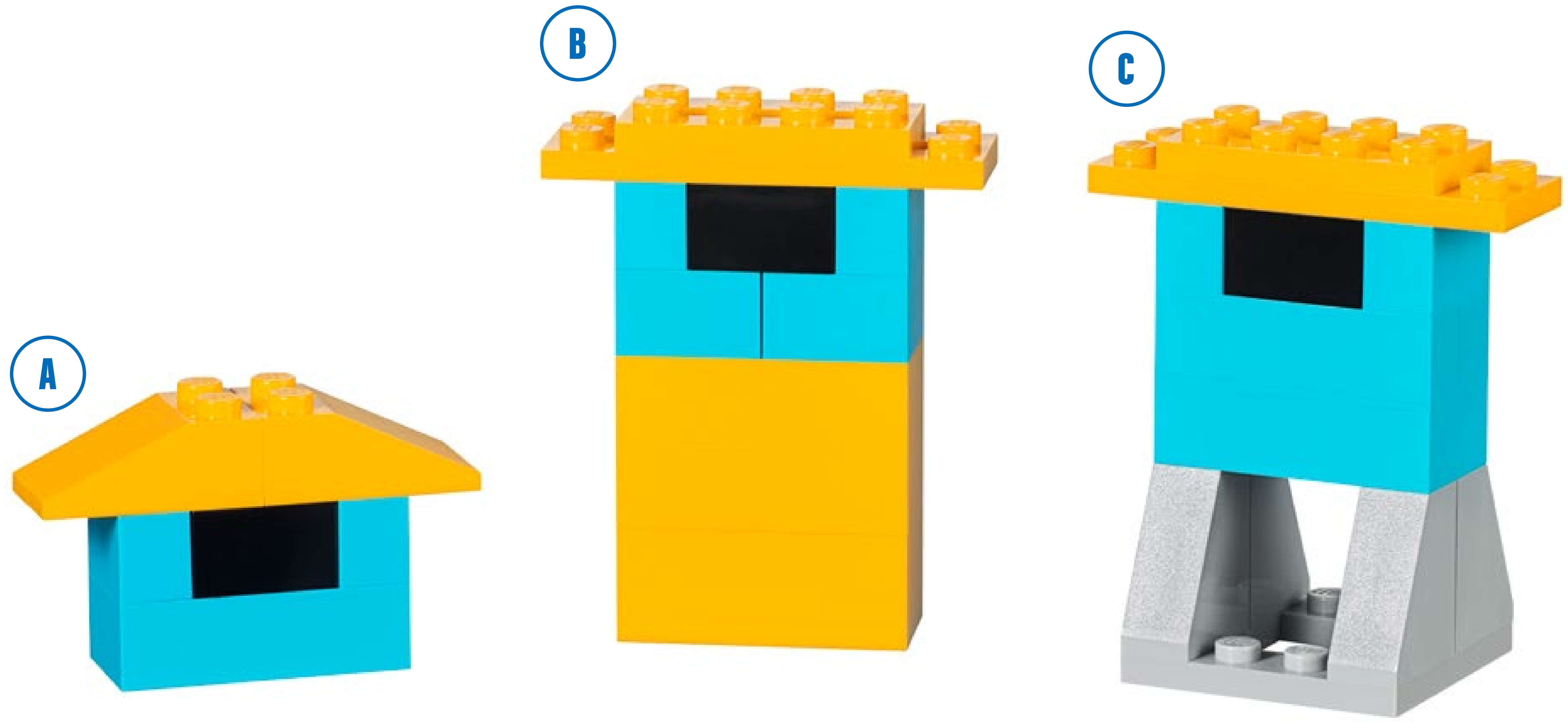
Pupils should be able to discover that with the same base area, the short building is more resistant than the tall building.

Important

Because not all of the motors react exactly the same, it is possible that magnitudes vary, giving different results for each team.

2. Change the width of the base.
With the same program, ask the pupils to test if the tall building with the narrow base (building B) can resist better than the narrow, tall building with the wide base (building C).

Pupils should be able to discover that with a larger base area, a tall building is more resistant.



Create phase

Use the “Investigate more” section of the pupil project as an optional extension. Keep in mind that these tasks are an extension of the “Investigate” section and are designed for older or more advanced pupils.

Investigate more with the earthquake simulator

Ask your pupils to explore other elements that affect the buildings’ resistance to vibration.

1. Change the magnitude.

Ask the pupils to predict what would happen to buildings A, B, and C if the magnitude of the earthquake was increased, for example, up to level 8.

Ask them to record their predictions and test each case.

2. Change buildings.

Applying the fact that a larger base will enable a building to withstand stronger vibrations, challenge your pupils to build the tallest possible, level-8 earthquake resistant, structure.

Ask the pupils to explore different building compositions:

- Explore different structural shapes.
- Introduce new materials.

Collaboration suggestion

Allow teams to compare their building designs. Ask one team to describe and test the work of another team:

- What are the structure’s strengths?
- What are the structure’s weaknesses?
- Will the building withstand the earthquake test?

Share phase

Complete the document

Ask the pupils to document their projects in different ways:

- Ask the pupils to take a video of each test they conduct in order to prove their claims.
- Ask your pupils to compare these conclusions with real-life cases.

Suggestions

Pupils may collect data in a chart format or on a spreadsheet.

Pupils may also graph the results of their tests.

Present results

At the end of this project, pupils should present the results of their investigations.

To enhance your pupils' presentation:

- Ask them to describe the factors that influence a building's stability.
- Ask them to compare these thoughts with their findings.
- Ask them to put their explanations into context:
- Ask them to reflect on their conclusions.
- Discuss whether their results reflect reality.

Robust Structures

One possible way of sharing

Pupils in this class are testing the tallest building.
They hope it will resist a level 10 earthquake.

Project 4

Frog's Metamorphosis

This project is about modelling a frog's metamorphosis using a LEGO® representation and identifying the characteristics of the organism at each stage.

Curriculum links

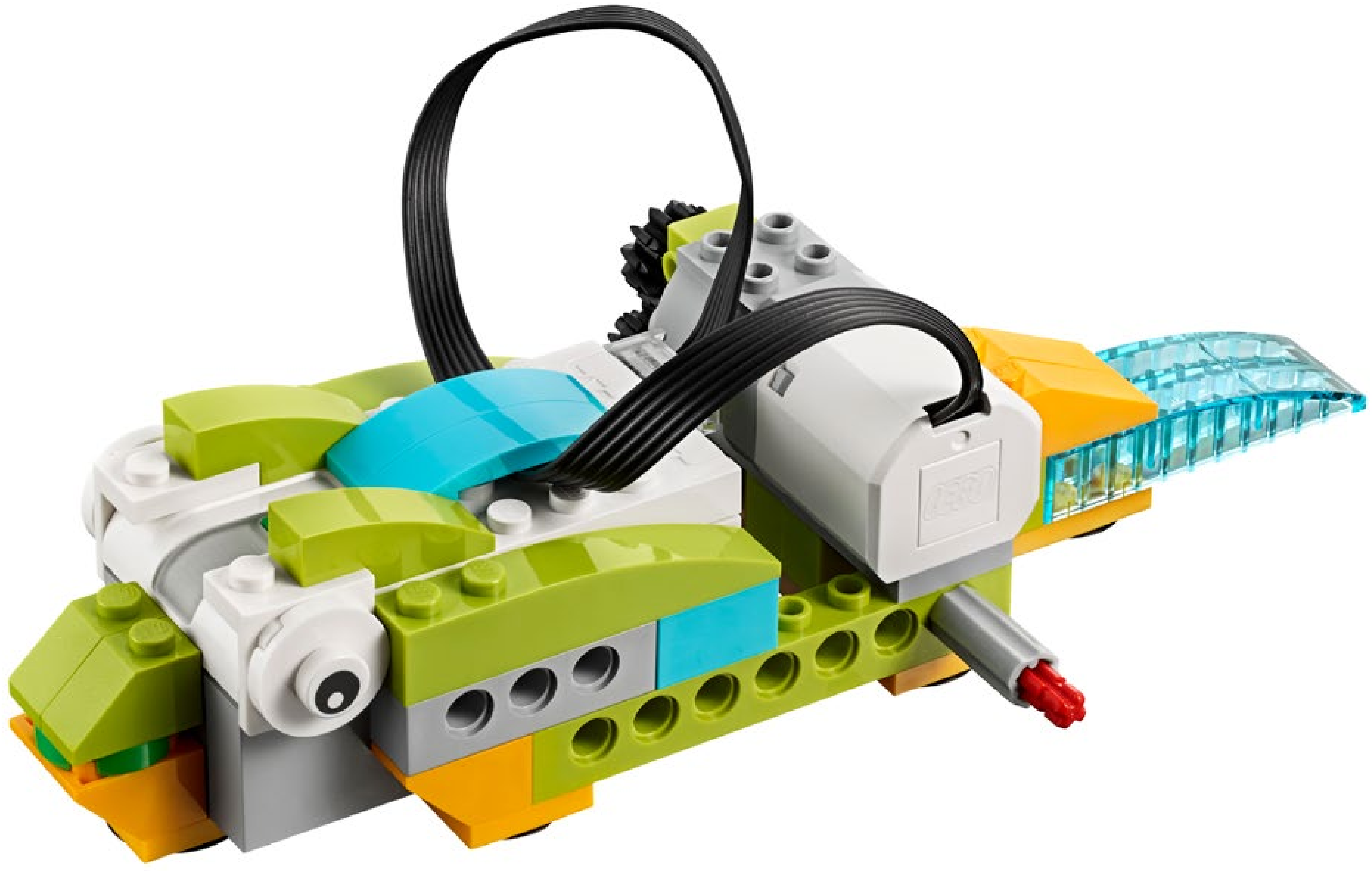
National Curriculum for science
(See page 23 for how this project addresses non-statutory requirements, and requirements for working scientifically)

3.A.s1: Identify that animals, including humans, need the right types and amount of nutrition, and that they cannot make their own food; they get nutrition from what they eat.

4.LTH.s3: Recognise that environments can change and that this can sometimes pose dangers to living things.
4.A.s3: construct and interpret a variety of food chains, identifying producers, predators and prey.

5.LTH.s1: Describe the differences in the life cycles of a mammal, an amphibian, an insect, and a bird.
5.LTH.s2: Describe the life process of reproduction in some plants and animals.
5.F.s3: recognise that some mechanisms, including levers, pulleys, and gears, allow a smaller force to have a greater effect.

6.LTH.s1: Describe how living things are classified into broad groups according to common observable characteristics and based on similarities and differences, including micro- organisms, plants, and animals.
6.LTH.s2: Give reasons for classifying plants and animals based on specific characteristics.
6.EI.s2: Recognise that living things produce offspring of the same kind, but normally offspring vary and are not identical to their parents.
6.EI.s3: Identify how animals and plants are adapted to suit their environment in different ways and that adaptation may lead to evolution.



Other National Curriculum links

Design and technology

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.

Evaluate:

Evaluate their ideas and products against their own design criteria and consider the views of others to improve their work.

Technical knowledge:

Understand and use mechanical systems in their products [for example, gears, pulleys, cams, levers, and linkages].

Understand and use electrical systems in their products [for example, series circuits incorporating switches, bulbs, buzzers, and motors].

Apply their understanding of computing to program, monitor, and control their products.

Computing

Design, write, and debug programs that accomplish specific goals, including controlling or simulating physical systems.

Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs.

Select, use and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems and content that accomplish given goals, including collecting, analysing, evaluating, and presenting data and information.

Quick glance: Plan this WeDo 2.0 project

Preparation: 30 min.
- Read the general preparation in the "Classroom Management" chapter.
- Read about the project so you have a good idea of what to do.
- Define how you want to introduce this project: Use the video provided in the WeDo 2.0 Software, or use material of your own choice.
- Determine the end result of this project: the parameters to present and produce the document.
- Make sure that timing allows for expectations to be met.

Important

This project uses models to represent a real-world concept. Please refer to the "WeDo 2.0 in Curriculum" chapter for further explanations of modelling practices. It introduces a frog's life as one representation of a life cycle. This project is intended to be an application of pupils' prior knowledge regarding life cycles of plants and animals. It could be used as an assessment itself.

Explore phase: 30-60 min.
- Start the project using the introductory video.
- Hold a group discussion.
- Allow pupils to document their ideas for Max and Mia's questions using the Documentation tool.

Create phase: 45-60 min.
- Ask the pupils to build the first model from the provided building instructions.
- Allow them to program the model using the sample program.
- Allow time, so that they can make the young frog evolve into an adult frog. In this step, guide them in building their frog according to what you have discussed in the Explore phase.

Create more phase (optional): 45-60 min.
- You can use this extension of the project for differentiation or for older pupils.

Share phase: 45 min. or more
- Make sure your pupils document the changes in their frogs and explain how they have modified their models to reflect the various stages of a frog's metamorphosis.
- Allow the pupils to share their experiences in different ways.
- Ask the pupils to create their final science report.
- Ask the pupils to present their projects.

Suggestion

Have a look at the following "Open Projects" when you have completed this project:
- Predator and Prey
- Extreme Habitats

Differentiation

To ensure success, consider giving more guidance on building and programming, such as:

- How to make back legs longer or how to create front legs
- How to change its appearance by changing its eyes
- Use the Motion Sensor to detect predators and escape.

Be specific about how you would like them to present and document their findings. For example, a team sharing session.

Suggestion

For more experienced pupils, you may want to allow them extra time for building and programming to allow them to create models of different animals. Then also ask them to compare and contrast the different animal life cycle models.

You could also revisit the model of the tadpole and determine a way to construct a functional tail. Review the turn base module in the Design Library to get help.

Use the model further

To use the model further, ask your pupils to study external factors that can influence the life cycle of the frog and their effects on the frog’s body. Examples could include: pollution effects, predator elimination, and population changes.

Pupils’ misconceptions

Pupils might think metamorphosis occurs for all animals. Certain animals have very similar life cycles, and some have very different ones. For example, mammals and insects have very different life cycles, but a horse and a cat are both similar because they are mammals. Explore the following terms while defining a life cycle.

Vocabulary

Life cycle
Important changes in an organism’s form that take place in specific stages
Metamorphosis
Extreme physical transformation of an organism, which is usually accompanied by a change of habitat or behaviour
Incomplete metamorphosis
An animal that only goes through three stages in the life cycle, for example, the dragonfly
Complete metamorphosis
An animal that completes four stages in the life cycle, for example, the butterfly or frog
Larva
The juvenile form of an animal that goes through metamorphosis (with frogs, a tadpole is the larval stage)

Scientific understanding assessment rubrics

You can use these assessment rubrics with the observation rubrics grid, which you will find in the "Assess with WeDo 2.0" chapter.

Explore phase

During the Explore phase, make sure that each pupil is actively involved in the discussion, asks and answers questions, and documents and offers responses to questions, such as "What are the different stages of a frog's life?", in his/her own words.

1. The pupil is not involved in the discussion of the questions posed during the Explore phase, and no documentation is captured.
2. The pupil contributes little to the discussion of the questions posed during the Explore phase and documents some of his/her responses.
3. The pupil contributes sufficiently to the discussion of the questions posed during the Explore phase and adequately documents his/her responses.
4. The pupil actively contributes to the discussion of the questions posed during the Explore phase and documents his/her responses.

Create phase

During the Create phase, make sure that each pupil actively investigates solutions by planning, designing, and redesigning, if necessary, and can apply his/her understanding of the life cycle of a frog when representing it in a model.

1. The pupil neglects to create a model to represent the frog life cycle that demonstrates evidence of comprehension.
2. The pupil creates a model to represent the frog life cycle that demonstrates some evidence of comprehension.
3. The pupil successfully creates a model to represent the frog life cycle that demonstrates adequate evidence of comprehension.
4. The pupil creates a model to represent the frog life cycle that demonstrates evidence of a highly developed comprehension.

Share phase

During the Share phase, make sure that each pupil can explain the life cycle of the frog and the changes it undergoes; identify limitations of their model (what is close to reality and what is not); and use important information from his/her project to create the final report.

1. The pupil neglects to discuss the limitations of the model or the life cycle of a frog. The pupil does not use the information to create the final report.
2. The pupil is able to discuss, with prompting, some of the limitations of the model and the life cycle of a frog. The pupil uses some information to create the final report.
3. The pupil is able to adequately discuss the limitations of the model and the life cycle of a frog and use all necessary information to create the final report.
4. The pupil discusses the limitations of the model and the life cycle of a frog and uses all necessary information to create the final report.

English, presentation and problem-solving assessment rubrics

You can use these assessment rubrics with the observation rubrics grid, which you will find in the "Assess with WeDo 2.0" chapter.

Explore phase

During the Explore phase, make sure that each pupil can effectively explain their own ideas through collaboration with peers and comprehension related to the questions posed.

1. The pupil does not share his/her ideas related to the questions posed during the Explore phase and shows no evidence of collaboration with peers.
2. The pupil is able, with prompting, to share his/her ideas through collaboration with peers during the Explore phase.
3. The pupil adequately shares his/her ideas through collaboration with peers during the Explore phase.
4. The pupil uses details to share insightful ideas through collaboration with peers during the Explore phase.

Create phase

During the Create phase, make sure that each pupil uses precise language and appropriate vocabulary, and makes appropriate choices in communicating concepts using the Documentation tool.

1. The pupil does not use precise language or vocabulary appropriately and does not demonstrate thoughtful choices in communicating concepts with the Documentation tool.
2. With prompting, the pupil can incorporate some appropriate vocabulary and generally makes appropriate choices in communicating concepts using the Documentation tool.
3. The pupil uses precise language and appropriate vocabulary and makes appropriate choices in communicating concepts using the Documentation tool.
4. The pupil uses precise language and advanced vocabulary and makes appropriate choices in communicating concepts using the Documentation tool.

Share phase

During the Share phase, make sure that each pupil describes the relationship between the model and scientific concepts related to the life cycle of a frog, using appropriate vocabulary.

1. The pupil does not effectively describe the relationship between the model and any scientific concepts related to the life cycle of a frog.
2. The pupil describes the relationship between the model and scientific concepts related to the life cycle of a frog, but there are inaccuracies and relevant pieces of information are missing.
3. The pupil adequately describes the relationship between the model and scientific concepts related to the life cycle of a frog using appropriate vocabulary.
4. The pupil describes, in detail, the relationship between the model and scientific concepts related to the life cycle of a frog using advanced vocabulary.

Explore phase

The introductory video may set the stage for the following ideas to be reviewed and discussed with pupils.

Introductory video

Unlike mammals, frogs go through metamorphosis:

1. Frogs start their lives as eggs. Not all baby frogs survive, many are eaten by predators.
2. When the eggs hatch, the tadpoles start looking for sources of food.
3. Tadpoles slowly grow legs as they become young frogs (froglets).
4. For many species, after about twelve weeks, the frog has its adult shape and can jump, eat flies, and reproduce.

Although this varies among frog species, the metamorphosis of a typical frog from birth to adult takes an average of sixteen weeks. Once a frog has reached adulthood, it can reproduce. There are species of frog that have a life span of less than two years, while other species may live up to fifteen years or more.

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Explore phase

Questions for discussion

1. Which physical features change as a frog progresses from tadpole to adult?
   The jaw changes shape, tail recedes, tongue for catching flies develops, hind legs and then front legs begin to grow, and lungs develop as gills disappear. This is merely a list of some of the most obvious changes that occur as a frog undergoes metamorphosis and is not intended to be an exhaustive description.
2. Are their links between the changes in a frog's physical characteristics and its habitat?
   Animals morph to survive in new environments. Tadpoles often move from aquatic to terrestrial environments as they morph into adult frogs, so their bodies must support different ways of eating, breathing, and moving.

Your pupils can collect their answers in the Documentation tool.

Other questions to explore

1. In which ways are the life cycles of plants and animals similar?
   Plants have similar life cycles to frogs because they both change shape during their lives and have a stage where they don't look like the adult stage (tadpole in the case of the frog, seedling in the case of the plant).
2. What are the stages in the life of a frog?
   For frogs, it would be egg-->tadpole-->froglet (young frog)-->adult frog. For other animals, answers will vary.
3. Are frogs the only animals that go through metamorphoses during their life cycle?
   No, butterflies and moths undergo complete metamorphoses, and dragonflies, certain fish, and various other organisms experience incomplete metamorphoses .
4. Do humans go through metamorphoses? How do you know?
   Although the human body grows during its life cycle, it does not change.

Create phase

1. Build a model of a tadpole (larva).
Pupils will start to build a tadpole with only eyes, a long tail, and, at first, no front legs. Ask them to take a photograph of this stage or sketch it in order to document it before they morph it into the young frog.

2. Build a young frog model (froglet).
Pupils will follow the building instructions to morph the tadpole into a young frog that can move, if activated by a program. Ask the pupils to describe the changes they note as the model progresses.

One important new feature that has changed in the young frog model is the development of back legs. The walk module used in the project uses gears. These gears move the back legs.

Pupils should once again document their models using pictures and/or sketches.

3. Program the young frog.
This program will turn the motor on in one direction at motor power 8 for 3 seconds and then stop.

Suggestion

Before your pupils start to modify their models, ask them to change the parameters of the program so that they fully understand it.

Create phase

Morphing from a young frog (froglet) to an adult frog
After building the young frog, pupils should modify it to create their own model.

There will be many possible solutions. Here are some examples:
1. Change both front and back legs.
The young frog will develop both front and back legs during its life. Pupils could build bigger legs in the back and create front legs. Pupils can also change the positions of the legs to show the different types of movements made by an adult frog. Pupils may modify their existing programs or create new programs to move the new legs.

2. Other changes in appearance
Removing the tail, adding a mature tongue, changing the eye position, and adding patterns to the skin are additional ways to make the model look like an adult frog.

3. Replicate adult frog behaviour.
Pupils could use sounds or the Motion Sensor to change the frog's behaviour. For example, with a Motion Sensor placed on the frog's head, it could be programmed to wait until it detects an object such as a hand and then move backwards.

Important
It is important to note that, because a pupil model will vary according to choice, there are no building instructions or sample programs provided to pupils for this part of the project.

Create phase

The "Use the model further" section of the pupil project is an optional extension. Keep in mind that these tasks extend on those of the "Use the model" section and are designed for older or more advanced pupils.

Use the model further

Frogs are amphibians that are very sensitive to the environment. For example, they have porous skin that can allow chemicals to affect their development.

Ask pupils to research the effects of damaging external factors on the frog life cycle. For example:

- Changes (such as damage or destruction) of habitats: Frogs would not be able to find a mate, move freely, or find food.
- Pollution or disease: Frogs could mutate by growing an extra leg or losing one.

Ask the pupils to use their models to illustrate the effects of such factors on frog behaviour and on the frog life cycle.

Suggestion

The framework for science education stresses that plants and animals have predictable characteristics relating to life processes, change, and growth. Animals and plants have similar growth processes, and offspring are related to the previous generations as inherent traits are realised. You could expand this modelling project to include other plants and animals.

Collaboration suggestion

Ask the teams to compare and share their findings and share information about the impact of external factors on frog populations.

Share phase

Complete the document

Ask the pupils to document their projects in different ways:

- Ask the pupils to take a photograph of every stage they create, and prepare to discuss how the model represents a frog's metamorphosis.
- Ask your pupils to compare images of their models with real-life images.
- Ask your pupils to record project presentation videos.

Present results

At the end of this project, pupils should present what they have learned.

To enhance your pupils' presentation:

- Ask the pupils to explain the life cycle of the frog.
- Make sure that they can explain the different stages.
- Ask them to compare this life cycle with that of other animals.
- Ask them to describe the limitations of their model.
- Ask them to create a display that puts the frog's metamorphosis into context.

Frog's Metamorphosis

One possible way of sharing

Pupils in this class explain that morphing into an adult frog allows the creature to move from a water to a land environment.

Project 5

Plants and Pollinators

This project is about modelling a LEGO® representation of the relationship between a pollinator and a flower during the reproduction phase.

Curriculum links

National Curriculum for science

(See page 23 for how this project addresses non-statutory requirements, and requirements for working scientifically)

3.P.s1: Identify and describe the functions of different parts of flowering plants: roots, stem/trunk, leaves and flowers.

5.LTH.s1: Describe the differences in the life cycles of a mammal, an amphibian, an insect and a bird.
5.LTH.s2 Describe the life process of reproduction in some plants and animals.
5.F.s3: Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

Other National Curriculum links

Design and technology

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.
Evaluate:
Evaluate their ideas and products against their own design criteria and consider the views of others to improve their work.
Technical knowledge:
Understand and use mechanical systems in their products [for example, gears, pulleys, cams, levers, and linkages].
Understand and use electrical systems in their products [for example, series circuits incorporating switches, bulbs, buzzers, and motors].
Apply their understanding of computing to program, monitor and control their products.

Computing
Design, write and debug programs that accomplish specific goals, including controlling or simulating physical systems.
Use sequence, selection, and repetition in programs; work with variables and various forms of input and output.
Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs.
Select, use, and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems and content that accomplish given goals, including collecting, analysing, evaluating, and presenting data and information.

Quick glance: Plan this WeDo 2.0 project

Preparation: 30 min.

- Read the general preparation in the "Classroom Management" chapter.
- Read about the project so you have a good idea of what to do.
- Define how you want to introduce this project: Use the video provided in the project in the WeDo 2.0 Software, or use material of your own choice.
- Determine the end result of this project: the parameters to present and produce the document.
- Make sure that timing allows for expectations to be met.

Important

This project uses models to represent a real-world concept. Please refer to the "WeDo 2.0 in Curriculum" chapter for further explanations of modelling practices.

Explore phase: 30-60 min.

- Start the project using the introductory video.
- Hold a group discussion.
- Allow pupils to document their ideas for Max and Mia's questions using the Documentation tool.

Create phase: 45-60 min.

- Ask the pupils to build the first model from the provided building instructions.
- Allow them to program the model using the sample program.
- Allow time so they can make different types of flowers and corresponding pollinators. Make sure that the pupils can explain the links between the two organisms.

Create more phase (optional): 45-60 min.

- You can use this extension of the project for differentiation or for older pupils.

Share phase: 45 min. or more

- Make sure your pupils document their work as they build new flowers and pollinators.
- Find different ways to let pupils share what they have learned and their reflections on these experiences.
- Ask the pupils to create their final reports and present their projects.

Suggestion

Have a look at the following "Open Projects" when you have completed this project:

- Animal Expression
- Wildlife Crossing

Differentiation

To ensure success, consider giving more guidance on building and programming, such as:
- Provide a list and images of potential pollinators.
- Provide a list of flower characteristics.

Be flexible about how the flowers are built and focus on what is most important: the general shape of the flower and its colour.

Be specific about how you would like them to present and document their findings. For example, a team sharing session.

Suggestion

For more experienced pupils, you may want to allow them extra time for building and programming so they can model more realistic flowers that include a stamen, stigma, petals, and other parts.

Use the model further

To use the model further, ask your pupils to explore the phases of the life cycle after the plant has been pollinated, such as seed dispersion.

Pupils' misconceptions

Pupils may believe that the main purpose of a pollinator is to be deliberately responsible for the reproduction of plants. It is more by chance that this phenomenon happens. The pollinator visits the flower with the intention of obtaining nutrients, and it is only indirectly that it transfers the pollen.

Vocabulary

Pollen
Powdery particles required for plant reproduction
Nectar
Liquid filled with sugar, produced by plants to attract animals
Seed
A plant embryo, provided in a protective shell
Stamen
Pollen-producing reproductive organ of a flower
Stigma
Pollen receptor organ of a flower
Pollinator
A living creature involved in the transport of pollen
Cross-pollination
Fertilisation of one plant by another

Scientific understanding assessment rubrics

You can use these assessment rubrics with the observation rubrics grid, which you will find in the “Assess with WeDo 2.0” chapter.

Explore phase

During the Explore phase, make sure that each pupil is actively involved in the discussion, asks and answers questions, and can answer questions in their own words.

1. The pupil is unable to adequately provide answers to questions or participate in discussions, or neglects to answer the questions posed during the Explore phase.
2. The pupil is able, with prompting, to adequately provide answers to questions or participate in discussions, and with prompting, answers some or all of the questions posed during the Explore phase.
3. The pupil is able to provide adequate answers to questions and participate in class discussions, and answer the questions posed during the Explore phase in his/her own words.
4. The pupil is able to extend the explanations in discussions and answer the questions posed during the Explore phase in his/her own words.

Create phase

During the Create phase, make sure that each pupil has developed a model that successfully demonstrates an animal’s role in the dispersion of seeds or the pollination of plants.

1. The pupil provides little or no evidence of an attempt to develop a model that demonstrates an animal’s role in the dispersion of seeds or the pollination of plants.
2. The pupil has attempted to develop a model that demonstrates an animal’s role in the dispersion of seeds or the pollination of plants, but some components of the model are incomplete or incorrect.
3. The pupil has developed a model that successfully demonstrates an animal’s role in the dispersion of seeds or the pollination of plants.
4. The pupil has developed an exceptional model that successfully demonstrates an animal’s role in the dispersion of seeds or the pollination of plants.

Share phase

During the Share phase, make sure that each pupil can explain what is happening in the pollination phase of a flower, and that they can identify the limitations of the model – what is realistic and unrealistic.

1. The pupil provides little, or no accurate explanation of what is happening in the pollination phase and is unable to identify the limitations of the model.
2. With prompting, the pupil can accurately explain what is happening in the pollination phase and may or may not identify the limitations of the model.
3. The pupil can explain, with accuracy, what is happening in the pollination phase and can identify specific limitations of the model.
4. The pupil can explain what is happening in the pollination phase, with ease and accuracy, and is able to clearly identify specific limitations of the model.

English, presentation and problem-solving assessment rubrics

You can use these assessment rubrics with the observation rubrics grid, which you will find in the "Assess with WeDo 2.0" chapter.

Explore phase

During the Explore phase, make sure that each pupil can effectively explain their own ideas and comprehension related to the questions posed.

1. The pupil is unable to share his/her ideas related to the questions posed during the Explore phase.
2. The pupil is able, with prompting, to share his/her ideas related to the questions posed during the Explore phase.
3. The pupil adequately expresses his/her ideas related to the questions posed during the Explore phase.
4. The pupil uses details to extend explanations of his/her ideas related to the questions posed during the Explore phase.

Create phase

During the Create phase, make sure that each pupil uses precise language and appropriate vocabulary, and makes appropriate choices in communicating concepts using the Documentation tool.

1. The pupil does not use precise language or vocabulary appropriately and does not demonstrate thoughtful choices in communicating concepts with the Documentation tool.
2. With prompting, the pupil uses precise language and appropriate vocabulary and makes appropriate choices in communicating concepts using the Documentation tool.
3. The pupil uses precise language and appropriate vocabulary and makes appropriate choices in communicating concepts using the Documentation tool.
4. The pupil uses precise language and advanced vocabulary and makes appropriate choices in communicating concepts using the Documentation tool.

Share phase

During the Share phase, make sure that each pupil provides reasons that are supported by scientific facts about pollination, to discuss how his/her model demonstrates animals' contribution to the life cycle of plants.

1. The pupil provides no reasons with supporting facts about pollination to discuss how his/her model demonstrates animals' contribution to the life cycle of plants.
2. The pupil provides one reason that is supported by scientific facts about pollination to discuss how his/her model demonstrates animals' contribution to the life cycle of plants.
3. The pupil provides more than one reason supported by scientific facts about pollination to discuss how his/her model demonstrates animals' contribution to the life cycle of plants.
4. The pupil provides several reasons that are well supported by scientific facts about pollination to discuss how his/her model demonstrates animals' contribution to the life cycle of plants.

Explore phase

The introductory video may set the stage for the following ideas to be reviewed and discussed with pupils for this project.

Introductory video

Pollination is a vital process in which a flower is affected by an external factor in order to have the pollen transported to the stigma:

1. Flowers rely on external factors, such as wind or animals, to help them to reproduce.
2. The flower of a plant is designed to attract animals. The colour, size, smell, and the nectar are all designed by nature.
3. Butterflies and moths have long tongues that allow them to reach deep inside tubular flowers. They are particularly attracted to bright-red flowers.
4. Hummingbirds have long beaks that are perfect for reaching the nectar deep inside tubular flowers.
5. Bats also play a role in pollination, using their very long tongues to get the nectar from flowers... mainly at night.

Pollination is only one step in a flowering plant’s life cycle. After the flower has been pollinated, the fruit or the seed will develop on the plant. The plant then gets further assistance from animals or external forces, such as wind or rain, to disperse the seeds.

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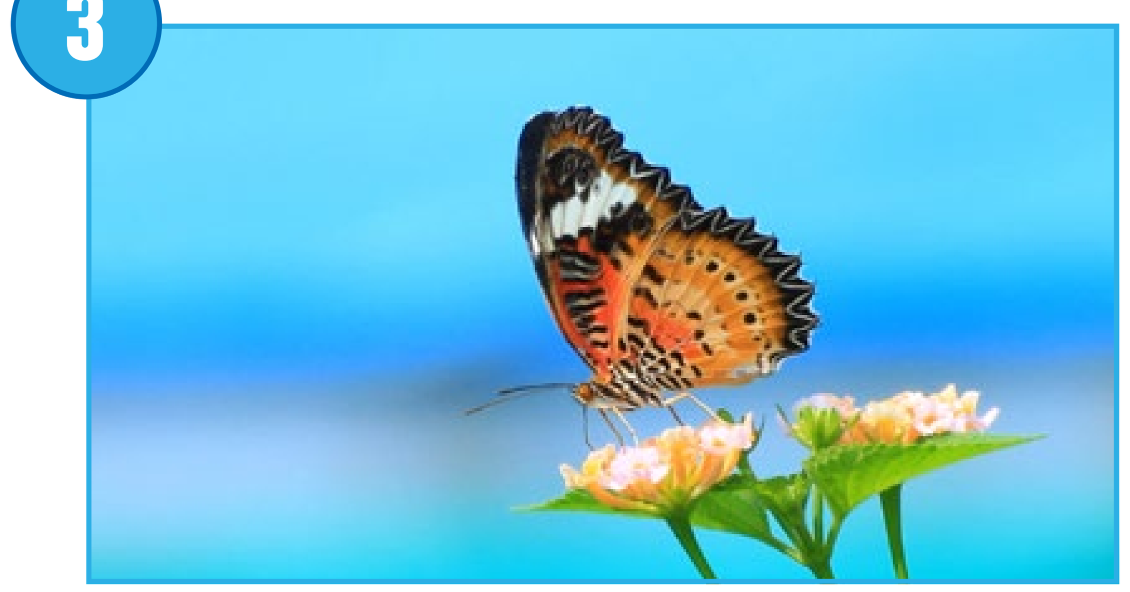

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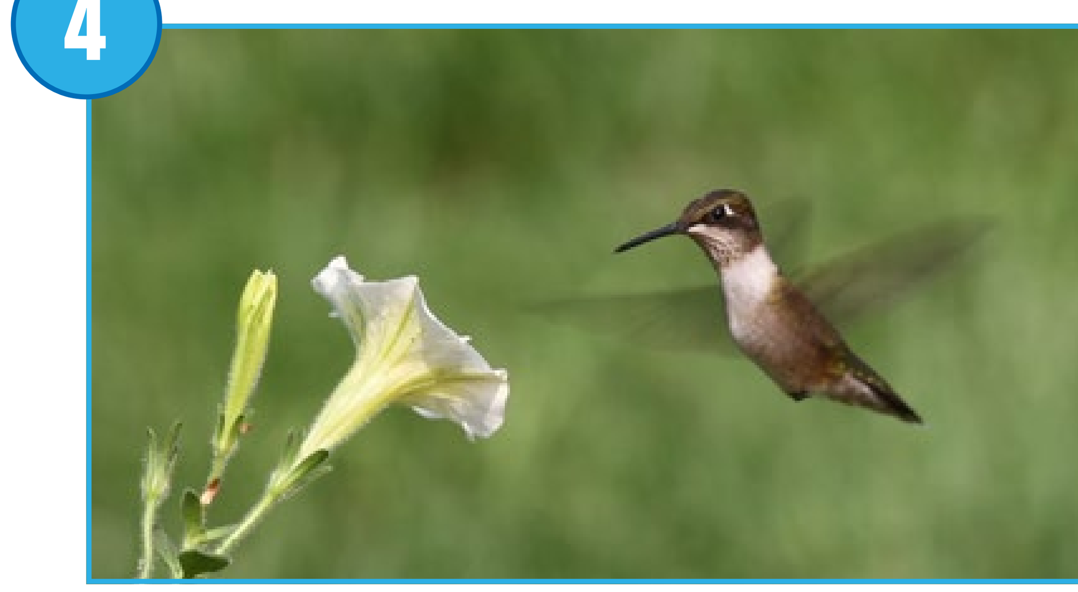

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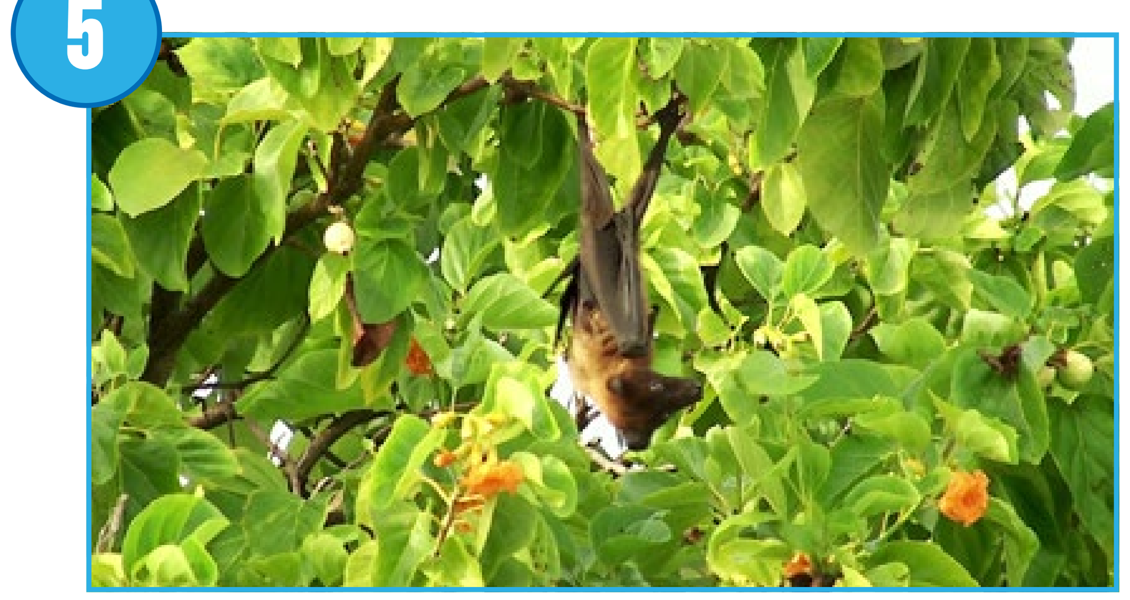


Explore phase

Questions for discussion

1. Name the different parts of a flower.
   Anther, stamen, stigma, style, pollen, nectar
2. Explain different ways in which animals help plants to reproduce.
   Pollinating animals go to the flower for nectar and will often get dusted with pollen, which is then transferred from one flower to the next. Most flowering plants rely on animals to pollinate them. Animals also help to disperse the seeds of many plants.
3. What are these processes called?
   Pollination is the process by which flowers reproduce. Around 90 percent of all pollination on the planet involves organisms. This is called biotic pollination.

Ask your pupils to answer with text or pictures using the Documentation tool.

Other questions to explore

1. Name three stages in the life of a flowering plant.
   Seed, seedling (tiny plant), and mature plant with flower
2. What is the role of a flower?
   The flower is the organ developed by a plant to attract animals in order to get help in the reproductive process and create seeds.
3. Do all flowers get pollinated by a pollinator?
   Some pollination takes place by wind or rain.

Create phase

Build and program a pollination model
Pupils will use the building instructions to create a model of a bee and a generic flower.

1. Build a pollination scenario.
This project model uses gears. These gears move on an axle to which the bee is attached. The flower uses a Motion Sensor to detect when the bee has landed on it.

2. Program the bee and the flower.
This program will turn the motor on in one direction until the bee is detected on top of the flower. When this happens, the motor will stop and a bee sound will be played.

Ask the pupils to use the transparent brick to represent the pollen.

Suggestion

Before your pupils start to modify their model, ask them to change the parameters of the program so that they fully understand it.

Create phase

Describe a pollination scenario

Using ideas from the first model, the pupils should be able to change both the pollinator and the flower.

When the pupils have built the bee, ask them to think about how they might build a new flower and a pollinator that would be attracted to it.
Encourage pupils to plan and test their designs.

1. Build a new flower.
As an example, the pupils could build a tubular, brightly-coloured, or large flower. When they design their flowers, make sure that they:

- Keep the Motion Sensor in the new flower.
- Use the transparent brick to represent pollen.
- Design the correct pollinator for the flower.

2. Build a new pollinator.
As an example, pupils can build a hummingbird, butterfly, fly, bat, or any other organism they know is a pollinator. When they design their pollinator, make sure that they:

- Attach their new pollinator to the axle.
- Design the correct flower for the pollinator.

3. Program a new scenario.
As an example, pupils can use a second flower to illustrate cross-pollination.
To do that, make sure that they:

- Program the new pollinator to act differently from the previous model.

Important

It is important to note that pupils' models will vary according to their individual choices, there are no building instructions or sample programs provided to pupils for this part of the project.

Collaboration suggestion

Teams working together can discuss, for example, if the pollinator of one type of flower can pollinate another type of flower and vice versa.

Create phase

The “Use the model further” section of the pupil project is an optional extension. Keep in mind that these tasks extend upon those of the “Use the model” section and are designed for older or more advanced pupils.

Use the model further

After the flower is pollinated, seeds or fruit appear on the plant.

1. Build and program a seed dispersion scenario.

Ask the pupils to modify the plant after the flower has been pollinated. Ask the pupils to explore the different types of seed dispersal. Ask them to pick one and create a model to represent it.

For example:

- Seeds hidden inside an attractive fruit to be eaten by an animal
- Seeds carried by animals and birds
- Seeds transported by wind or water
- Seeds that have self-propulsion mechanisms

Share phase

Complete the document
Ask the pupils to include a picture of every stage of the pollination process, in their final products :
- Ask your pupils to compare these images with real-life images.
- Ask your pupils to record a video of themselves describing how animals help plants to reproduce.

Present results
At the end of this project, pupils should present what they have learned.

To enhance your pupils' presentations:
- Ask the pupils to use the model to explain the relationship between the pollinator and the flower in the context of a plant's life cycle.
- Make sure that they can explain why and how the pollinator plays an active role in the pollination process.
- Ask them to put some context into their explanation, such as describing where the flower is, or in what season the event is taking place.

Plants and Pollinators

One possible way of sharing

Pupils in this class use their models to explain how a bee can pollinate a flower.

Project 6

Prevent Flooding

This project is about designing an automatic LEGO® floodgate to control water according to various precipitation patterns.

Curriculum links

National Curriculum for science

(See page 23 for how this project addresses non-statutory requirements, and requirements for working scientifically)

4.SM.s3: Identify the part played by evaporation and condensation in the water cycle and associate the rate of evaporation with temperature.

5.F.s2: Identify the effects of air resistance, water resistance and friction, that act between moving surfaces.
5.F.s3: Recognise that some mechanisms, including levers, pulleys, and gears, allow a smaller force to have a greater effect.

Other National Curriculum links

Design and technology

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.

Evaluate:
Evaluate their ideas and products against their own design criteria and consider the views of others to improve their work.

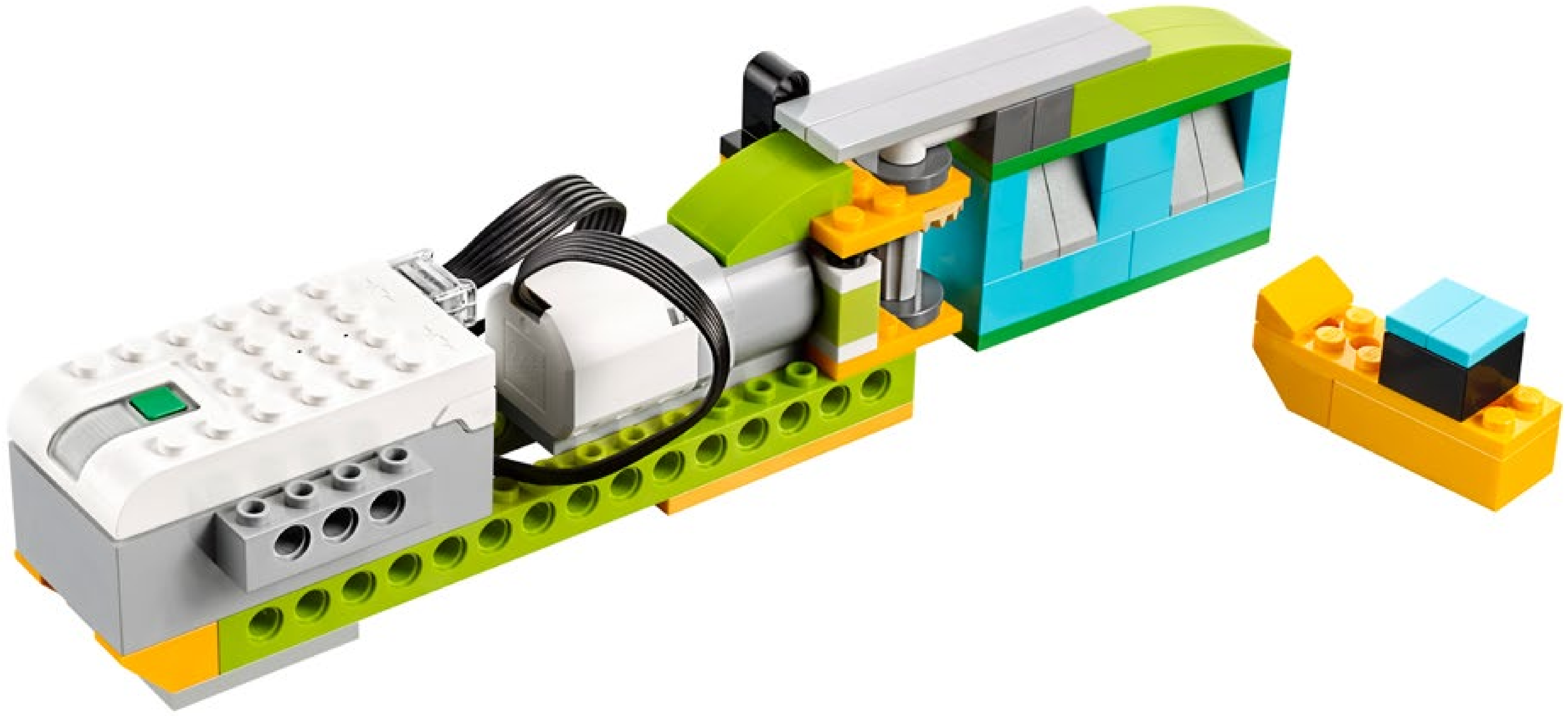
Technical knowledge:
Understand and use mechanical systems in their products [for example, gears, pulleys, cams, levers, and linkages].
Understand and use electrical systems in their products [for example, series circuits incorporating switches, bulbs, buzzers, and motors].
Apply their understanding of computing to program, monitor, and control their products.

Computing

Design, write, and debug programs that accomplish specific goals, including controlling or simulating physical systems.
Use sequence, selection, and repetition in programs; work with variables and various forms of input and output.
Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs.
Select, use, and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems, and content that accomplish given goals, including collecting, analysing, evaluating, and presenting data and information.

Geography

Human and physical geography:
Describe and understand key aspects of physical geography, including: climate zones, biomes and vegetation belts, rivers, mountains, volcanoes and earthquakes, and the water cycle.



Quick glance: Plan this WeDo 2.0 project

Preparation: 30 min.

- For information regarding general preparation, please see the “Classroom Management” chapter.
- Read about the project so you have a good idea of what to do.
- Define how you want to introduce this project: Use the video provided in the project in the WeDo 2.0 Software, or use material of your own choice.
- Determine the end result of this project: the parameters to present and produce the document.
- Make sure that timing allows for expectations to be met.

Important

This project is a design brief. Please refer to the “WeDo 2.0 in Curriculum” chapter for further explanations of design practices.

Explore phase: 30-60 min.

- Start the project using the introductory video.
- Hold a group discussion.
- Allow pupils to document their ideas for Max and Mia’s questions using the Documentation tool.

Create phase: 45-60 min.

- Ask the pupils to build the first model from the provided building instructions.
- Allow them to program the model using the sample program.
- Allow time for them to build different devices to create automatic doors.

Create more phase (optional): 45-60 min.

- You can use this extension of the project for differentiation or for older pupils.

Share phase: 45 min. or more

- Make sure your pupils document their findings as they work with sensors.
- Allow the pupils to share their experiences in different ways.
- Ask the pupils to create their final science reports and present their projects.

Suggestion

Have a look at the following “Open Projects” when you have completed this project:

- Hazard Alarm
- Extreme Habitats

Differentiation

To ensure success, consider giving more guidance on building and programming, such as:

- Explain how to use sensors.
- Define the types of precipitation for each season together with your pupils, and help them to determine which season they will focus on.
- Explain engineering-based design.

Be specific about how you would like them to present and document their findings. For example, a team sharing session.

Suggestion

For more experienced pupils, you may want to allow them extra time for building and programming to allow them to create different and more extensive types of devices. Ask them to use the design process to explain all of the versions they make.

Design further solutions

When designing further solutions, ask the pupils to use their knowledge of floodgates and different water sources to describe the body of water they are trying to control, and to take into consideration the position of mountains, cities, and lakes. Provide them with opportunities to expand the design process to include other ideas about how floodgates and other types of automatic doors function.

Pupils' misconceptions

Pupils tend to view the earth as static, stable, and unchanging. They often have difficulty comprehending that rocks can be worn down through the process of weathering. They often have difficulty understanding the role of dams or floodgates in the protection of land masses.

Vocabulary

Floodgate
An adjustable gate used to control the flow of water
Sluice
A sliding gate or other device for controlling the flow of water
Dike
A wall or embankment that prevents the flow of water
Upstream
Moving in the opposite direction to the water flow
Downstream
Moving in same direction as the water flow
Precipitation
Any form of water, such as rain, snow, sleet, or hail, that falls to the earth's surface
Dam
A barrier that impounds water or underground streams
Erosion
The process in which earth is worn away, often by water, wind, or ice
Automate
Convert a process or facility to work on its own, operated by a machine or computer.

Scientific understanding assessment rubrics

You can use these assessment rubrics with the observation rubrics grid, which you will find in the “Assess with WeDo 2.0” chapter.

Explore phase

During the Explore phase, make sure that each pupil is actively involved in the discussion, asks and answers questions, and can create a graph of precipitation for each season.

1. The pupil is unable to provide answers to questions or participate in discussions adequately, or create a graph of precipitation for each season.
2. The pupil is able, with prompting, to adequately provide answers to questions, participate in discussions, and with help, can create a graph of precipitation for each season.
3. The pupil is able to provide adequate answers to questions, participate in class discussions, and create a graph of precipitation for each season.
4. The pupil is able to extend on explanations during discussions and can create a graph of precipitation for each season.

Create phase

During the Create phase, make sure that each pupil works well as part of a team, justifies his/her best solution, and utilises the information gathered during the Explore phase.

1. The pupil is unable to work as part of a team, justify solutions, or use gathered information for further development.
2. The pupil is able to work as part of a team, gather and use information with guidance, or, with help, can justify solutions.
3. The pupil is able to work as part of a team, contribute to the team discussions, justify solutions, and gather and use information.
4. The pupil is able to work as part of a team, serve as the team leader, and can justify and discuss solutions that allow for the gathering and use of information.

Share phase

During the Share phase, make sure that each pupil can explain how the design for the floodgate was created, has used sensors to control the floodgate, and can use important information gathered during the project to create a final report.

1. The pupil is unable to engage in the discussions about the design, explain the model’s use of sensors, or use gathered information to create a final project.
2. The pupil is able, with prompting, to engage in the discussions about the design of the floodgate and the model’s use of sensors, and can use limited information to create a final project.
3. The pupil is able to engage in discussions about the design of the floodgate and the model’s use of sensors, and can use gathered information to produce a final project.
4. The pupil is able to engage extensively in class discussions about the topic, and can use gathered information to create a final project that includes additional elements.

English, presentation and problem-solving assessment rubrics

You can use these assessment rubrics with the observation rubrics grid, which you will find in the “Assess with WeDo 2.0” chapter.

Explore phase

During the Explore phase, make sure that each pupil can effectively explain their own ideas and comprehension related to the questions posed.

1. The pupil is unable to share his/her ideas related to the questions posed during the Explore phase.
2. The pupil is able, with prompting, to share his/her ideas related to the questions posed during the Explore phase.
3. The pupil adequately expresses his/her ideas related to the questions posed during the Explore phase.
4. The pupil uses details to extend explanations of his/her ideas related to the questions posed during the Explore phase.

Create phase

During the Create phase, make sure that each pupil makes appropriate choices (i.e., screenshot, image, video, text) and follows the established expectations for documenting their findings.

1. The pupil fails to document findings throughout the investigation.
2. The pupil documents his/her findings, but the documentation is incomplete or does not comply with all of the established expectations.
3. The pupil adequately documents his/her findings for each part of the investigation and makes appropriate choices and selections.
4. The pupil uses a variety of appropriate methods for documentation and exceeds the established expectations.

Share phase

During the Share phase, make sure that each pupil uses the evidence that they gathered during their investigations to justify their reasoning,
and that they adhere to established guidelines when presenting their findings to an audience.

1. The pupil does not use evidence from his/her findings in connection with the ideas shared during the presentation. The pupil does not follow the established guidelines.
2. The pupil uses some evidence from his/her findings, but the justification is limited. Established guidelines are generally followed, but may be lacking in one or more areas.
3. The pupil adequately provides evidence to justify his/her findings and follows established guidelines for presenting.
4. The pupil fully discusses his/her findings and thoroughly utilises appropriate evidence to justify his/her reasoning, while following all established guidelines.

Explore phase

The introductory video may set the stage for the following ideas to be reviewed and discussed with pupils for this project.

Introductory video

For many centuries, humans have created devices to prevent water from flooding populated areas:

1. Weather brings various types of precipitation during the year.
2. Sometimes, there is so much water that rivers and streams break their banks.
3. Erosion is a natural phenomenon that occurs in areas with high precipitation.
4. Floodgates allow water to flow downstream in canals or rivers.
5. During periods of regular precipitation, the floodgates are opened to keep the level of the reservoir low.
6. During periods of high precipitation, the floodgates are closed to fill the reservoir with the extra water.

You can compare the idea of floodgates to filling a bathtub:

- Opening the floodgates allows the water from upstream to flow downstream, just like running a tap into a bathtub with the plug removed; allowing the water to escape down the drain.
- Closing the floodgates completely would stop the water flow and cause flooding upstream. Just like running a tap into a bathtub with the plug inserted; the bathtub would fill up and eventually overflow.

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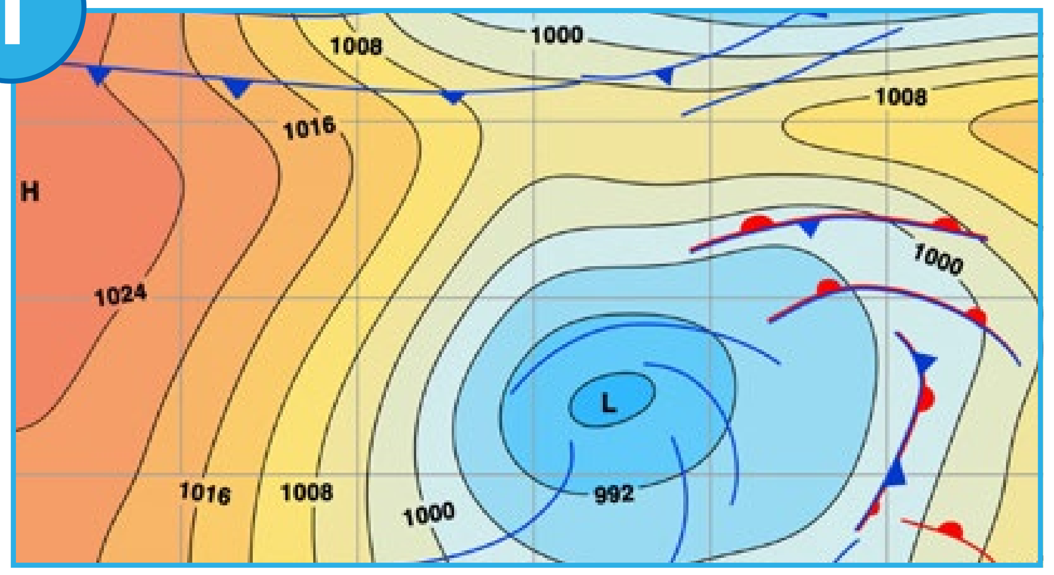

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5

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Explore phase

Questions for discussion

1. Use a bar graph to describe the precipitation levels for each season in your part of the world.
   The answer to this question will vary according to your location. Use descriptive words such as high rain season, low rain season, and flooding.
   The bar should show high, medium, and low precipitation.
2. How does precipitation influence the water level of rivers?
   Precipitation is not the only factor that influences the water level of rivers, but in general:
   - High precipitation raises the water level.
   - Low precipitation lowers the water level.
3. List ways in which a flood can be prevented.
   There are many ways in which we can prevent flooding, for example, dikes, dams, trenches, and reforestation.
4. Imagine a device that can prevent flooding from occurring.
   The answer to this question will guide pupils to the design process.

Ask your pupils to answer with text or pictures using the Documentation tool.

Other questions to explore

1. What is water erosion?
   Water erosion is a natural process by which water changes the shape of the land.
2. How is this bar graph different from the bar graph of your own region?
   The answer to this question will vary according to the pupil's location.

Create phase

Build and program a floodgate
Pupils will follow the building instructions to create a floodgate. This gate can be closed and opened using the motor.

1. Build a floodgate.
The module used in this project uses a bevel gear. This bevel gear can change the axis of rotation, allowing the floodgate to open and close.

2. Program the model to open and close the floodgate.
This program will display the image of the precipitation and run the motor in one direction for 2 seconds. Then it will display an image of the sun and run the motor in the opposite direction for 2 seconds.

Important

The use of the bar graph should help the pupils to explain why they need to close or open the floodgate.

Suggestion

Before your pupils begin designing their solutions, ask them to adjust the parameters of the program so that they fully understand it.

Create phase

Automate the floodgate
The pupils should add sensors to their models to make them react to the environment. They should consider at least one of these options:

1. Add a Tilt Sensor handle to operate the gate.
A Tilt Sensor handle will allow the operator to open and close the gate.

2. Add a Motion Sensor to detect rising water.
A Motion Sensor will let you open and close the door according to water levels. Use your hands or LEGO® bricks to simulate different water levels.

3. Add a Sound Sensor Input to activate emergency protocol.
The emergency protocol can be used to play a sound, flash the lights, send a text message, or close the floodgates.

Important

It is important to note that pupils’ models will vary according to their individual choices, there are no building instructions or sample programs provided to pupils for this part of the project.

Suggestion

Pupils can refer to the Design Library for inspiration.

Create phase

Use the “Design new solutions” section of the pupil project as an optional extension. Keep in mind that these tasks are an extension of the “Design a solution” section and are meant for older or more advanced pupils.

Design further solutions

Flooding and erosion do not just happen anywhere.

1. Draw a map of the floodgate location, including the land and river areas:

- Ask your pupils to create a map or a display of the river with other elements, such as mountains, valleys, or cities.
- Ask them to describe where a floodgate might be used.
- Ask them to illustrate where the water comes from and where it goes to.

2. Find other uses for a floodgate.

You could use the floodgate in situations other than a flood. Ask your pupils to think of gates and doors in general.

Collaboration suggestion

The floodgate can also be used in a canal navigation scenario. Pair up teams and ask them to illustrate what might happen in a boat transportation sequence.

3. Program two floodgates to control the navigation of water in and out of a section of the river.

Ask the pupils to describe and program the sequence for operating the floodgates.

Share phase

Complete the document

Ask the pupils to document their projects in different ways:

- Ask the pupils to take photographs of each version they create. Ask them to explain which is the best solution and provide evidence for their reasoning.
- Ask your pupils to compare these images with real-life images.
- Ask your pupils to record project presentation videos.

Present results

In this project, the pupils should explain how the sensors are incorporated into their models.

To enhance your pupils' presentations:

- Make sure that they can explain why the floodgates can prevent water from changing the shape of the land.
- Ask them to put their explanation into context: Where is it occurring? In which season? Under what conditions?

Prevent Flooding

One possible way of sharing

Pupils explain how a floodgate can prevent water from reshaping the land downstream.

Project 7

Drop and Rescue

This project is about designing a device to reduce the impact caused by a weather-related hazard on humans, animals, and the environment.

Curriculum links

National Curriculum for science

(See page 23 for how this project addresses non-statutory requirements, and requirements for working scientifically)

5.F.s3: Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

Other National Curriculum links

Design and technology

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.

Evaluate:

Evaluate their ideas and products against their own design criteria and consider the views of others to improve their work.

Technical knowledge:

Understand and use mechanical systems in their products [for example, gears, pulleys, cams, levers, and linkages].

Understand and use electrical systems in their products [for example, series circuits incorporating switches, bulbs, buzzers, and motors].

Apply their understanding of computing to program, monitor and control their products.

Computing

Design, write, and debug programs that accomplish specific goals, including controlling or simulating physical systems.

Use sequence, selection, and repetition in programs; work with variables and various forms of input and output.

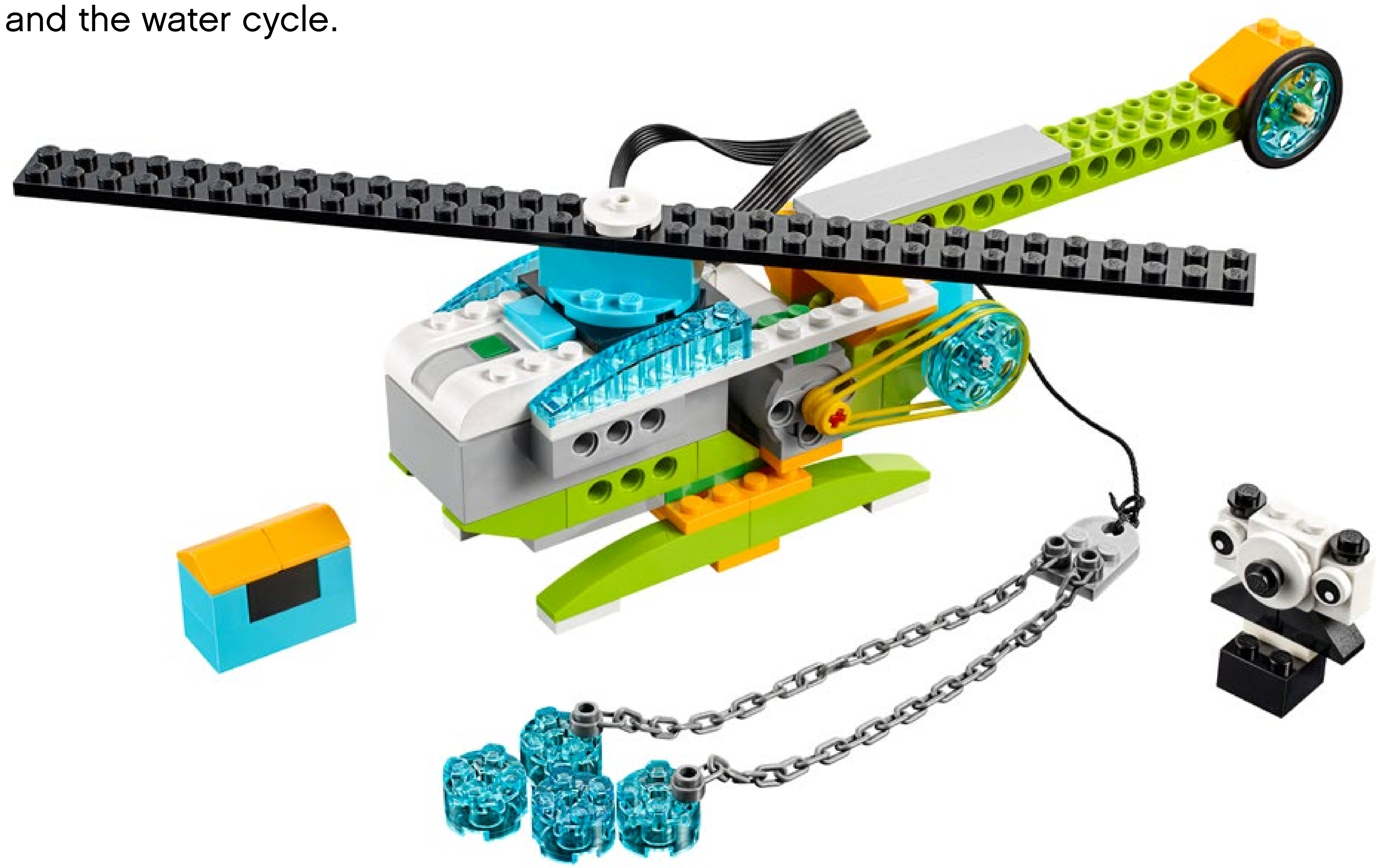
Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs.

Select, use, and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems, and content that accomplish given goals, including collecting, analysing, evaluating, and presenting data and information.

Geography

Human and physical geography:

Describe and understand key aspects of physical geography, including: climate zones, biomes and vegetation belts, rivers, mountains, volcanoes and earthquakes, and the water cycle.



Quick glance: Plan this WeDo 2.0 project

Preparation: 30 min.

- Read the general preparation in the “Classroom Management” chapter.
- Read about the project so you have a good idea of what to do.
- Define how you want to introduce this project: Use the video provided in the project in the WeDo 2.0 Software, or use material of your own choice.
- Determine the end result of this project: the parameters to present and produce the document.
- Make sure that timing allows for expectations to be met.

Important

This project is a design brief. Please refer to the “WeDo 2.0 in Curriculum” chapter for further explanations of design practices.

Explore phase: 30-60 min.

- Start the project using the introductory video.
- Hold a group discussion.
- Allow the pupils to document their ideas for Max and Mia’s questions using the Documentation tool.

Create phase: 45-60 min.

- Ask the pupils to build the first model using the provided building instructions.
- Allow them to program the model using the sample program.
- Allow time for them to design two different prototypes for one of the rescue missions: relocate an endangered animal, drop materials to help people, or drop water to put out fires.

Create more phase (optional): 45-60 min.

- You can use this extension of the project for differentiation or for older pupils.

Share phase: 45 min. or more

- Make sure that your pupils document the results of each mission.
- Ask the pupils to share the reasoning behind the designs of their prototypes for each mission.
- Ask them to discuss the engineering-based design process and ways that they had to change or adjust the prototypes.
- Ask the pupils to create their final presentations.
- Find different ways to let the pupils share their results.
- Ask the pupils to present their projects.

Suggestion

Have a look at the following “Open Projects” when you have completed this project:

- Cleaning the Ocean
- Space Exploration

Differentiation

To ensure success, consider giving more guidance on building and programming, such as:

- Make sure that the pupils understand the problem they have to solve.
- Ask them to write a text or record a video describing the problem.
- Explain engineering-based design.
- Explain how to use sensors.

Be specific about how you would like them to present and document their findings. For example, a team sharing session.

Suggestion

You may want to ask the more experienced pupils to use the Tilt Sensor to control the up-and-down movement of the string.

Design further solutions

To extend this part of the project, ask the pupils to design a completely new solution to the problem, moving away from the helicopter into something different.

Pupils' misconceptions

It is possible that pupils will only articulate experiences about what they can imagine happening within their own local environments. For example, pupils from coastal communities may only consider sea rescue. Ask the pupils to project themselves into another context and to explore solutions to problems within that environment.

Vocabulary

Stretcher
A special apparatus designed to move injured or endangered people or animals
Rescue
Responsive operations that save lives or prevent further danger to inhabitants of an affected area
Prototype
Early sample or model that is used to test a concept
Weather
The daily conditions of the atmosphere in terms of temperature, atmospheric pressure, wind, and moisture
Weather-related hazard
A group of natural hazards caused by weather

Scientific understanding assessment rubrics

You can use these assessment rubrics with the observation rubrics grid, which you will find in the “Assess with WeDo 2.0” chapter.

Explore phase

During the Explore phase, make sure that each pupil is actively involved in the discussion, asks and answers questions, and can describe, in their own words, the problem that they have to solve in each mission.

1. The pupil is unable to provide answers to questions, participate in discussions, or adequately describe the problem to be solved in each mission.
2. The pupil is able, with prompting, to adequately provide answers to questions, participate in discussions, and with help, can give a basic description of the problem to be solved in each mission.
3. The pupil is able to provide adequate answers to questions, participate in class discussions, and describe the problem to be solved in each mission.
4. The pupil is able to extend the explanations in discussions or describe the problem to be solved in each mission.

Create phase

During the Create phase, make sure that each pupil is able to work as part of a team, can discuss what they think is the best solution for each mission, and uses the information gathered in the Explore phase to suggest prototype solutions for each mission.

1. The pupil is unable to work well as part of a team, cannot discuss the best solution for each mission, and does not demonstrate the ability to use the engineering design process to solve problems.
2. The pupil is able to solve problems as part of a team, can discuss the best solution for each mission, and, with help, can demonstrate the use of the engineering design process to gather and use information to solve problems.
3. The pupil is able to work as part of a team, contributes to discussions, and can demonstrate the use of the engineering design process to gather and use information to solve problems.
4. The pupil is able to work as a team leader and extend the use of engineering-based design to gather and use information to solve problems in many ways.

Share phase

During the Share phase, make sure that each pupil can describe the different solutions that he/she has developed for each mission, explain how their solution can solve the problem they have identified for each mission, and use important information from their project to create their final report.

1. The pupil is unable to engage in discussions about the mission or design processes, and cannot explain the solutions to the problems posed or use the information to create a final project.
2. The pupil is able, with prompting, to engage in discussions about design processes as well as demonstrate, with limited ability, the use of information to solve real-world problems and create a project.
3. The pupil is able to engage in discussions about design processes or use gathered information to produce a final project that presents solutions for the posed problems.
4. The pupil is able to engage extensively in class discussions about the topic and uses gathered information to create a final project that includes additional required elements.

English, presentation and problem-solving assessment rubrics

You can use these assessment rubrics with the observation rubrics grid, which you will find in the “Assess with WeDo 2.0” chapter.

Explore phase

During the Explore phase, make sure that each pupil can effectively explain his/her own ideas and comprehension related to the questions posed.

1. The pupil is unable to share his/her ideas related to the questions posed during the Explore phase.
2. The pupil is able, with prompting, to share his/her ideas related to the questions posed during the Explore phase.
3. The pupil adequately expresses his/her ideas related to the questions posed during the Explore phase.
4. The pupil uses details to extend on explanations of his/her ideas related to the questions posed during the Explore phase.

Create phase

During the Create phase, make sure that each pupil makes appropriate choices (i.e., screenshot, image, video, text) and follows the established expectations for documenting their findings.

1. The pupil fails to document findings throughout the investigation.
2. The pupil documents his/her findings, but the documentation is incomplete or does not comply with all of the established expectations.
3. The pupil adequately documents findings for each part of the investigation and makes appropriate choices and selections.
4. The pupil uses a variety of appropriate methods for documentation and exceeds the established expectations.

Share phase

During the Share phase, make sure that each pupil uses the evidence that they gathered during their investigations to justify their reasoning, and that they adhere to established guidelines when presenting their findings to an audience.

1. The pupil does not use evidence from his/her findings when sharing ideas during the presentation. The pupil does not follow the established guidelines.
2. The pupil uses some evidence from his/her findings, but the justification is limited. Established guidelines are generally followed but may be lacking in one or more areas.
3. The pupil adequately provides evidence to justify his/her findings and follows established guidelines for presenting.
4. The pupil fully discusses his/her findings and thoroughly utilises appropriate evidence to justify his/her reasoning, while following all established guidelines.

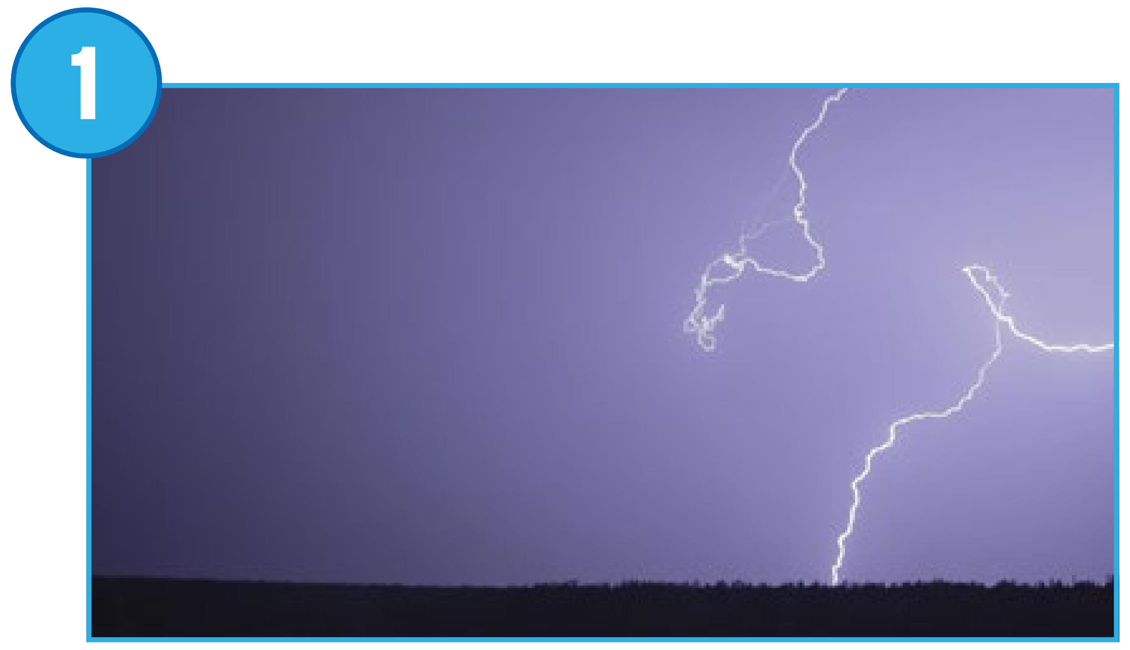
Explore phase

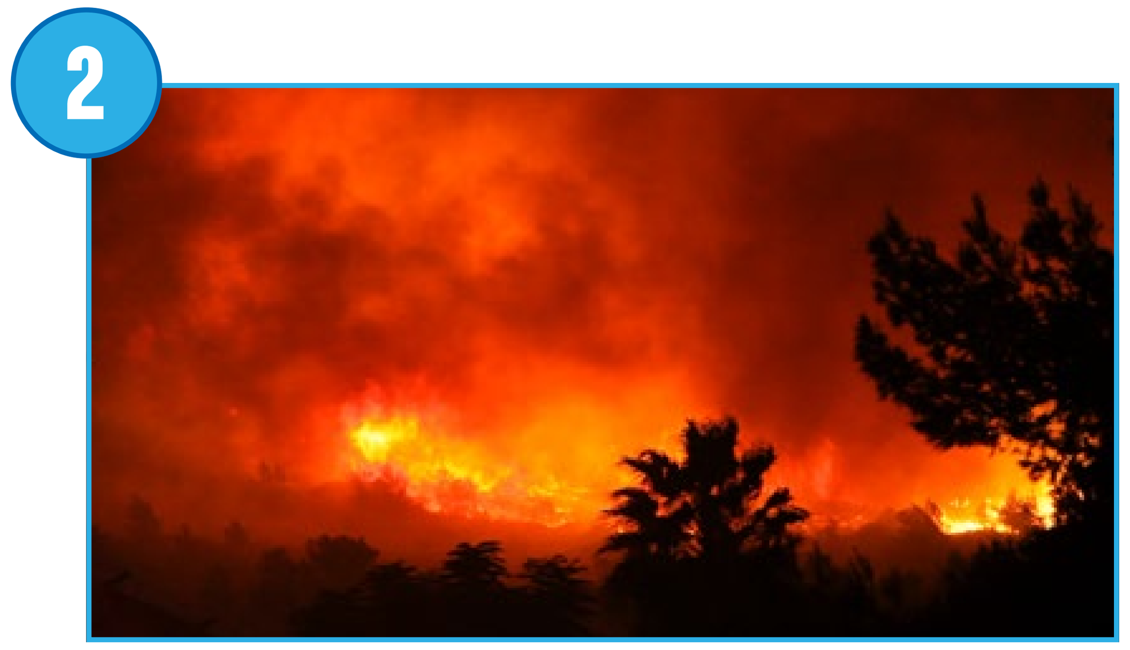
The introductory video may set the stage for the following ideas to be reviewed and discussed with pupils for this project.

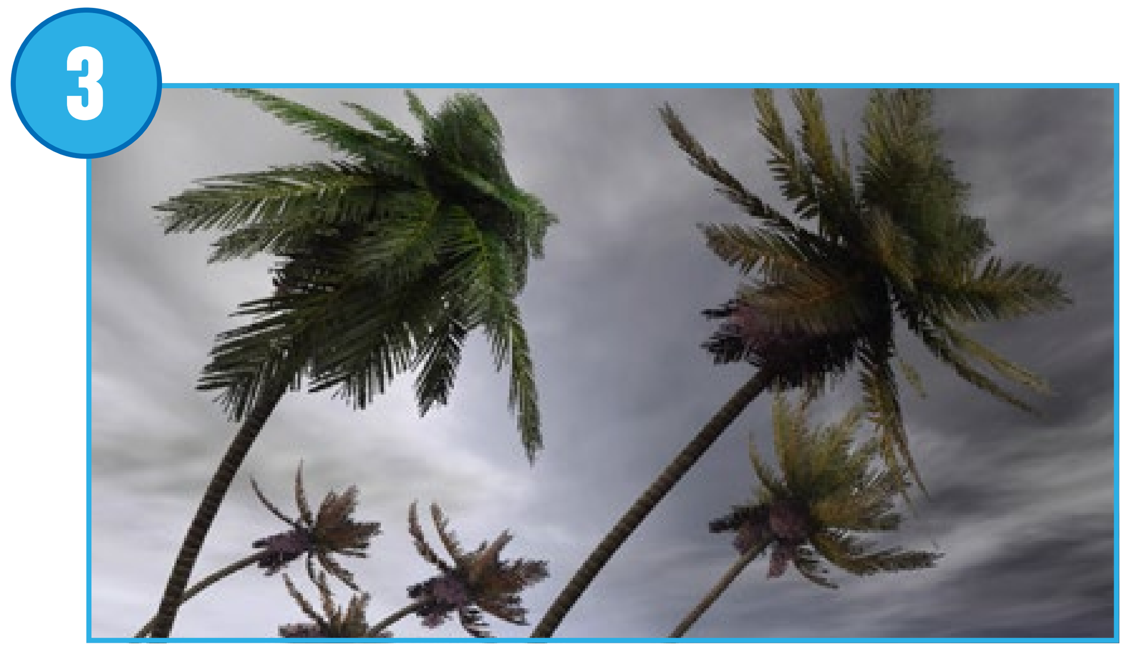
Introductory video

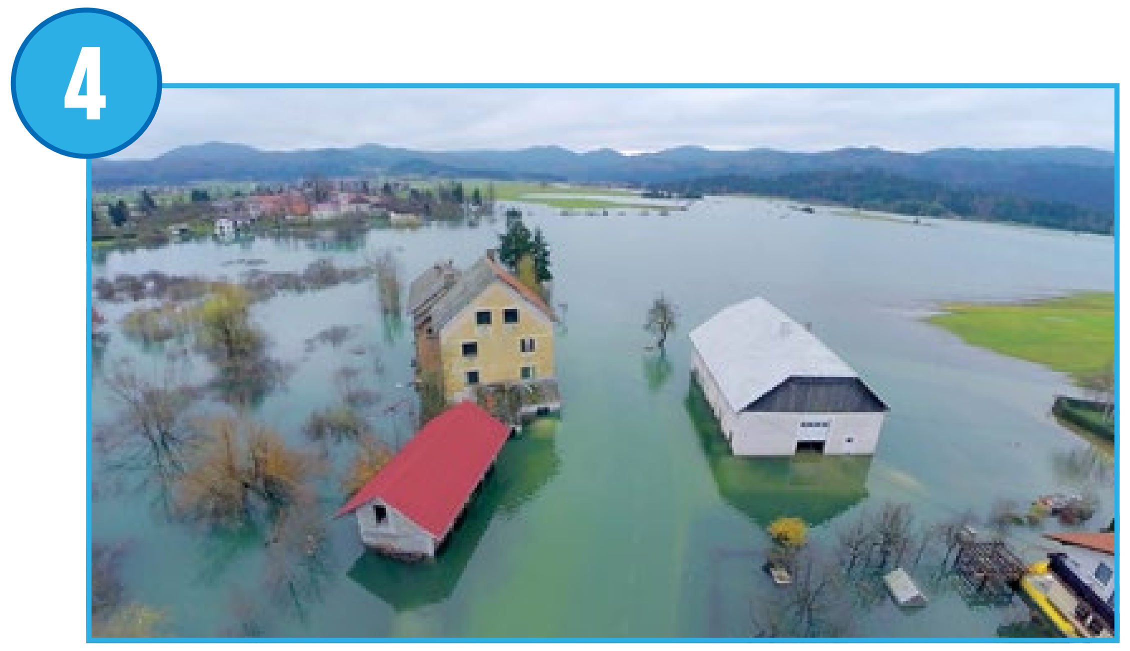
Serious weather-related hazards can destroy areas very quickly and violently. When this happens, animals and people can be in danger:

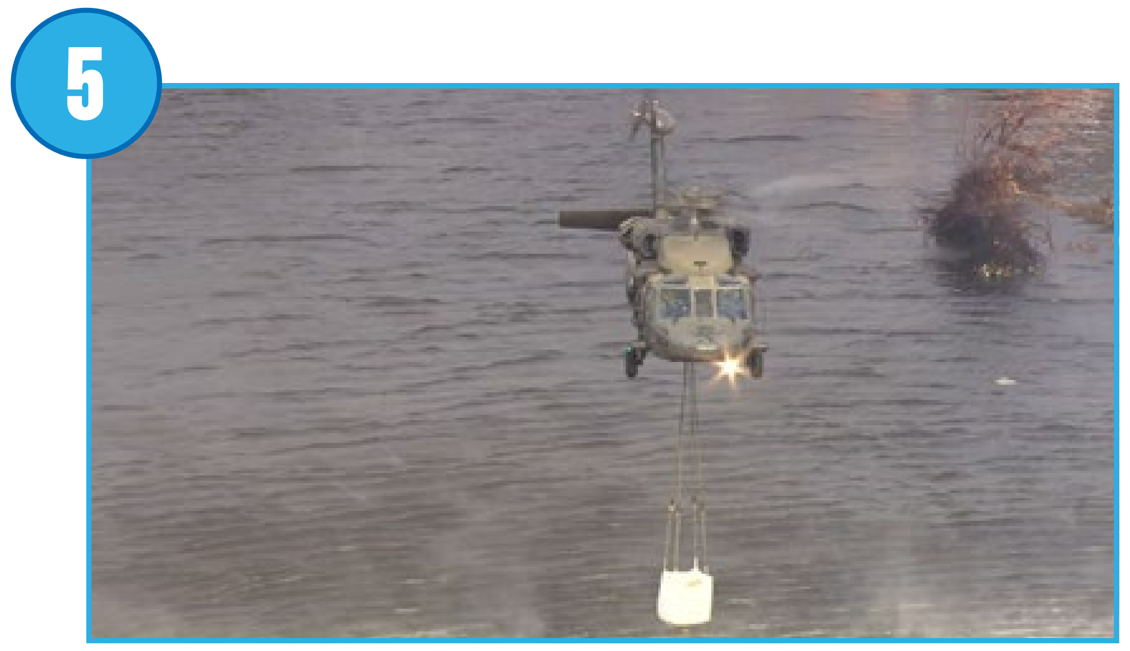
1. Lightning storms are responsible for a lot of natural fires.
2. When fire starts, it can destroy habitats very quickly.
3. Strong winds and floods can also be hazardous.
4. In extreme cases, authorities launch rescue missions.
5. Helicopters can be used to airlift animals and people out of danger zones or bring vital supplies to those in need.











Explore phase

Questions for discussion

1. What kinds of weather-related hazards occur in your area or in other areas?
   The answer to this question might include forest fires, floods, hurricanes, or tornadoes.
2. How do weather-related hazards affect animals or people?
   The answer to this question will depend on the location.
3. Describe different ways in which a helicopter can be used during a weather-related hazard.
   Helicopters can be used to airlift people and supplies, and to conduct aerial water drops on forest fires.

Ask your pupils to answer with text or pictures using the Documentation tool.

Create phase

Build and program a rescue helicopter
Pupils will follow the building instructions to create an exciting rescue helicopter.

1. Build a helicopter.
The model used in this project uses a pulley to transmit the movement from the motor axle to the string axle.

2. Program the helicopter to lower and raise its string.
When the first Start Block is pressed, the motor will run in one direction for 2 seconds. The motor will run in the opposite direction when the second Start Block is pressed.

Suggestion

Before your pupils begin designing their solutions, ask them to adjust the parameters of the program so that they fully understand it.

Create phase

From this model, pupils should be to able design their own drop or rescue device.

Pupils have to modify the helicopter so it can be used in a weather-damaged area, making sure that their designs are safe, easy to use, and adapted to the situation. There is definitely more than one good answer to this challenge, but a good answer is something that can be linked to the criteria.

Ask the pupils to build at least two solutions for one of the cases, so that they can compare them.

1. Build a device to relocate an endangered animal.
Pupils can build a platform, a box, or a stretcher to lift the animal. They should make sure that the animal can not fall out during transportation.

2. Build a device that can drop materials to people in need.
Pupils can build a basket, a net, or a stretcher to lower materials. They should make sure that nothing can fall out under transportation.

3. Build a device that can drop water to put out a fire.
This modification could lead to a new design for the helicopter body, using the motor to drop water instead of moving the string.

Important

It is important to note that the pupils' models will vary according to their individual choices, there are no building instructions or sample programs provided to pupils for this part of the project.

Important

Ask the pupils to build two solutions for one of the cases listed above. Make sure that they compare their solutions according to the above listed criteria.

Create phase

Use the “Design further solutions” section of the pupil project as an optional extension. Keep in mind that these tasks are an extension of the “Use the model” section and are designed for older or more advanced pupils.

Design further solutions

In certain situations, helicopters might not be suitable for performing rescue missions. Describe a situation in which this might arise, and ask the pupils to think of alternative solutions to the problem. The situation could be:

- A rescue during a tornado.
- A rescue following an avalanche.
- Providing vital resources during a drought period.

Ask the pupils to reflect on what they learned in the previous part of the project. Ask them to explain how their ability to find solutions to problems has improved.

Collaboration suggestion

Teams can work together to find solutions to situations that have multiple rescue aspects. For example, one team could focus on removing debris and the second team could focus on rescuing people or animals.

Share phase

Complete the document

Ask the pupils to document their projects in a variety of ways:

- Ask the pupils to take photographs of each version they create, to present what they consider to be their best solution, and to explain why.
- Ask your pupils to compare these images with real-life images.
- Ask your pupils to record project presentation videos.

Present results

In this project, ask the pupils to present two of their designs, and ask them to explain why these solutions meet the criteria or why not.

To enhance pupils' presentations:

- Ask them to describe how their solution is used in the rescue mission they have chosen.
- Ask them to add some context to their explanation.
- Ask them to describe where this is happening, in what conditions, and to identify any safety issues they needed to address.

Drop and Rescue

One possible way of sharing

Pupils in this class have designed a helicopter to deliver vital supplies and carry out rescue missions involving both people and animals.

Project 8

Sort to Recycle

This project is about designing a device that uses the physical properties of objects, including their shape and size, to sort them.

Curriculum links

National Curriculum for science

(See page 23 for how this project addresses non-statutory requirements, and requirements for working scientifically)

5.F.s3: Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

Other National Curriculum links

Design and technology

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.

Evaluate:

Evaluate their ideas and products against their own design criteria and consider the views of others to improve their work.

Technical knowledge:

Understand and use mechanical systems in their products [for example, gears, pulleys, cams, levers, and linkages].
Understand and use electrical systems in their products [for example, series circuits incorporating switches, bulbs, buzzers, and motors].
Apply their understanding of computing to program, monitor, and control their products.

Computing

Design, write, and debug programs that accomplish specific goals, including controlling or simulating physical systems.
Use sequence, selection, and repetition in programs; work with variables and various forms of input and output.
Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs.
Select, use, and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems and content that accomplish given goals, including collecting, analysing, evaluating, and presenting data and information.

Quick glance: Plan this WeDo 2.0 project

Preparation: 30 min.

- For information regarding general preparation, please see the "Classroom Management" chapter.
- Read about the project so you have a good idea of what to do.
- Define how you want to introduce this project: Use the video provided in the project in the WeDo 2.0 Software, or use material of your own choice.
- Determine the end result of this project: the parameters to present and produce the document.
- Make sure that timing allows for expectations to be met.

Important

This project is a design brief. Please refer to the "WeDo 2.0 in Curriculum" chapter for further explanations of design practices.

Explore phase: 30-60 min.

- Start the project using the introductory video.
- Hold a group discussion.
- Allow the pupils to document their ideas for Max and Mia's questions using the Documentation tool.

Create phase: 45-60 min.

- Ask the pupils to build the first model from the provided building instructions.
- Allow them to program the model using the sample program.
- Allow time for the pupils to create different ways of sorting the two objects.
- Consider asking your pupils to sketch their designs and modifications as part of this project.

Create more phase (optional): 45-60 min.

- You can use this extension of the project for differentiation or for older pupils.

Share phase: 45 min. or more

- Make sure that your pupils document their prototypes – what works and what doesn't – and describe the design challenges they encounter.
- Encourage your pupils to share their experiences in different ways.
- Ask the pupils to present their projects.
- Ask the pupils to create their final science report.

Suggestion

Have a look at the following Open Projects after this one:

- Cleaning the Oceans
- Extreme Habitats

Differentiation

To ensure success, consider giving more guidance on building and programming, such as:

- Allow more time for pupils to understand how the first prototype works.
- Allow them time to create more than one prototype.
- Explain engineering-based design.

Be specific about how you would like them to present and document their findings. For example, a team sharing session.

Design further solutions

For more experienced pupils, you may want to allocate extra time for building and programming to allow them to create different types of devices that sort according to other properties beyond shape. Ask them to use the design process to explain all of the versions they make.

Pupils' misconceptions

Pupils will often confuse weight, mass, and volume. They will make the correlation that the heavier an object is, the bigger it is. They will also fail to connect gravity to the content. Be sure to formulate equations in the areas of weight, mass, and volume.

Vocabulary

Physical property
The characteristic of an object that can be observed or measured without changing its chemical composition, such as appearance, smell, or height

Recycle
To convert waste items into usable materials

Sort
To arrange into groups by type

Efficient
Works in the best possible manner

Waste
Discarded material deemed no longer useful

Scientific understanding assessment rubrics

You can use these assessment rubrics with the observation rubrics grid, which you will find in the "Assess with WeDo 2.0" chapter.

Explore phase

During the Explore phase, make sure that each pupil is actively involved in the discussion, asks and answers questions, and can explain how the properties of an object help them to sort it.

1. The pupil is unable to provide adequate answers to questions, participate in discussions, or adequately describe the properties of the object and how it can be sorted.
2. The pupil is able, with prompting, to provide adequate answers to questions, participate in discussions, or with help, describe the properties of the object and how it can be sorted.
3. The pupil is able to provide adequate answers to questions and participate in class discussions, and can describe the properties of the object and how it can be sorted.
4. The pupil is able to extend on explanations in discussions and describe the properties of the object and how it can be sorted.

Create phase

During the Create phase, make sure that each pupil can work as part of a team, demonstrates the use of the engineering design process, and gathers and uses information to solve problems.

1. The pupil is unable to work as part of a team to solve problems and does not demonstrate the ability to use the engineering design process to solve problems.
2. The pupil is able to work as part of a team to solve problems, or with help can demonstrate the use of the engineering design process to gather and use information to solve problems.
3. The pupil is able to work as part of a team to solve problems, and can demonstrate the use of the engineering design process to gather and use information to solve problems.
4. The pupil works as a team leader, is able to extend the use of engineering design and can gather and use information to solve problems in many ways.

Share phase

During the Share phase, make sure that each pupil can explain how they solved the problem and that they communicate how they used the size of objects to sort them.

1. The pupil does not explain how he/she solved the problem and does not communicate how he/she sorted the objects by size.
2. The pupil can partially explain how he/she solved the problem and communicates, with prompting, some ideas on how he/she sorted objects by size.
3. The pupil can explain adequately how he/she solved the problem and communicates how he/she sorted objects by size.
4. The pupil can explain, in detail, how he/she solved the problem and communicates very clearly and thoroughly how he/she sorted objects by size.

English, presentation and problem-solving assessment rubrics

You can use these assessment rubrics with the observation rubrics grid, which you will find in the “Assess with WeDo 2.0” chapter.

Explore phase

During the Explore phase, make sure that each pupil can effectively explain his/her own ideas and comprehension related to the questions posed.

1. The pupil is unable to share his/her ideas related to the questions posed during the Explore phase.
2. The pupil is able, with prompting, to share his/her ideas related to the questions posed during the Explore phase.
3. The pupil adequately expresses his/her ideas related to the questions posed during the Explore phase.
4. The pupil uses details to extend explanations of his/her ideas related to the questions posed during the Explore phase.

Create phase

During the Create phase, make sure that each pupil makes appropriate choices (i.e., screenshot, image, video, text) and follows the established expectations for documenting their findings.

1. The pupil fails to document findings throughout the investigation.
2. The pupil documents his/her findings, but the documentation is incomplete or does not comply with all of the established expectations.
3. The pupil adequately documents findings for each part of the investigation and makes appropriate choices and selections.
4. The pupil uses a variety of appropriate methods for documentation and exceeds the established expectations.

Share phase

During the Share phase, make sure that each pupil uses the evidence that they gathered during their investigations to justify their reasoning, and that they adhere to established guidelines when presenting their findings to an audience.

1. The pupil does not use evidence from his/her findings when sharing ideas during the presentation. The pupil does not follow the established guidelines.
2. The pupil uses some evidence from his/her findings, but the justification is limited. In general, established guidelines are followed, but may be lacking in one or more areas.
3. The pupil adequately provides evidence to justify his/her findings and follows established guidelines for presenting.
4. The pupil fully discusses his/her findings and thoroughly utilises appropriate evidence to justify his/her reasoning, while following all established guidelines.

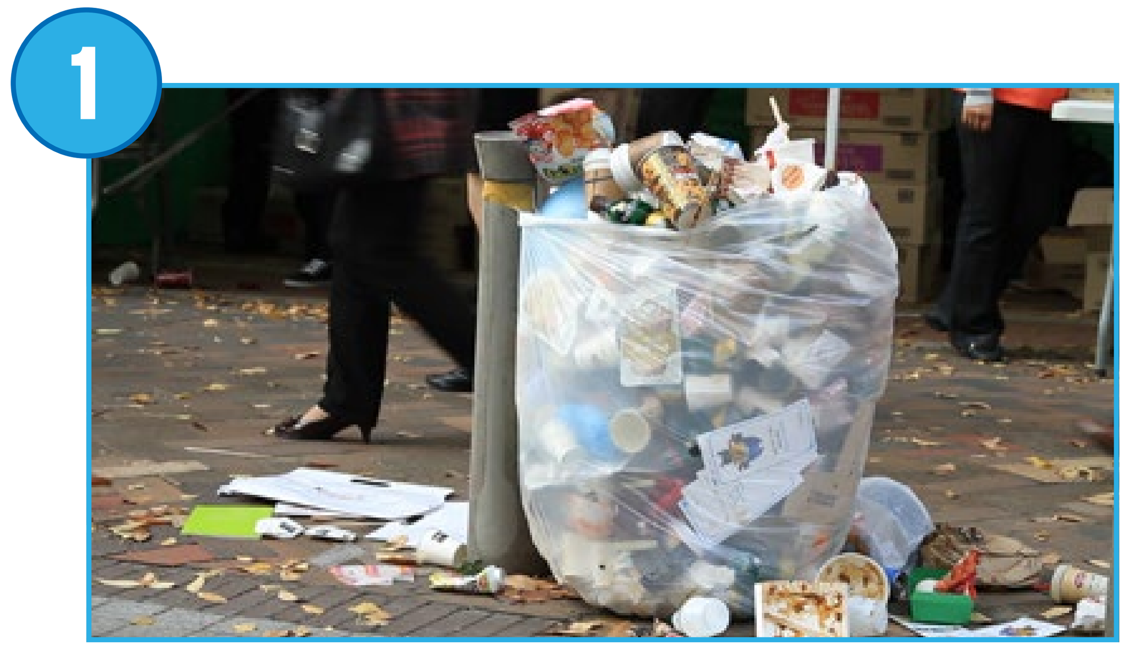
Explore phase

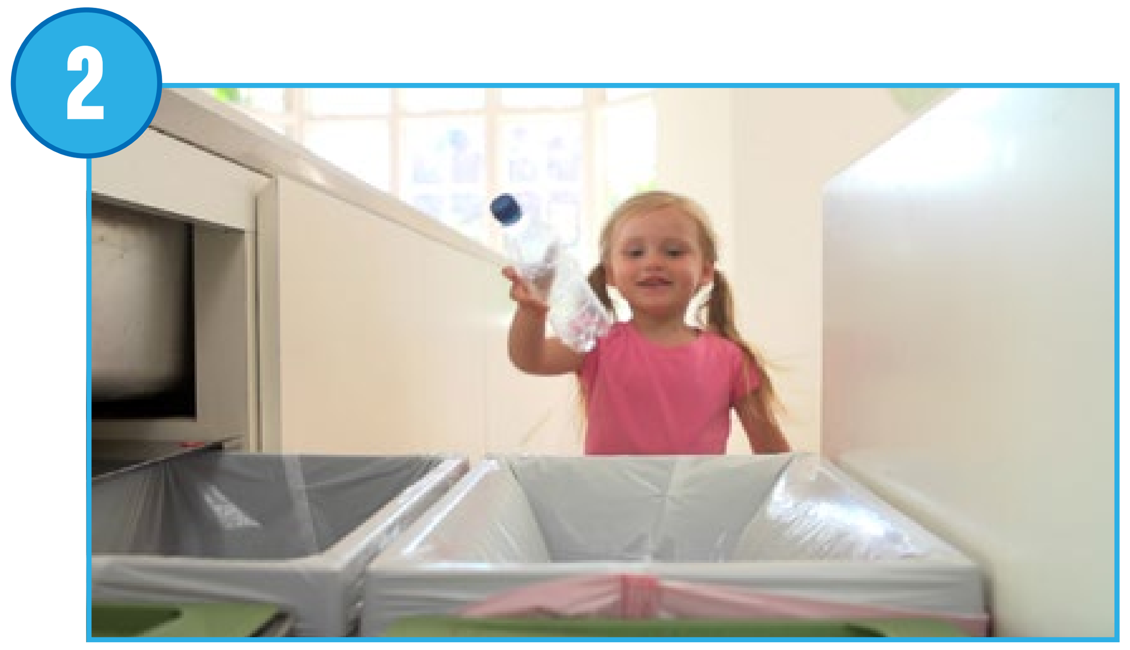
The introductory video may set the stage for the following ideas to be reviewed and discussed with pupils for this project.

Introductory video

Recycling material is one of the biggest challenges of the 21st century. Recycling can give a second life to the waste materials. Encouraging more people to consistently recycle their waste is a challenge. One way to encourage more widespread recycling is to increase the efficiency of sorting methods:

1. People must adopt behaviour that leads to a reduction in the disposal of waste.
2. Recyclable materials should be sorted at the beginning of the recycling process, instead of being mixed together and sent to recycling centres.
3. People or machines can separate waste according to its kind: paper, plastic, metal, or glass.
4. When a machine is used to sort objects, it needs to use one of the object's physical characteristics, such as weight, size, shape, or even its magnetic properties.





Explore phase

Questions for discussion

1. What does it mean to recycle?
   Recycling is a process for converting waste materials into something new. Commonly recycled items include paper, plastic, and glass.
2. How are recyclable materials sorted in your area?
   Discuss whether the materials are sorted by hand or machine, together with your pupils. Ask the pupils if they sort waste items for recycling at home.
3. Imagine a device that can sort waste according to its shape.
   The answer to this question will guide pupils to the design process.

Ask your pupils to answer with text or pictures using the Documentation tool.

Other questions to explore

1. Where does your recycling material go to?
   The answer to this question will be different according to your location, but most likely, materials will go to the local recycling facility. Non-recyclable material will go to a different location, such as a landfill or an incinerator.

Create phase

Build and program a truck to sort recyclable objects
Pupils will follow the building instructions to create a sorting truck and the recyclable objects.

1. Build a sorting truck.
The model used in this project uses a pulley system to flip the truck load on an axis. At first, both parts should be able to pass through, even though they are different shapes. Later, pupils will be challenged to modify the design so that the objects are sorted by size.

2. Program the truck bed.
This program will turn the motor on in one direction for 1 second to make sure that the bed is at its reset position. It will wait 3 seconds for the boxes to be loaded by the pupil, play an engine sound, and then flip the bed to drop the boxes.

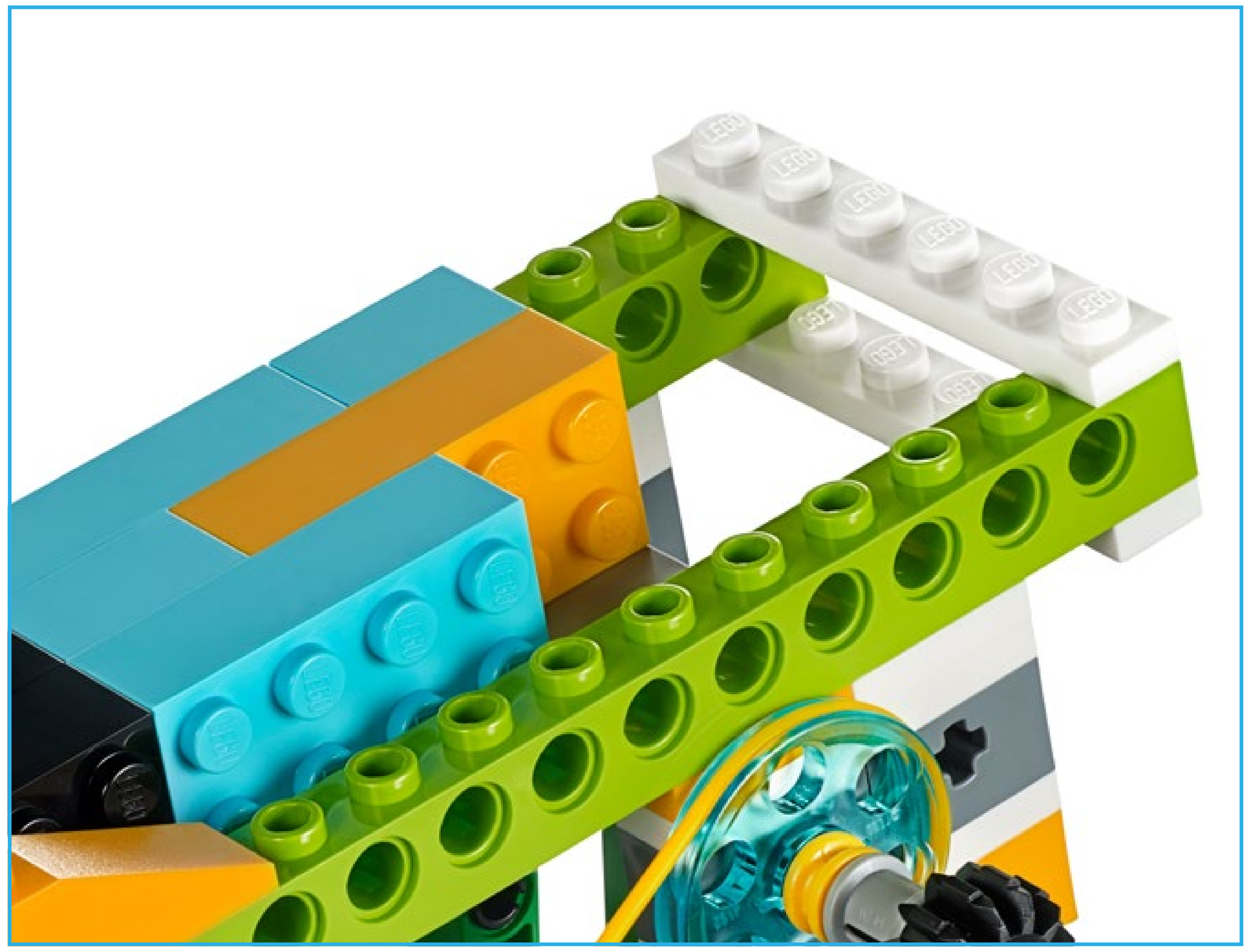
Important
Pupils may have to adjust the power level of the motor in order for this program to work. The power efficiency of the motors can vary.

Suggestion
Before your pupils begin their investigations, ask them to adjust the parameters of the program so that they fully understand it.

Create phase

Design another solution

From this model, pupils should be able to change the design of the truck load to sort the boxes into two different groups according to their shape. Allow the pupils a lot of flexibility. There are simple and more complex solutions to this problem that may involve changes to the design of the sorter, the program, or a combination of both.



Solution ideas

1. Modify the truck to sort the boxes.

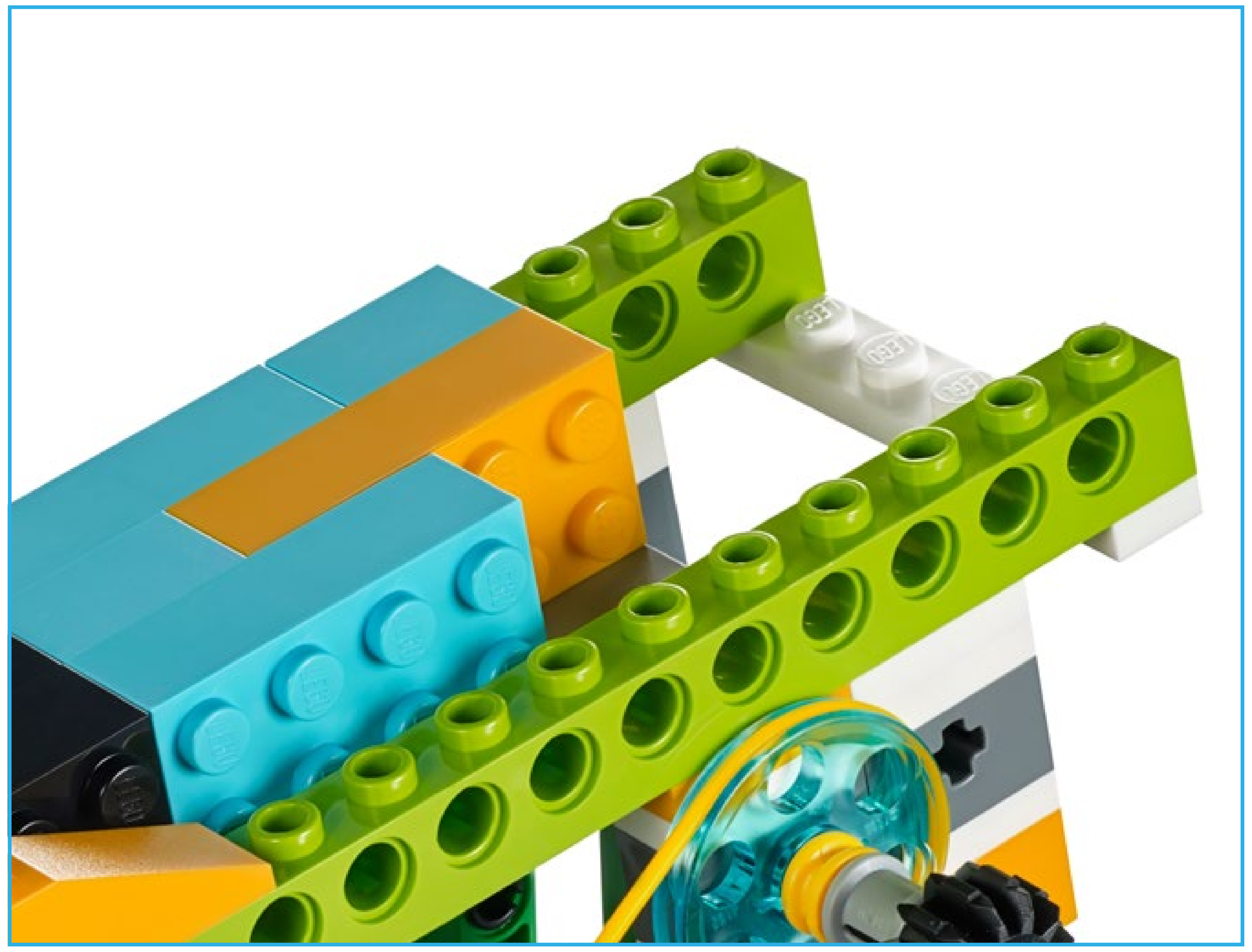
By removing the LEGO® back plate of the truck, one box should be able to fall into the first hole while the other box slides off the back, due to its shape. Other designs may work just as well.

2. Use the Motion Sensor to sort.

By placing the Motion Sensor on the side of the load in the proper position and by creating the right program, the sensor can detect objects based on size.

3. Sort the boxes outside the truck.

This solution would require building something else in addition to, or instead of, the truck. The boxes can be delivered to the factory and sorted in another way.



Important

It is important to note that pupils' models will vary according to their individual choices, there are no building instructions or sample programs provided to pupils for this part of the project.

Create phase

Use the “Design further solutions” section of the pupil project as an optional extension. Keep in mind that these tasks are an extension of the “Use the model” section and are designed for older or more advanced pupils.

The next step to this design project could be to ask pupils to design a solution for a more complex problem.

Design further solutions

Ask pupils to design a third object to sort. In order to sort items, pupils will probably have to move away from the truck model and design another type of device:

1. Sort the objects using a conveyor belt.
2. Sort the objects using a robot arm.
3. Sort the objects using two different devices.

Note, it is not essential that the device works perfectly, or that the pupils find a successful solution. It is more important that the reasoning behind the sorting principles are well articulated as pupils apply principles of engineering design.

Collaboration suggestion

If you group teams together, pupils will get more options to create sorting strategies. You could ask one team to sort the objects and then ask the second team to sort them further. For example, the first team could sort small objects from the medium and large ones. The second team would then sort the medium from the large.

Share phase

Complete the document

Ask the pupils to document their project in several ways:

- Ask the pupils to take photographs of each version they create and ask them to explain the most successful solution or the one with the most potential.
- Ask the teams of pupils to compare and contrast their designs with each other.
- Ask the pupils to document how the objects could be sorted by shape, and how the shape of each object was important to the solution.

Present results

Pupils should describe how their solutions sorts objects according to their shape.

To enhance pupils' presentations:

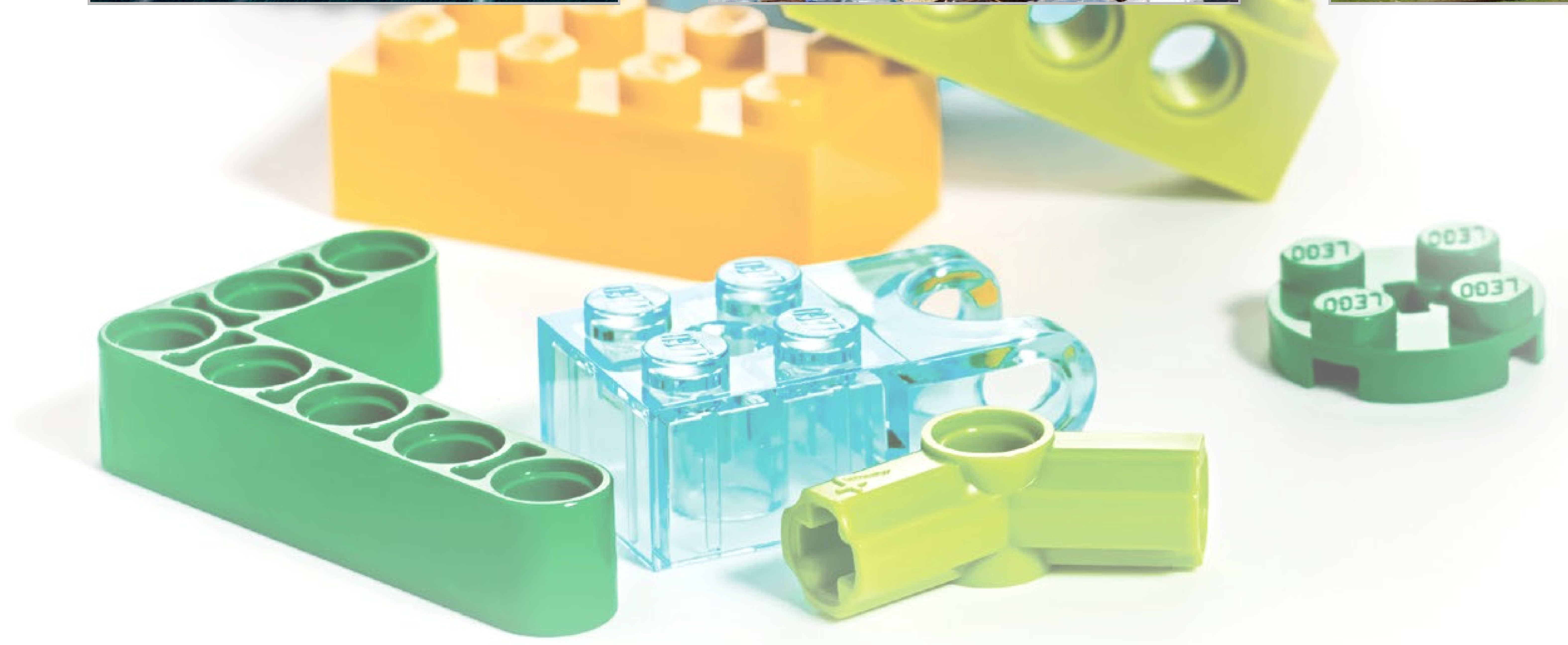
- Ask the pupils to present how they worked toward solving this problem.
- Ask them to explain the challenges they encountered and how they worked to modify their designs and programs as a result.
- Ask them to describe the context around their explanation.
- Discuss if this solution could be applied in real life.

Sort to Recycle

One possible way of sharing

Pupils in this class have designed different ways of sorting objects according to their shapes.

Open Projects overview



Project 9

Predator and Prey

This project is about modelling a LEGO® representation of the behaviour of predators and their prey.

Curriculum links

National Curriculum for science
(See page 24 for how this project addresses non-statutory requirements, and requirements for Working Scientifically)

3.A.s2: Identify that humans and some other animals have skeletons and muscles for support, protection and movement.

4.A.s3: Construct and interpret a variety of food chains, identifying producers, predators and prey.

5.F.s3: Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

6.El.s3: Identify how animals and plants are adapted to suit their environment in different ways and that adaptation may lead to evolution.

Other National Curriculum links
Design and technology
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.
Evaluate:
Evaluate their ideas and products against their own design criteria and consider the views of others to improve their work.
Technical knowledge:
Apply their understanding of how to strengthen, stiffen, and reinforce more complex structures.
Understand and use mechanical systems in their products [for example, gears, pulleys, cams, levers, and linkages].
Understand and use electrical systems in their products [for example, series circuits incorporating switches, bulbs, buzzers, and motors].
Apply their understanding of computing to program, monitor, and control their products.

Computing
Design, write, and debug programs that accomplish specific goals, including controlling or simulating physical systems.
Use sequence, selection, and repetition in programs; work with variables and various forms of input and output.
Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs.
Select, use, and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems and content that accomplish given goals, including collecting, analysing, evaluating, and presenting data and information.

Explore phase

Predators share fascinating dynamic relationships with their prey. They have evolved over centuries to improve as hunters and trappers. This has forced prey to adapt in order to evade predators and survive.

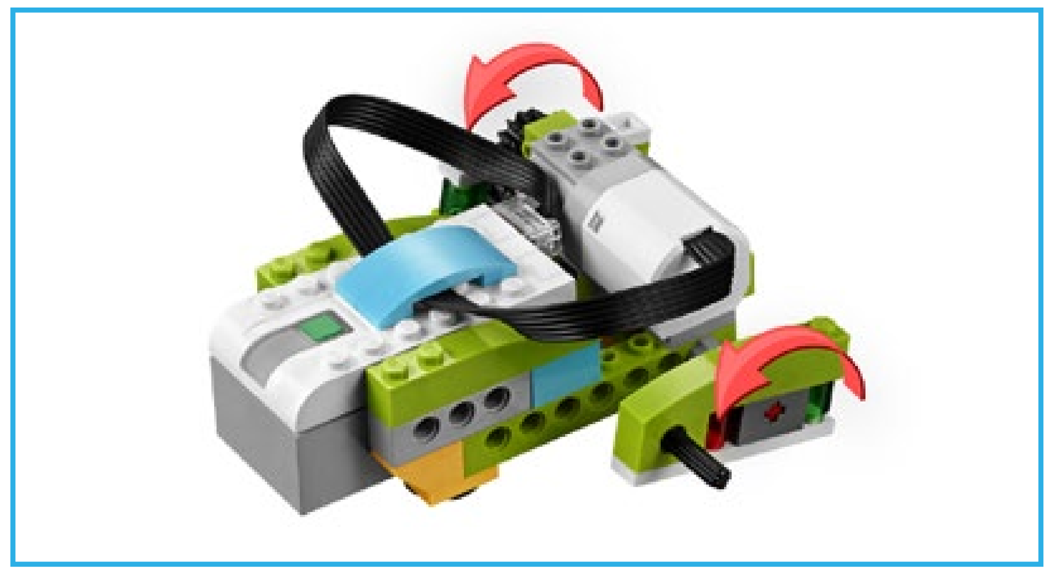
Let pupils explore the developing relationships between different sets of predators and their prey.

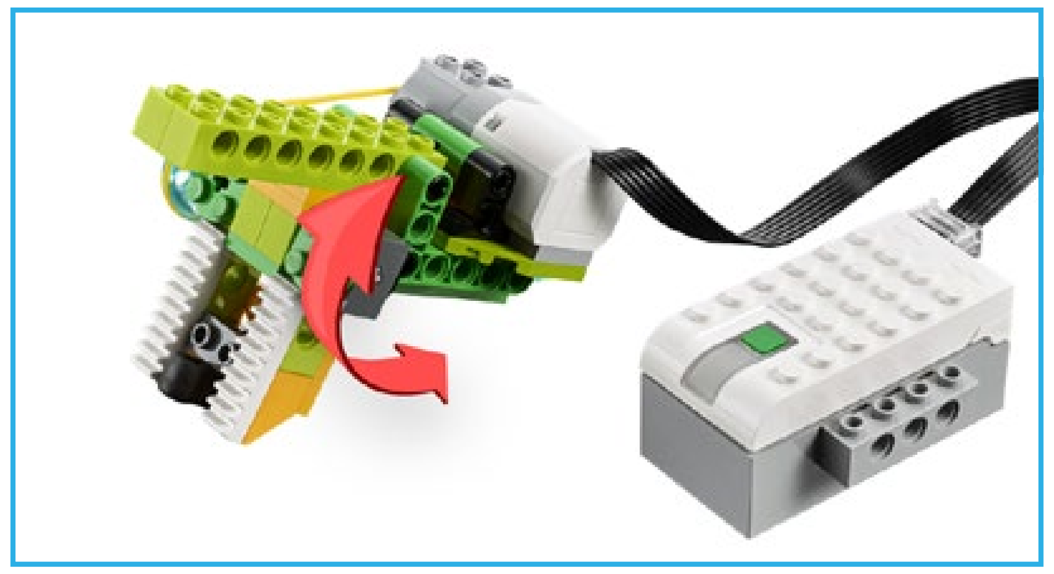
Create phase

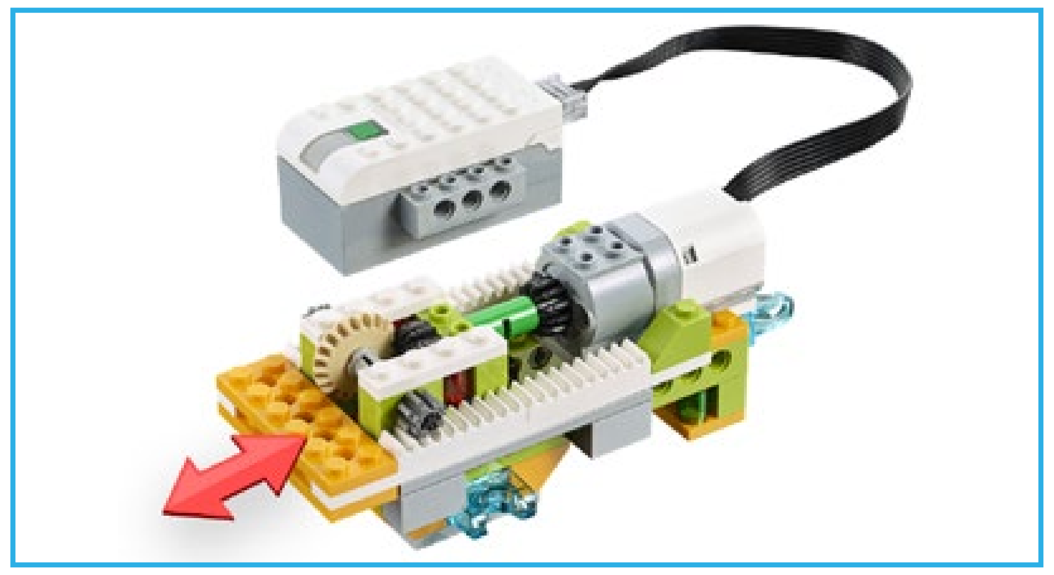
Pupils create a predator or prey model in order to describe the relationship between a predator and its prey.

Let pupils explore the Design Library so they can choose a model for inspiration. Then allow them to experiment and create their own solutions, modifying any basic model as they see fit.

Suggested Design Library base models include:
- Walk
- Grab
- Push







Suggestion

Ask the teams to work in pairs, with one team modelling a predator and the other team modelling the prey.

Share phase

Pupils should present their predator or prey models, explaining how they have represented the relationship between two species. They can use research and portfolio documentation to support their explorations and ideas.

Assessment

Ensure that pupils explain the different strategies the chosen predator uses to attract and catch its prey.

Project 10

Animal Expression

This project is about modelling a LEGO® representation of the various communication methods used in the animal kingdom.

Curriculum links

National Curriculum for science

(See page 24 for how this project addresses non-statutory requirements, and requirements for Working Scientifically)

5.LTH.s1: Describe the differences in the life cycles of a mammal, an amphibian, an insect, and a bird.
5.LTH.s2: Describe the life process of reproduction in some plants and animals.
5.F.s3: Recognise that some mechanisms, including levers, pulleys, and gears, allow a smaller force to have a greater effect.

6.LTH.s1: Describe how living things are classified into broad groups according to common observable characteristics and based on similarities and differences, including micro- organisms, plants, and animals.
6.LTH.s2: Give reasons for classifying plants and animals based on specific characteristics.

Other National Curriculum links

Design and technology
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.
Evaluate:
Evaluate their ideas and products against their own design criteria and consider the views of others to improve their work.
Technical knowledge:
Apply their understanding of how to strengthen, stiffen, and reinforce more complex structures.
Understand and use mechanical systems in their products [for example, gears, pulleys, cams, levers, and linkages].
Understand and use electrical systems in their products [for example, series circuits incorporating switches, bulbs, buzzers, and motors].
Apply their understanding of computing to program, monitor, and control their products.

Computing
Design, write, and debug programs that accomplish specific goals, including controlling or simulating physical systems.
Use sequence, selection, and repetition in programs; work with variables and various forms of input and output.
Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs.
Select, use, and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems, and content that accomplish given goals, including collecting, analysing, evaluating, and presenting data and information.

Explore phase

Bioluminescence is the biochemical emission of light by living organisms, such as fireflies, shrimp, and certain types of deep-sea fish. Bioluminescent creatures use their glowing ability to camouflage themselves, lure prey, and communicate. Most other animals communicate through sound and movement.

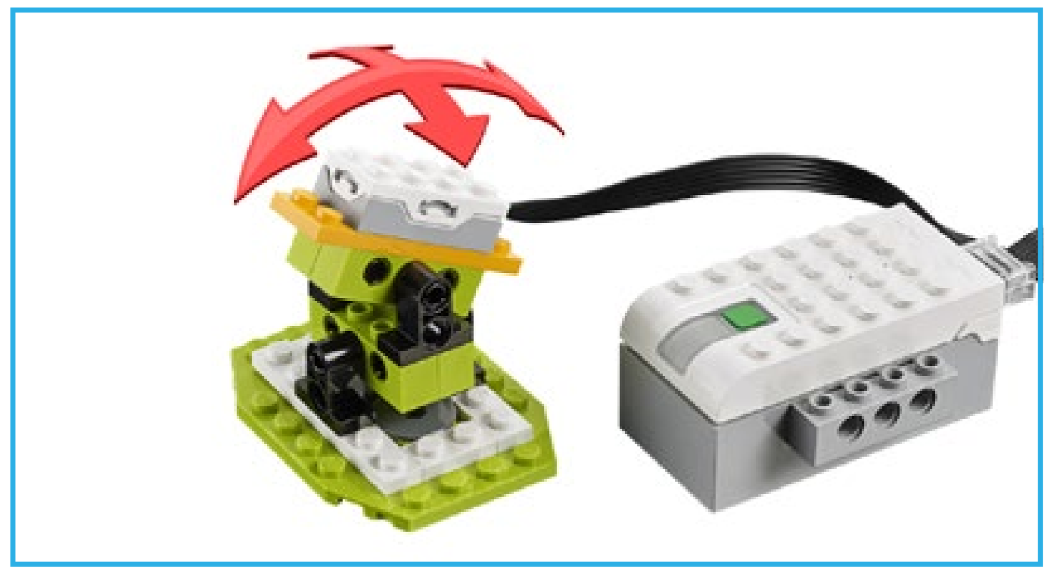
Let the pupils explore different kinds of social interaction between species to determine how communication helps them to find mates, reproduce, and survive.

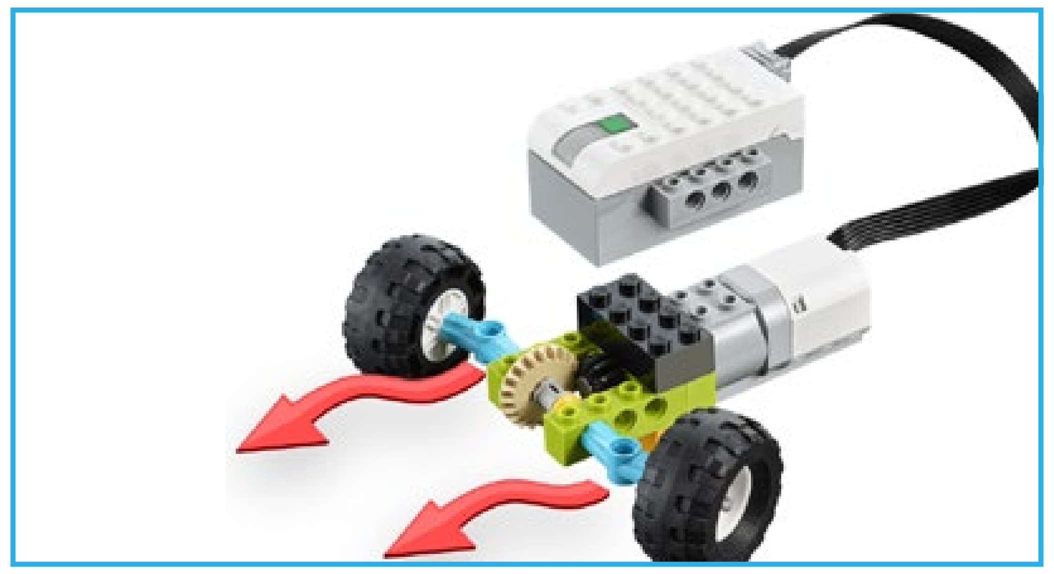
Create phase

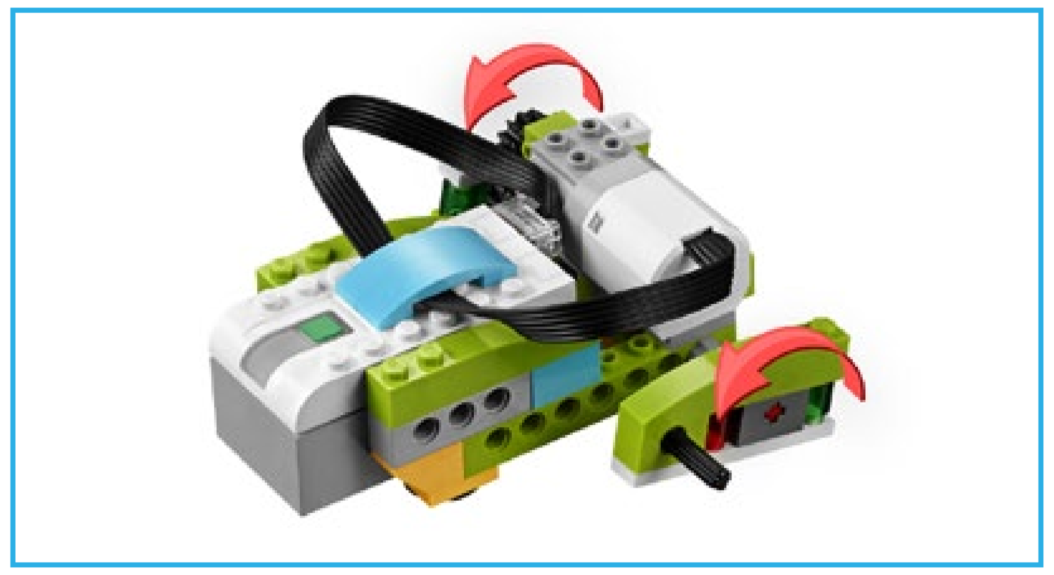
Pupils create a creature and illustrate its method of communication.
The model should display one specific type of social interaction, such as light, movement, or sound.

Let pupils explore the Design Library so they can choose a model for inspiration. Then allow them to experiment and create their own solutions, modifying any basic model as they see fit.

Suggested Design Library models include:
- Tilt
- Wobble
- Walk







Share phase

Pupils should present their models, explaining how they represent a method of communication. They can use research and portfolio documentation to support their explorations and ideas.

Assessment
Ensure that pupils explain how the chosen method of communication creates social interaction. Ask them to explain why the animals interact in this way. Some research about the social interaction of animals might be necessary.

Project 11

Extreme Habitats

This project is about modelling a LEGO® representation of the influence of habitat on the survival of some species.

Curriculum links

National Curriculum for science
(See page 24 how this project addresses non-statutory requirements, and requirements for Working Scientifically)

4.LTH.s3: Recognise that environments can change and that this can sometimes pose dangers to living things.

5.F.s3: Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

6.EI.s3: Identify how animals and plants are adapted to suit their environment in different ways and that adaptation may lead to evolution.

Other National Curriculum links
Design and technology
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.
Evaluate:
Evaluate their ideas and products against their own design criteria and consider the views of others to improve their work.
Technical knowledge:
Apply their understanding of how to strengthen, stiffen, and reinforce more complex structures.
Understand and use mechanical systems in their products [for example, gears, pulleys, cams, levers, and linkages].
Understand and use electrical systems in their products [for example, series circuits incorporating switches, bulbs, buzzers, and motors].
Apply their understanding of computing to program, monitor, and control their products.

Computing
Design, write, and debug programs that accomplish specific goals, including controlling or simulating physical systems.
Use sequence, selection, and repetition in programs; work with variables and various forms of input and output.
Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs.
Select, use, and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems, and content that accomplish given goals, including collecting, analysing, evaluating, and presenting data and information.

Explore phase

Fossils reveal a lot about why animals were able to survive in their surroundings. Habitat, climate, food, shelter, and available resources all contribute to the success of a species.

Let pupils explore both carnivores and herbivores and what their fossils tell us about how they lived. They could consider how some species evolved to survive into the modern era. For example, ask the pupils to build a flying or a climbing dinosaur that nests in the treetops to protect its eggs, or a crocodile to show how it uses its body, tail, and jaws in combination with its water habitat.

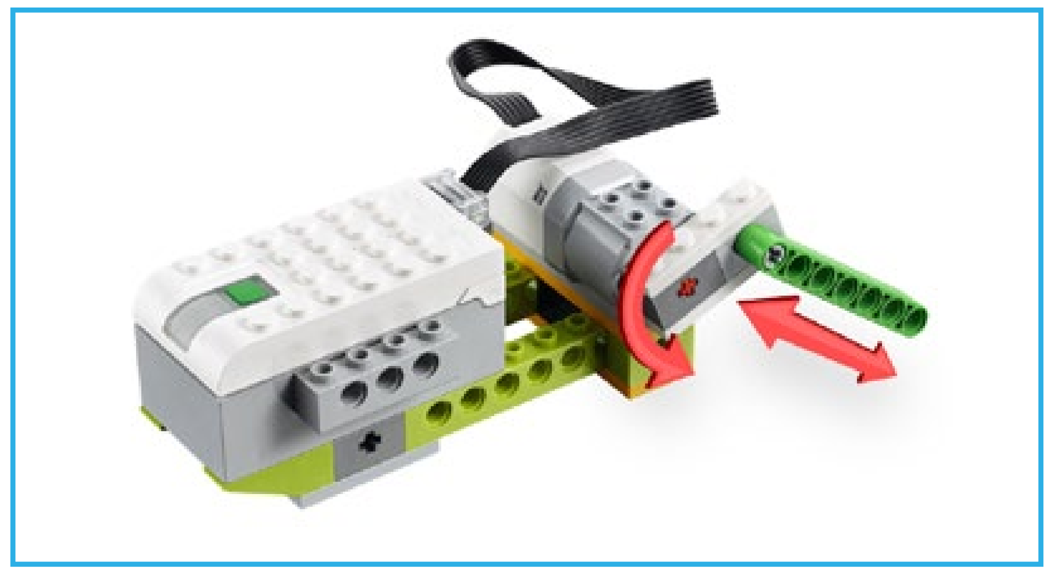
Alternatively, pupils could look at extreme habitats or even fictional habitats, as long as they are able to make the link between the habitat and their creature.

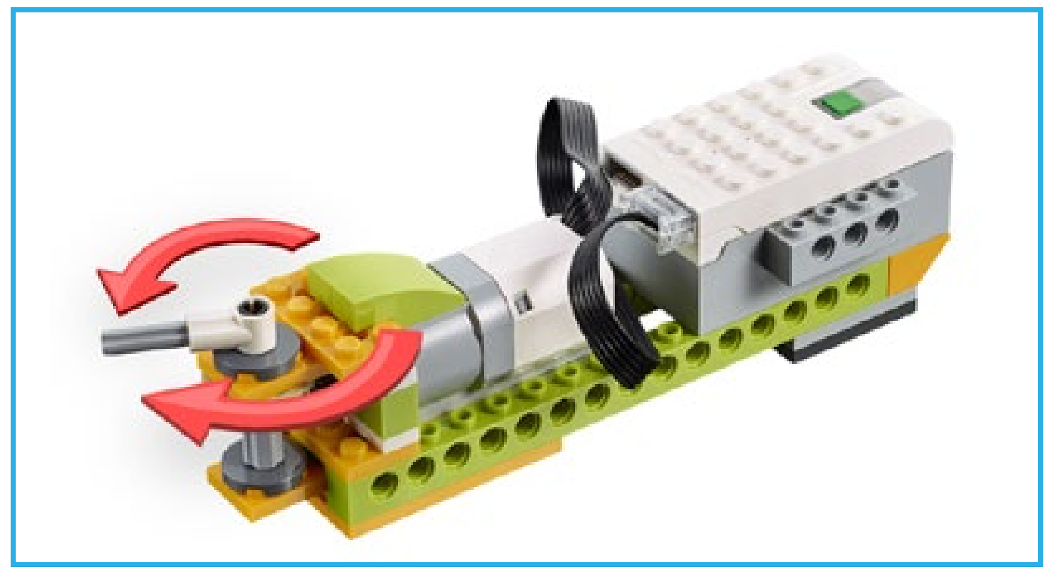
Create phase

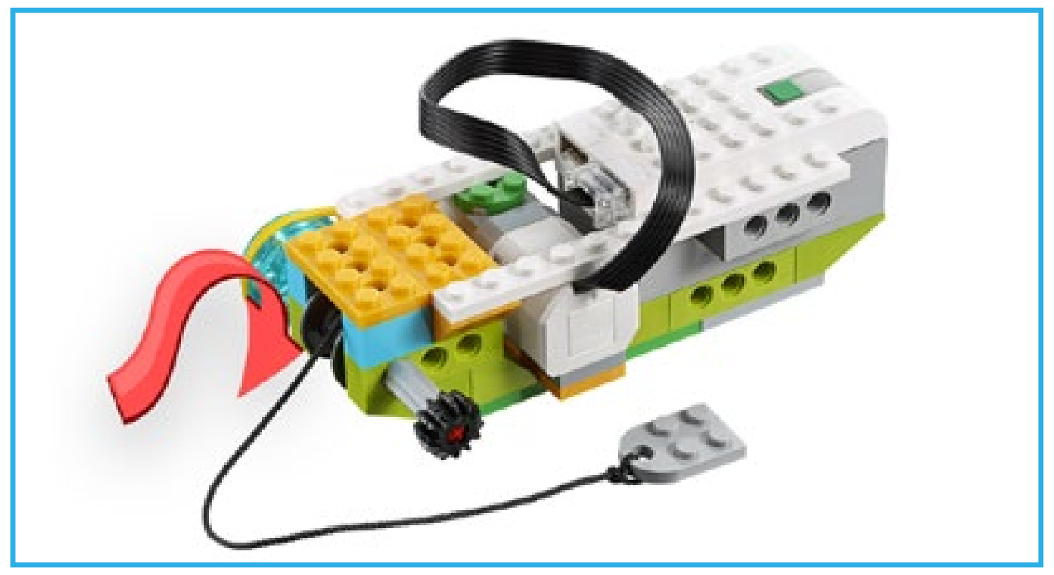
Pupils create both a creature and the habitat it lives in, showing how the creature has adapted to its surroundings.

Let pupils explore the Design Library so they can choose a model for inspiration. Then allow them to experiment and create their own solutions, modifying any basic model as they see fit.

Suggested Design Library models include:
- Crank
- Flex
- Reel







Share phase

Pupils should present their models, explaining the representation of the effect the habitat has on the creature. They can use research and portfolio documentation to support their explorations and ideas.

Assessment
Ensure that pupils explain the adaptations and unique characteristics that allow the creature to develop and survive.

Project 12

Space Exploration

This project is about designing a LEGO® prototype of a rover that would be ideal for exploring distant planets.

Curriculum links

National Curriculum for science

(See page 24 for how this project addresses non-statutory requirements, and requirements for Working Scientifically)

5.ES.s1: Describe the movement of the Earth, and other planets, relative to the Sun in the solar system.
5.ES.s2: Describe the movement of the Moon relative to the Earth.
5.ES.s3: Describe the Sun, Earth and Moon as approximately spherical bodies.
5.F.s3: Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

Other National Curriculum links

Design and technology

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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Understand and use mechanical systems in their products [for example, gears, pulleys, cams, levers, and linkages].
Understand and use electrical systems in their products [for example, series circuits incorporating switches, bulbs, buzzers, and motors].
Apply their understanding of computing to program, monitor, and control their products.

Computing
Design, write, and debug programs that accomplish specific goals, including controlling or simulating physical systems.
Use sequence, selection, and repetition in programs; work with variables and various forms of input and output.
Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs.
Select, use, and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems and content that accomplish given goals, including collecting, analysing, evaluating, and presenting data and information.

Explore phase

A rover is an automated motor vehicle that propels itself across the surface of a celestial body. A rover may examine territory and interesting features, analyse weather conditions, or even test materials such as soil and water.

Let the pupils explore rovers and discover their many interesting features and functions. Pupils should design various functions for their rover prototypes.

Create phase

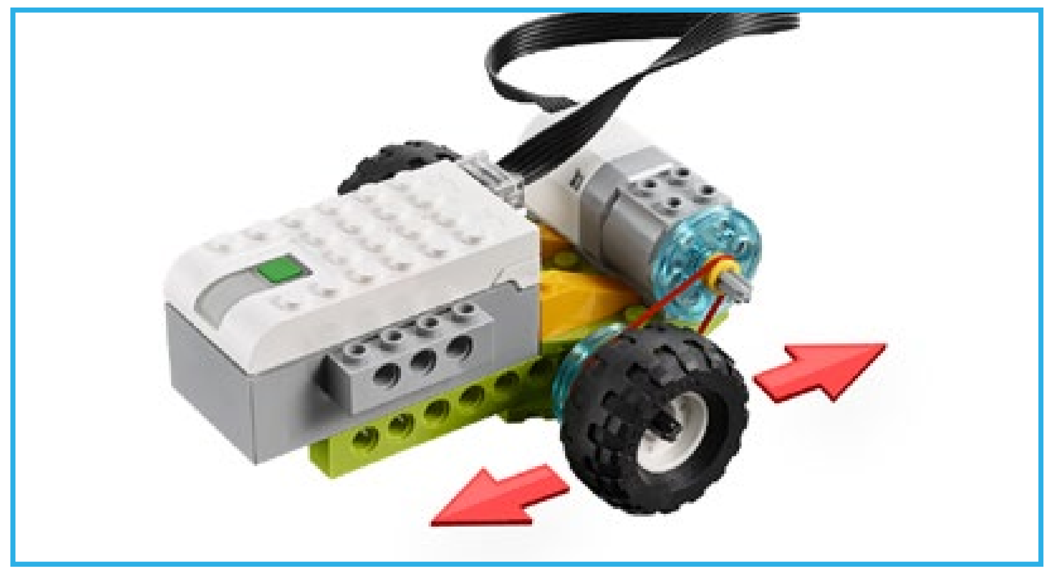
Pupils design, build, and test a rover that can achieve one of the following missions when sent to another planet:

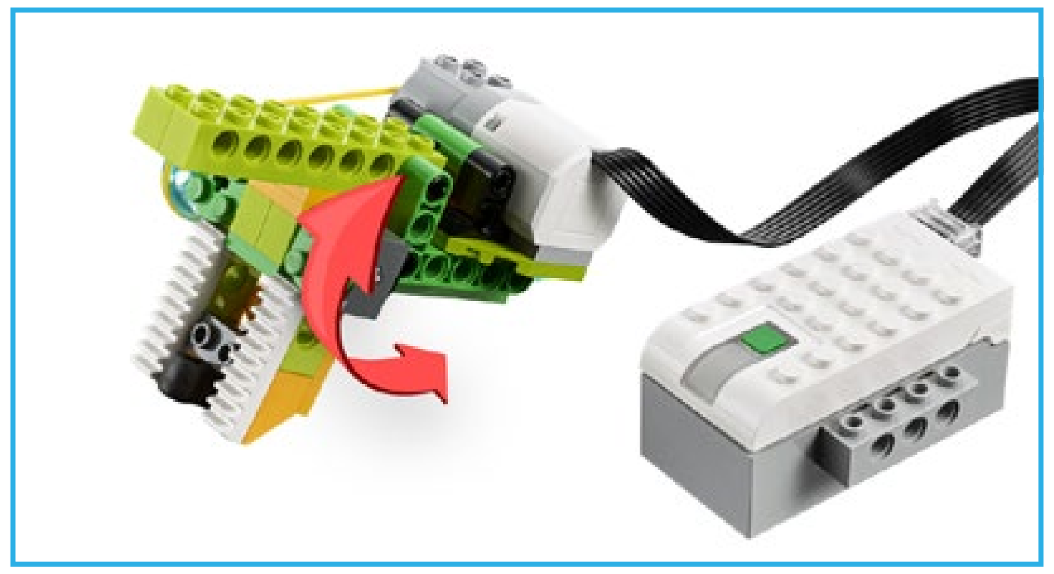
- Move in and out of a crater.
- Collect a rock sample.
- Drill a hole in the ground.

Let pupils explore the Design Library so they can choose a model for inspiration. Then allow them to experiment and create their own solutions, modifying any basic model as they see fit.

Suggested Design Library models are:

- Drive
- Grab
- Sweep





Share phase

Pupils should present their models, explaining how they have designed and tested their rover to complete a series of planetary exploration-based tasks.
Ask the pupils to compare models and provide feedback to each other on how well the models fit the constraints and meet the criteria of the given problem.

Assessment
Ensure that pupils explain why each function is important and how they have allowed for the rover to move over fluctuating terrain to complete the assigned or chosen task.

Project 13

Hazard Alarm

This project is about designing a LEGO® prototype of a weather alarm device to alert people and reduce the impact of severe storms.

Curriculum links

National Curriculum for science

(See page 23 for how this project addresses non-statutory requirements, and requirements for Working Scientifically)

5.F.s3: Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

Other National Curriculum links

Design and technology

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.

Evaluate:

Evaluate their ideas and products against their own design criteria and consider the views of others to improve their work.

Technical knowledge:

Apply their understanding of how to strengthen, stiffen and reinforce more complex structures.

Understand and use mechanical systems in their products [for example, gears, pulleys, cams, levers, and linkages].

Understand and use electrical systems in their products [for example, series circuits incorporating switches, bulbs, buzzers, and motors].

Apply their understanding of computing to program, monitor, and control their products.

Computing

Design, write, and debug programs that accomplish specific goals, including controlling or simulating physical systems.

Use sequence, selection, and repetition in programs; work with variables and various forms of input and output.

Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs.

Select, use, and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems, and content that accomplish given goals, including collecting, analysing, evaluating, and presenting data and information.

Geography

Human and physical geography:

Describe and understand key aspects of physical geography, including: climate zones, biomes and vegetation belts, rivers, mountains, volcanoes and earthquakes, and the water cycle.

Explore phase

The National Oceanic and Atmospheric Administration's (NOAA) Storm Prediction Center (SPC) exists to protect people by issuing timely and accurate forecasts for tornadoes, wildfires, and other natural hazards. Early warning systems for severe storms help save buildings, property, and lives.

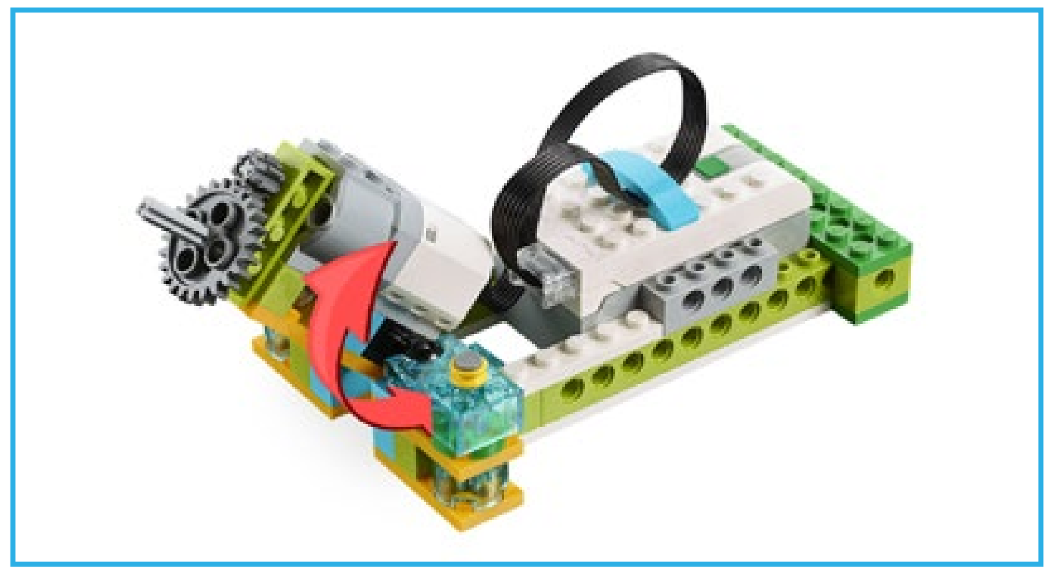
Let pupils explore the equipment and alarm systems.

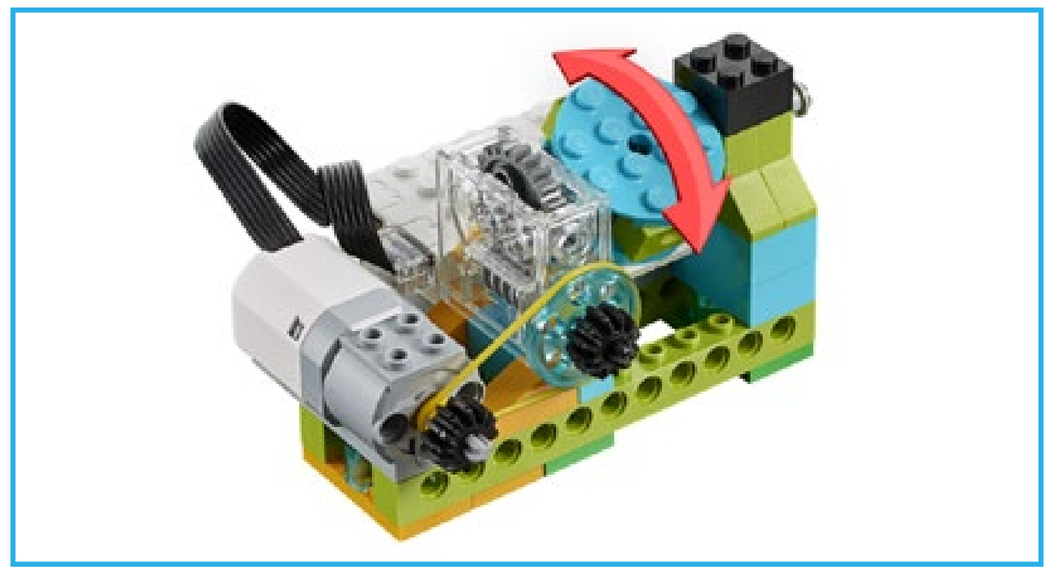
Create phase

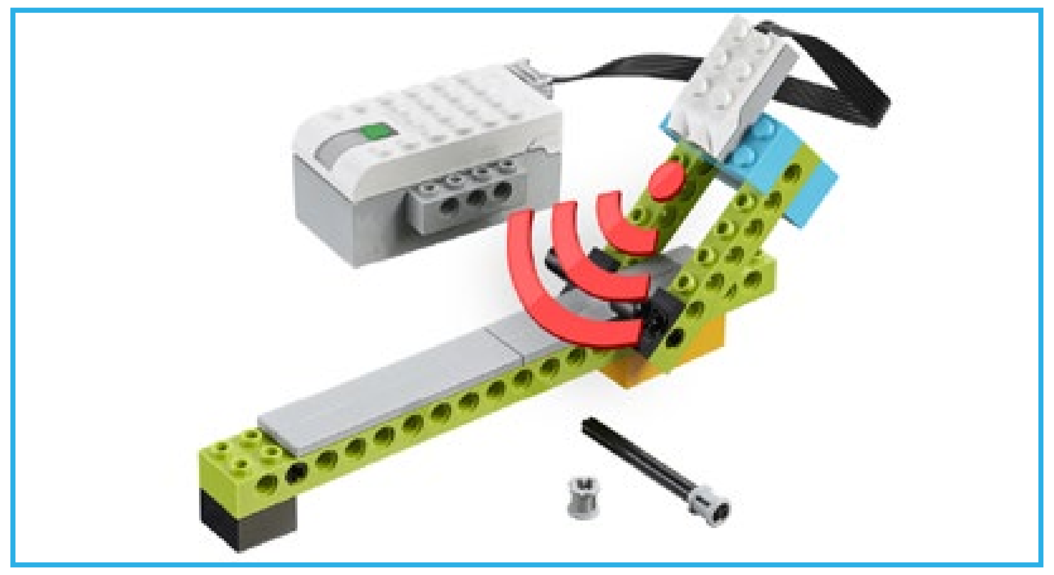
Pupils design, build, and test an alarm device for wind, rain, fire, earthquake, or other natural/weather-related hazards. This could be done according to a set of criteria or with a more open outcome as determined by the teacher.

Let pupils explore the Design Library so they can choose a model for inspiration. Then allow them to experiment and create their own solutions, modifying any basic model as they see fit.

Suggested Design Library models are:
- Joint
- Revolve
- Motion







Share phase

Pupils should present their models, explaining how they designed and tested the hazard alarms. They can use research and portfolio documentation to support their explorations and ideas.

Assessment
Ensure that the pupils explain why the alarm is important, and how it has been designed and tested to help to reduce the impact of a specific hazard or to alert people of potential hazards.

Project 14

Cleaning the Ocean

This project is about designing a LEGO® prototype for a device that could help to remove plastic waste from the ocean.

Curriculum links

National Curriculum for science
(See page 24 for how this project addresses non-statutory requirements, and requirements for Working Scientifically)

4.LTH.s3: Recognise that environments can change and that this can sometimes pose dangers to living things.

5.F.s3: Recognise that some mechanisms, including levers, pulleys. and gears, allow a smaller force to have a greater effect.

Other National Curriculum links
Design and technology

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.

Evaluate:

Evaluate their ideas and products against their own design criteria and consider the views of others to improve their work.

Technical knowledge:

Apply their understanding of how to strengthen, stiffen, and reinforce more complex structures.

Understand and use mechanical systems in their products [for example, gears, pulleys, cams, levers, and linkages].

Understand and use electrical systems in their products [for example, series circuits incorporating switches, bulbs, buzzers, and motors].

Apply their understanding of computing to program, monitor, and control their products.

Computing

Design, write, and debug programs that accomplish specific goals, including controlling or simulating physical systems.

Use sequence, selection, and repetition in programs; work with variables and various forms of input and output.

Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs.

Select, use, and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems, and content that accomplish given goals, including collecting, analysing, evaluating, and presenting data and information.

Explore phase

Millions of tons of plastic have entered the oceans in recent decades. It is important that the oceans are cleared of plastic bags, bottles, containers, and other debris that are endangering sea animals and fish, and their habitats.

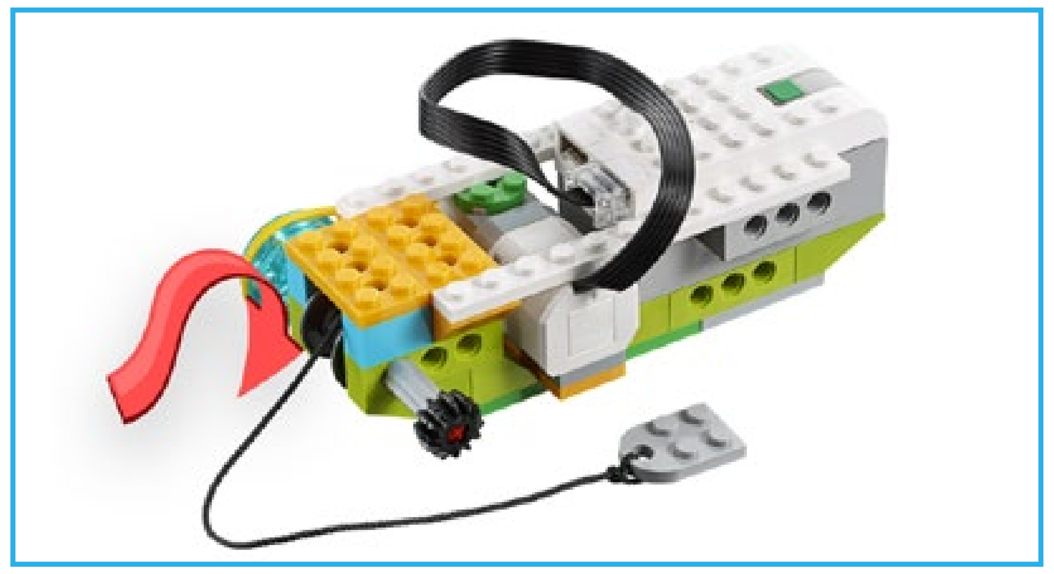
Let pupils explore collection technology and vehicles currently used and being proposed to clean the oceans of plastic waste.

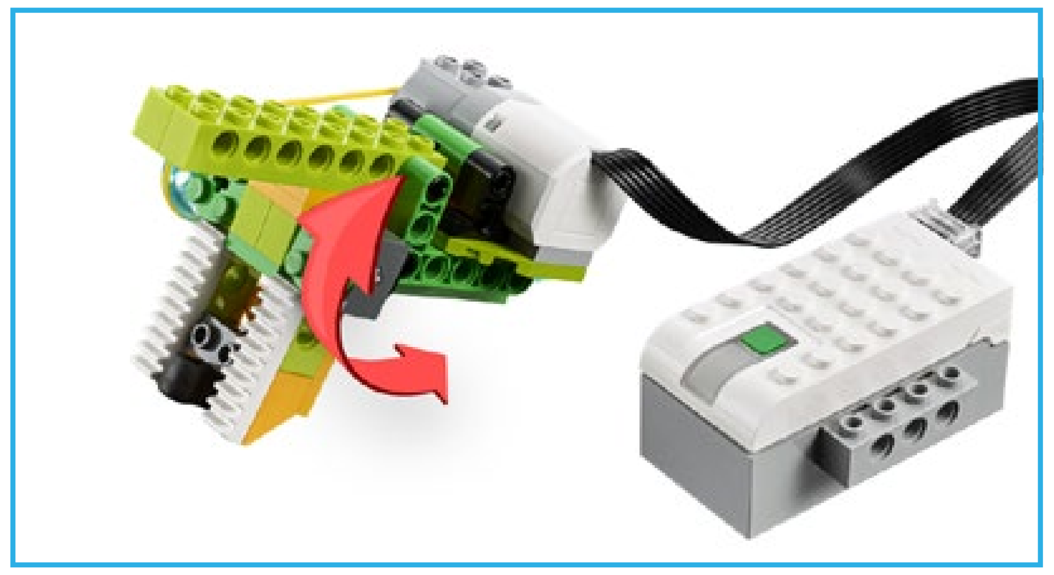
Create phase

Pupils design and build a plastic waste collection vehicle or device. Although a prototype, the model should ideally be able to physically collect plastics of a certain type.

Let the pupils explore the Design Library so they can choose a model for inspiration. Then allow them to experiment and create their own solutions, modifying any basic model as they see fit.

Suggested Design Library models are:
- Reel
- Sweep
- Grab





Share phase

Pupils should present their models, explaining how they have designed the prototype to collect certain types of plastics. They can use research and portfolio documentation to support their explorations and ideas.

Assessment
Ensure that pupils explain why cleaning the ocean is important, and how their prototype provides an ideal solution to the problem.

Project 15

Wildlife Crossing

This project is about designing a LEGO® prototype to allow an endangered animal species to safely cross a road or other hazardous area.

Curriculum links

National Curriculum for science

(See page 24 how this project addresses non-statutory requirements, and requirements for Working Scientifically)

5.F.s3: Recognise that some mechanisms, including levers, pulleys, and gears, allow a smaller force to have a greater effect.

6.EI.s3: Identify how animals and plants are adapted to suit their environment in different ways and that adaptation may lead to evolution.

Other National Curriculum links

Design and technology

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.

Evaluate:

Evaluate their ideas and products against their own design criteria and consider the views of others to improve their work.

Technical knowledge:

Apply their understanding of how to strengthen, stiffen, and reinforce more complex structures.

Understand and use mechanical systems in their products [for example, gears, pulleys, cams, levers, and linkages].

Understand and use electrical systems in their products [for example, series circuits incorporating switches, bulbs, buzzers, and motors].

Apply their understanding of computing to program, monitor, and control their products.

Computing

Design, write, and debug programs that accomplish specific goals, including controlling or simulating physical systems.

Use sequence, selection, and repetition in programs; work with variables and various forms of input and output.

Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs.

Select, use, and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems, and content that accomplish given goals, including collecting, analysing, evaluating, and presenting data and information.

Explore phase

Wildlife crossings are structures that allow animals to safely cross human-made barriers. Types of wildlife crossings include underpasses, tunnels, and viaducts. Rescue vehicles are also used in extreme or difficult cases.

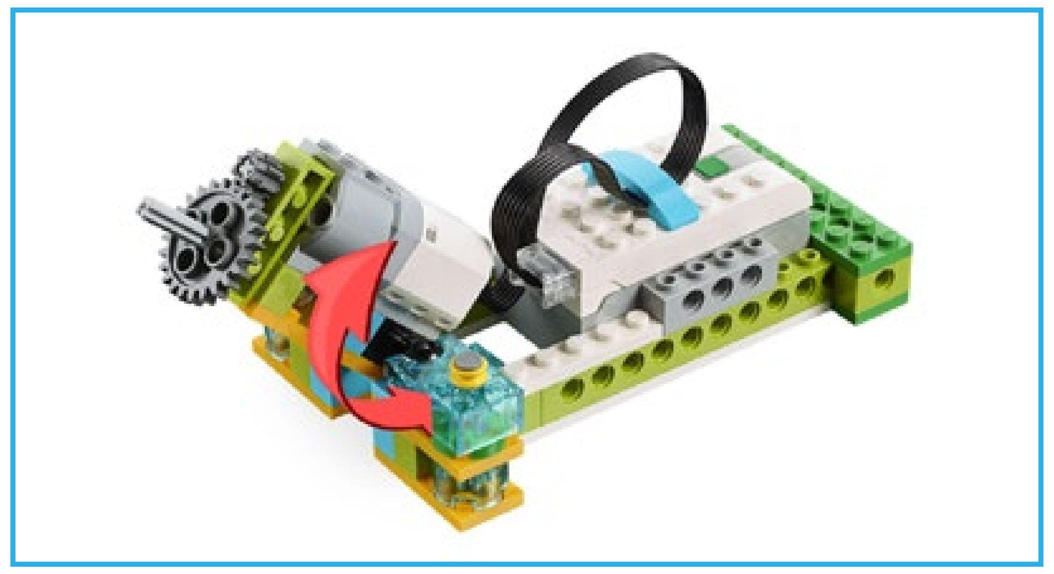
Let pupils explore existing wildlife crossings, especially local examples such as underpasses and cattle crossings. You may also wish to share specific examples of situations or conditions in which wildlife is put at risk and where a crossing may be a solution.

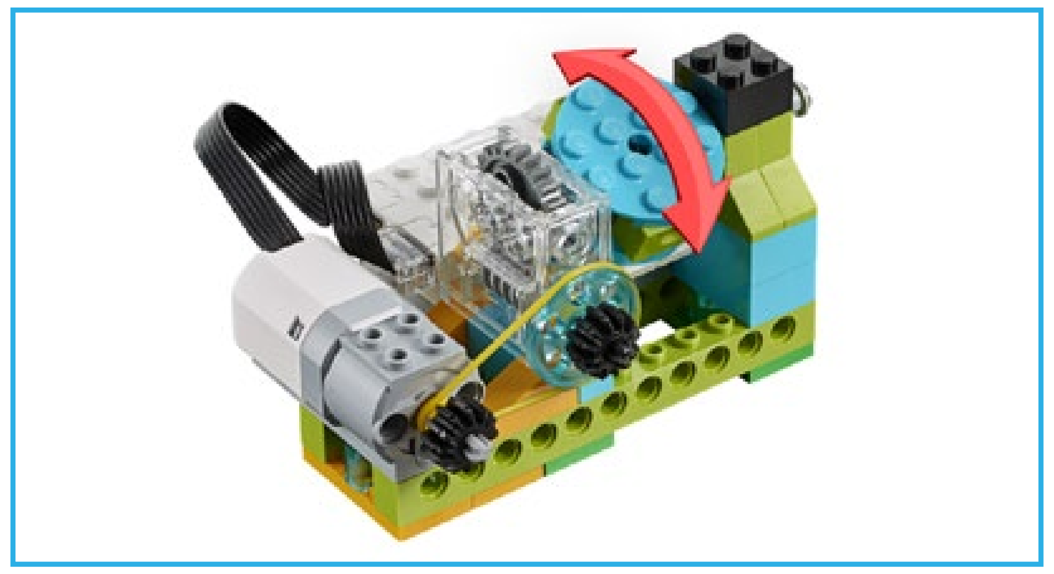
Create phase

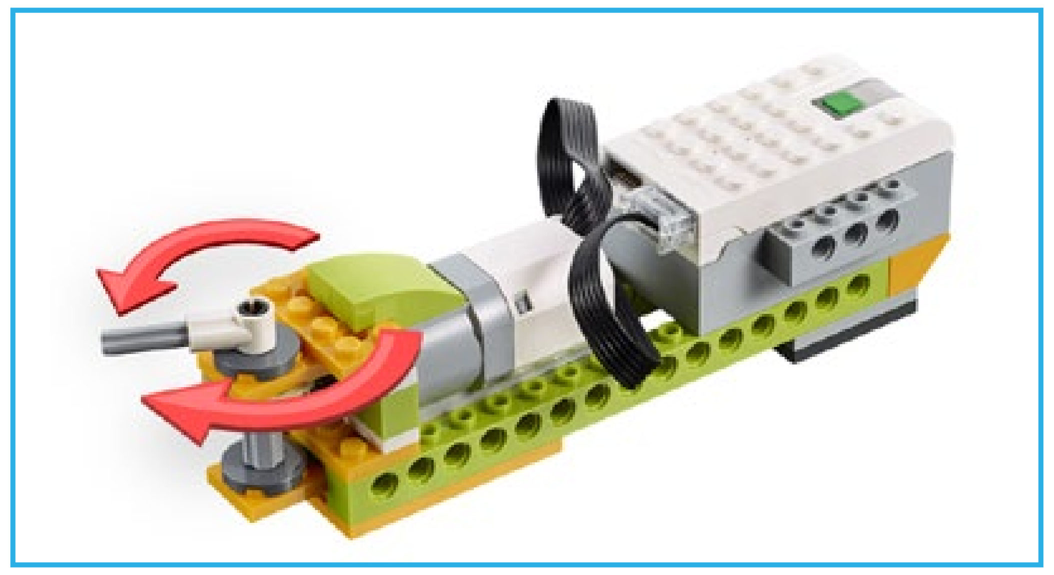
Pupils design and build a wildlife crossing for a chosen type of animal.
They could also build the road or hazard that the safe crossing is designed to avoid.

Let pupils explore the Design Library so they can choose a model for inspiration. Then allow them to experiment and create their own solutions, modifying any basic model as they see fit.

Suggested Design Library models are:
- Spin
- Revolve
- Flex







Share phase

Pupils should present their models, explaining how they have designed the prototype to allow for their chosen wildlife to cross safely. They can use research and portfolio documentation to support their explorations and ideas.

Assessment
Ensure that the pupils explain why it is important to look after endangered species, and that they understand the impacts humans have on animal habitats.

Project 16

Moving Materials

This project is about designing a LEGO® prototype of a device that can move certain objects around in a safe and efficient way.

Curriculum links

National Curriculum for science

(See page 24 for how this project addresses non-statutory requirements, and requirements for Working Scientifically)

5.F.s3: Recognise that some mechanisms, including levers, pulleys, and gears, allow a smaller force to have a greater effect.

Other National Curriculum links

Design and technology

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.

Evaluate:

Evaluate their ideas and products against their own design criteria and consider the views of others to improve their work.

Technical knowledge:

Apply their understanding of how to strengthen, stiffen, and reinforce more complex structures.

Understand and use mechanical systems in their products [for example, gears, pulleys, cams, levers, and linkages].

Understand and use electrical systems in their products [for example, series circuits incorporating switches, bulbs, buzzers, and motors].

Apply their understanding of computing to program, monitor, and control their products.

Computing

Design, write, and debug programs that accomplish specific goals, including controlling or simulating physical systems.

Use sequence, selection, and repetition in programs; work with variables and various forms of input and output.

Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs.

Select, use, and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems, and content that accomplish given goals, including collecting, analysing, evaluating, and presenting data and information.

Explore phase

The motorised forklift is used to lift and move heavy materials over short distances. It was developed in the early 20th century, but its use became widespread after World War II. Forklifts have become a vital part of warehouse and manufacturing operations.

Let pupils explore forklift designs and other ways to move objects, and make observations about the way these devices lift and move materials.

Important

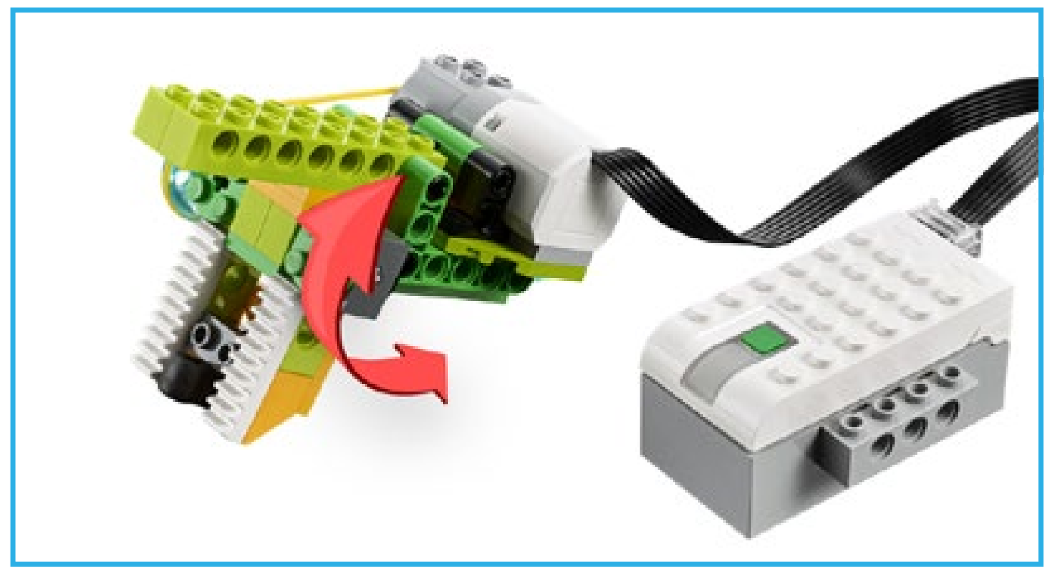
The focus of this project could be on both the device used to move the objects and on the way the objects are prepared to be moved, such as stacking them on pallets or in containers.

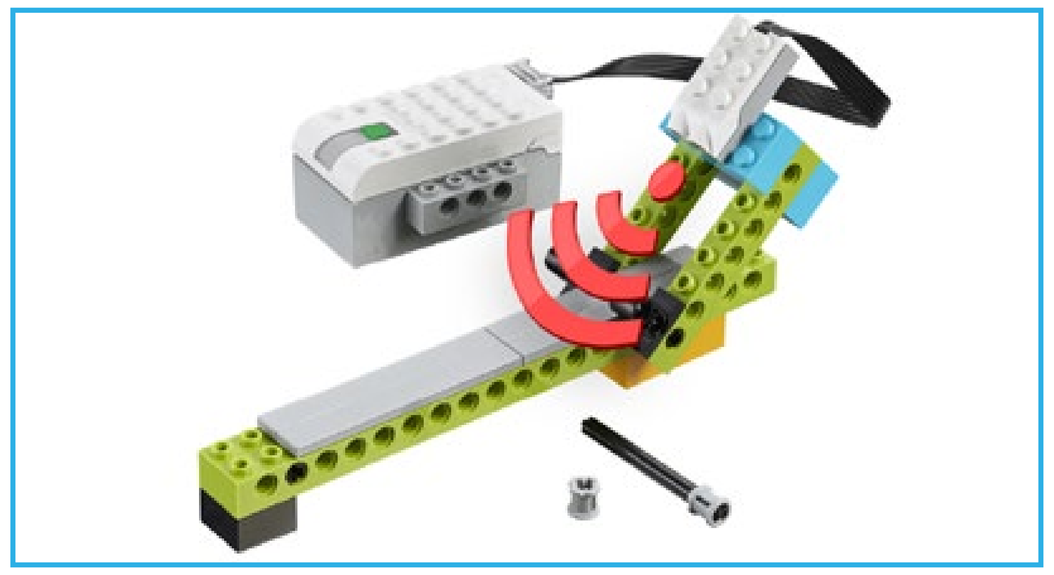
Create phase

Pupils design and build a vehicle or a device for lifting, moving, and/or packing a pre-determined set of objects. They should also consider how boxes can be designed to be moved and stored easily.

Let the pupils explore the Design Library so they can choose a model for inspiration. Then allow them to experiment and create their own solutions, modifying any basic model as they see fit.

Suggested Design Library models are:
- Steer
- Grab
- Motion





Share phase

Pupils should present their models, explaining how the vehicle was designed to move objects. They can use research and portfolio documentation to support their explorations and ideas.

Assessment
Ensure that pupils explain how boxes can be designed to be moved and stored easily and how the design allows vehicles to do this efficiently.

LEGO® Education WeDo 2.0 Toolbox

Program with WeDo 2.0

Programming is an important part of 21st century learning, and it is an essential part of all WeDo 2.0 projects.

It brings life to the models that pupils create and teaches them computational thinking.

Introduction to a WeDo 2.0 program string

To bring life to their models, the pupils will drag and drop blocks onto the Programming Canvas. Your pupils will be creating program strings. They can create multiple program strings on the canvas, but each needs to start with a Start Block.

Here are some important terms to use:

1. Start Block – a Start Block is required to execute a program string. “Execute” means to start a series of actions until they are completed.
2. Programming block – programming blocks are used in the WeDo 2.0 Software to build a program string. Blocks with symbols are used instead of text code.
3. Program string – a program string is a sequence of programming blocks.

Top Five program strings

The following program strings are used to complete some of the most important functions when working with WeDo 2.0. It is recommended that you and your pupils make yourselves familiar with them.

Important

In WeDo 2.0, the unit of time has been set to seconds. Pupils should therefore input:

- 1, for the motor to run for 1 second
- 4.5, for the motor to run for 4.5 seconds

Program string 1

Is my motor working?

The main function of this program is to test the motor. When you press start, the power of the motor will be set to 10, and the motor will turn in one direction for three seconds, then in the opposite direction for three seconds, and then stop.

Top Five program strings

Program string 2

Is my sensor responding?

To be able to use this program, you need a motor and a Motion Sensor attached to the Smarthub. By executing the program, the motor will run in one direction and wait for an object (e.g., your hand) to pass in front of the Motion Sensor. When an object is detected, the motor will stop.

The same program can be used with the Tilt Sensor Input or the Sound Sensor Input by changing the attachment of the Wait For Block.

Program string 3

Is the light flashing?

This program tests the light of the Smarthub. By executing the program, the light will illuminate for one second and then turn off for one second. The action is repeated infinitely, causing the light on the Smarthub to flash.

Top Five program strings

Program string 4

Does my device play sounds?

This program will play sound No. 1 from your device.

Program string 5

Is my device displaying images?

This program will show image No. 1 as well as the word “WeDo” on the display.

Other programming opportunities

The following programs are also frequently used when working with WeDo 2.0. Once the top five program strings have been explored, it is recommended that you and your pupils make yourselves familiar with their functions.

Program string 6

Using the Random Input

This program string will randomly change the colour of the light on the Smarthub. The colour of the bulb will change at one second intervals.

Other programming opportunities

Program string 7

Activating two motors at the same time

You can label Motor Blocks and Sensor Inputs if you are using more than one at a time. You can use a maximum of three LEGO® Smarthubs at any one time.

To label a Block or an Input, Long Press the block you need to label to open the Labelling panel:

- Press once to label with one dot.
- Press again to label from two to six dots.
- Press again to remove the label.

If a Motor Block is not labelled and more than one motor is connected, all motors will be executed in the same way. If a Sensor Input block is not labelled and more than one sensor is connected, it waits for one of the connected sensors.

Program string 8

Use the Sound Sensor Input

This program string will run the motor at a power level that is equal to the level of sound detected by the microphone on the device:

- If the sound level is low, the motor will run slowly.
- If the sound level is high, the motor will run quickly.

Other programming opportunities

Program string 9

Create a countdown

This program string will display numbers on the screen, starting from five, and then count down in one second increments. When the loop has run five times, a sound will be played.

Program string 10

Do two things at the same time

When the Play icon is tapped, it will send a message No. 1 (WeDo) to the Programming Canvas. All of the “play on” message blocks that have message No. 1 (WeDo) will then be triggered, playing, in this case, a sound and displaying an image at the same time.

Build with WeDo 2.0

WeDo 2.0 has been designed to provide opportunities for pupils to sketch, build, and test prototypes and representations of objects, animals, and vehicles that have a real-world focus.

The hands-on approach encourages pupils to be fully engaged in the designing and building process.

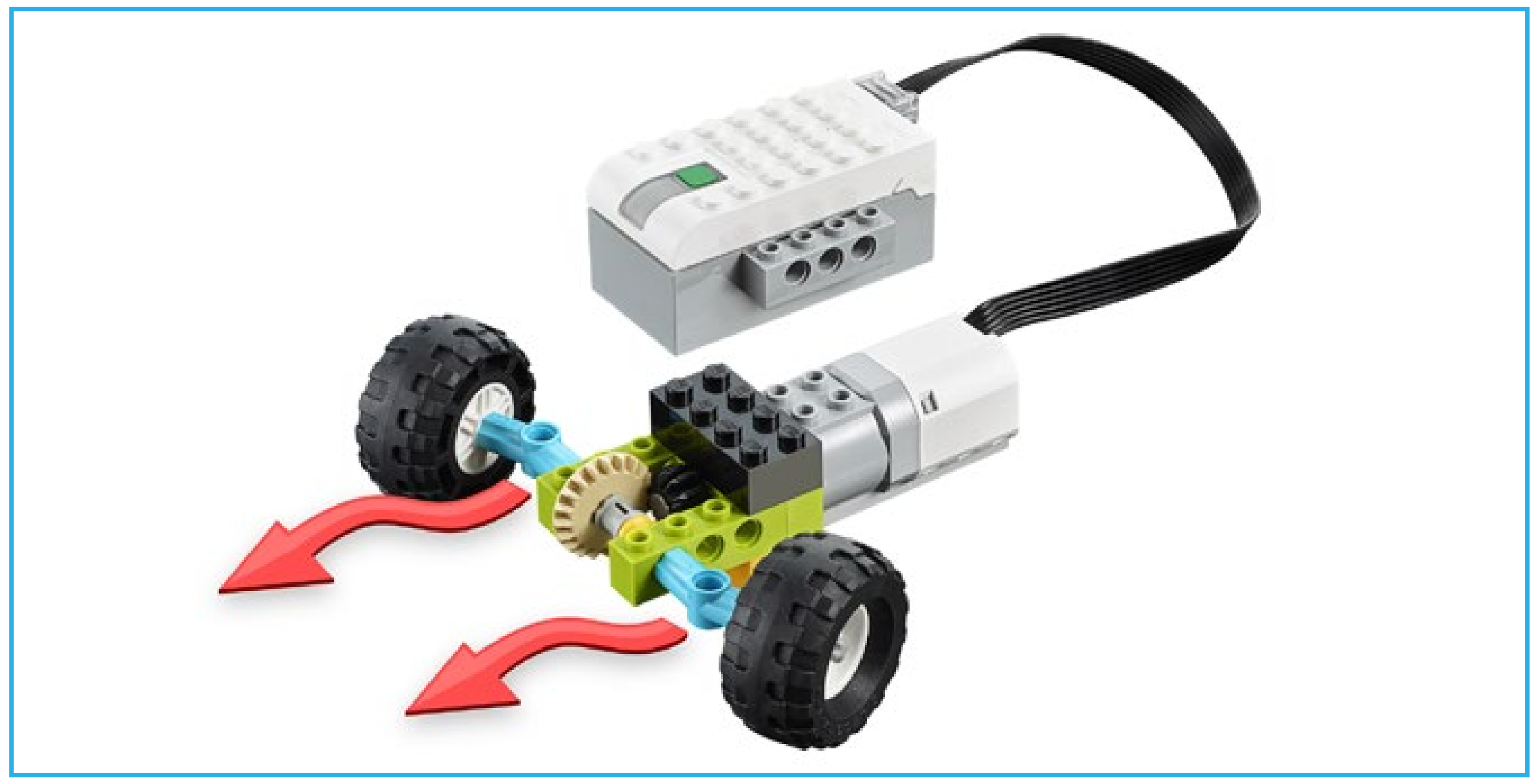
The importance of designing in WeDo 2.0

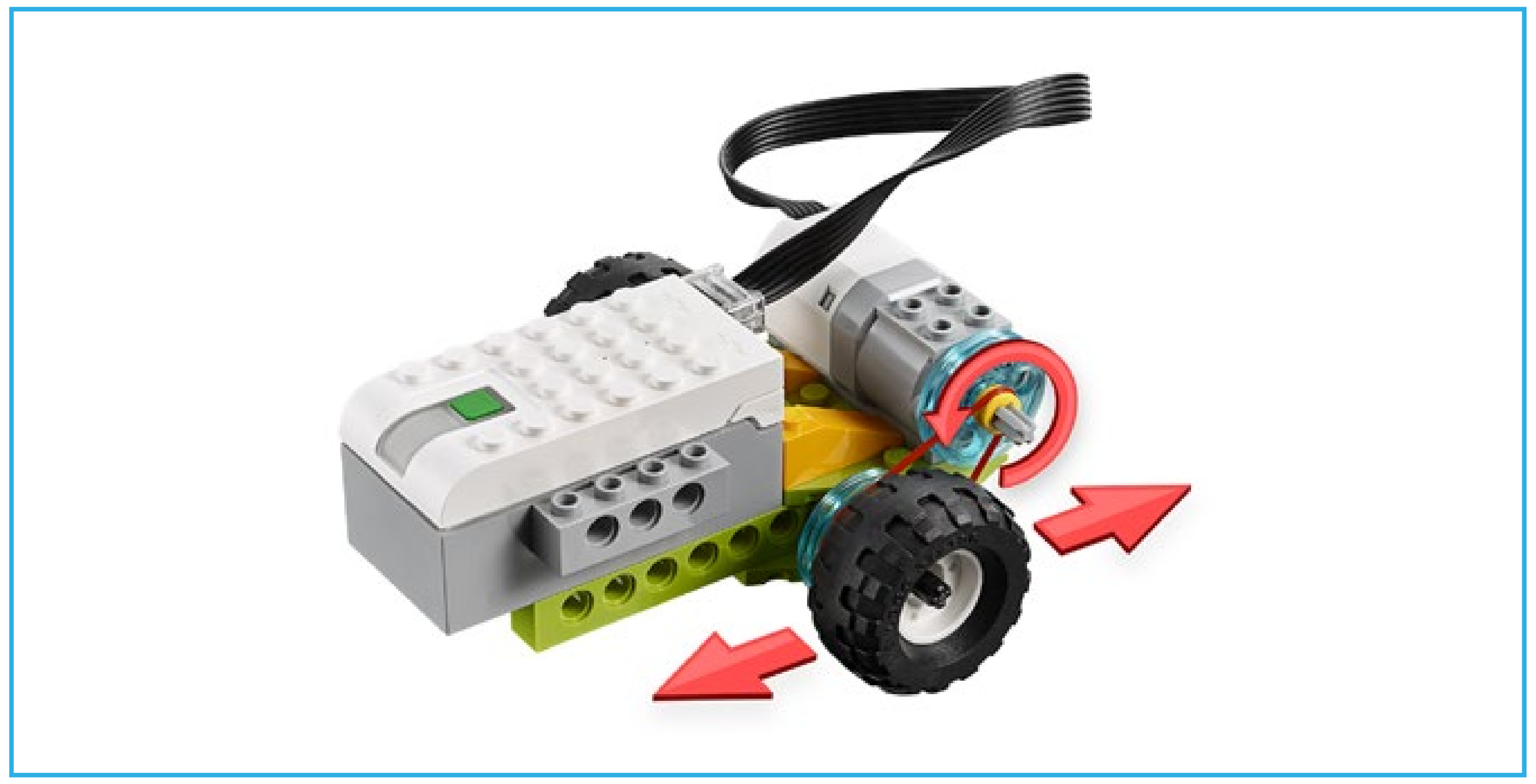
The WeDo 2.0 projects will take you and your pupils on a journey of using mechanisms in their models. These mechanisms will bring your pupils' models to life.

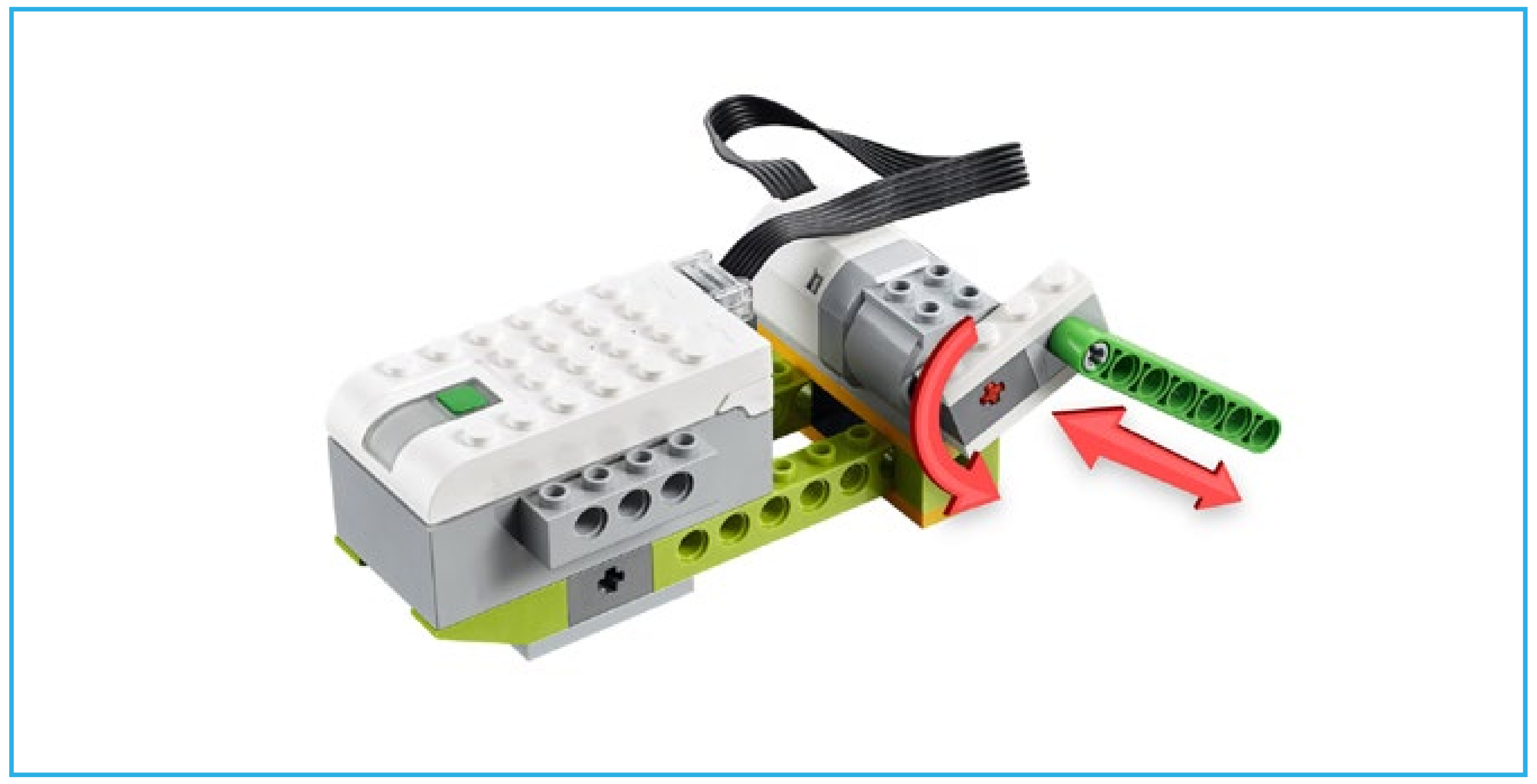
The mechanisms have been ordered by their function, in the Design Library.
In the software, pupils will find building instructions that will enable their models to:

1. Wobble
2. Drive
3. Crank
4. Walk
5. Spin
6. Flex
7. Reel
8. Lift
9. Grab
10. Push
11. Revolve
12. Steer
13. Sweep
14. Detect motion
15. Detect tilt

These are provided to give inspiration to your pupils when they look for solutions. All these functions use what is called "simple machines" that you can explore together with your pupils.

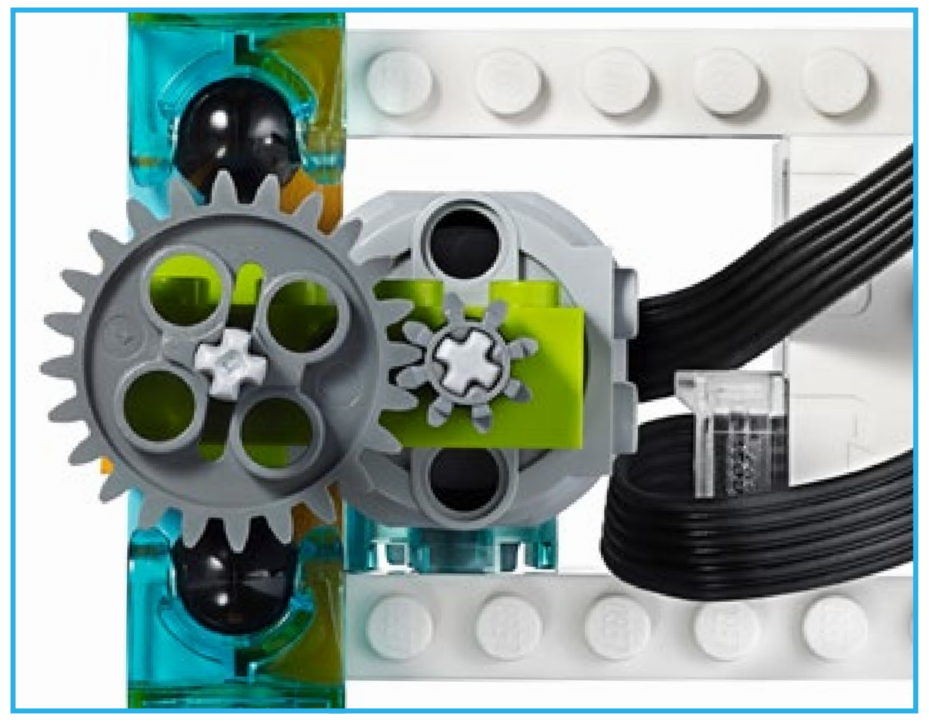






Base models exploration

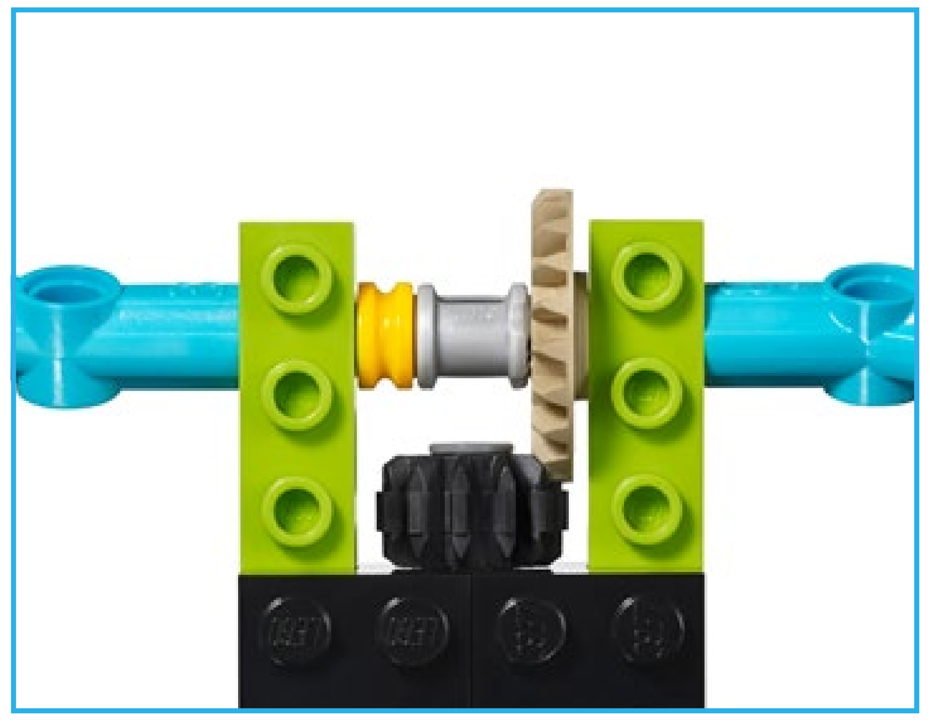
Name of the part: Gear
A gear is a toothed wheel that rotates and makes another part move. You can find gear wheels on your bicycle, they are linked together by a chain. A gear train is a system of gears that transmits motion from one part to another.



Types of gear train
Gear up: A large gear drives a small gear to produce more rotations.
Gear down: A small gear drives a large gear to produce fewer rotations.

Used in Design Library base models
Walk, Spin

Name of the part: Bevel gear
This is an angled gear that can be placed perpendicular to another gear, changing the axis of rotation.

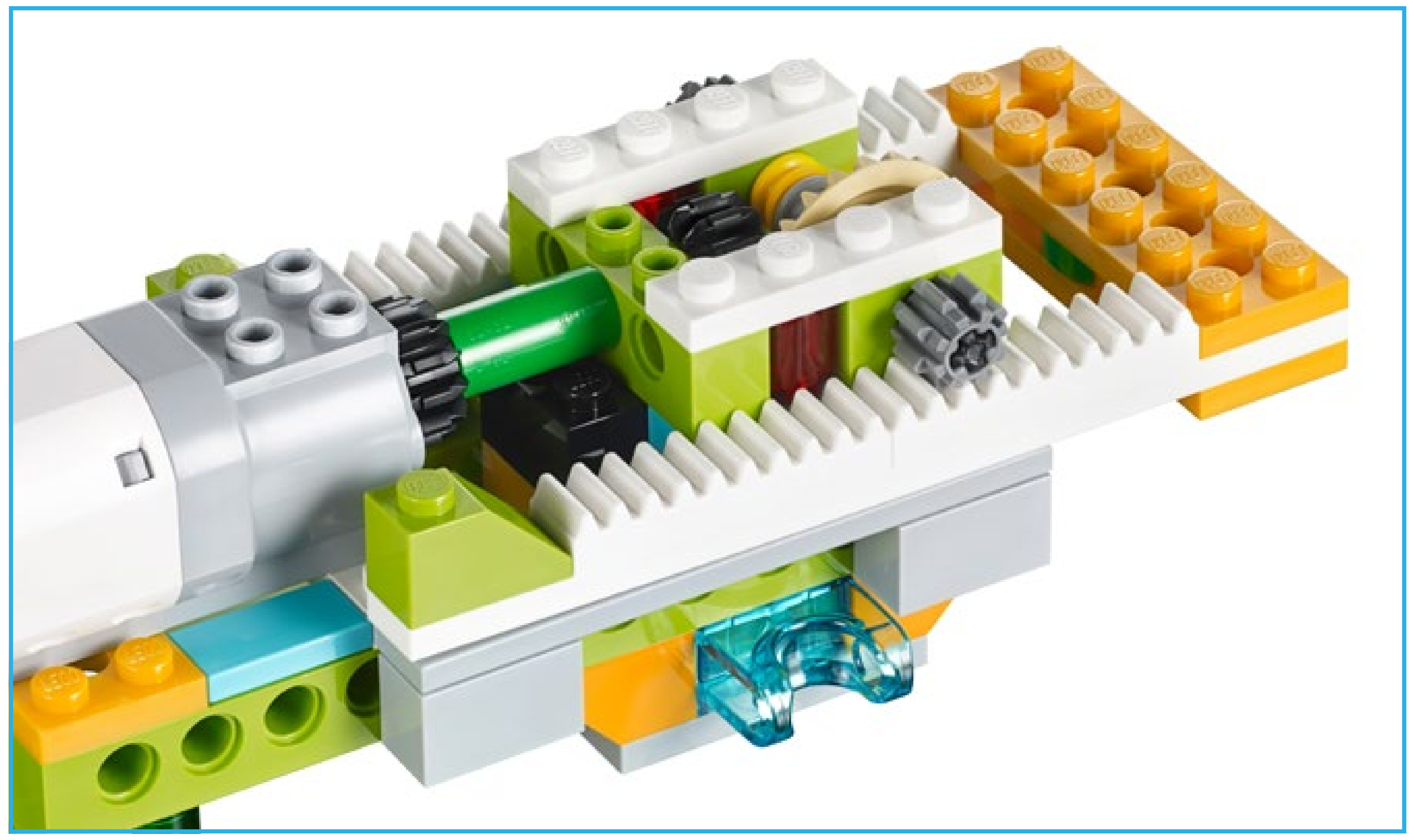


Used in Design Library base models
Flex, Wobble, Push

Base models exploration

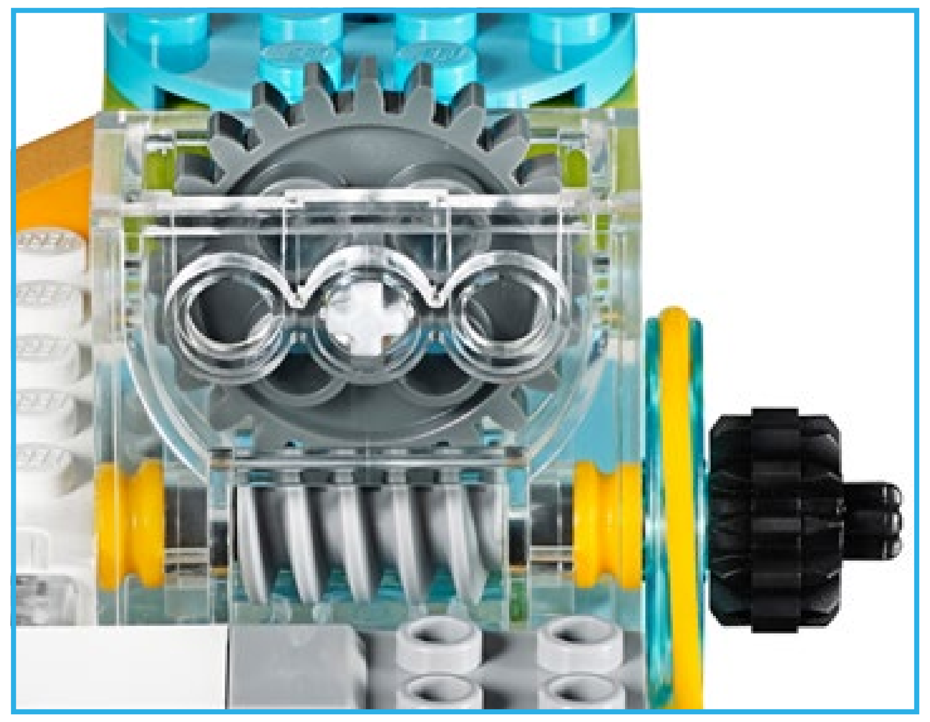
Name of the part: Rack
A rack is a flat element with teeth that engage a circular gear, often referred to as a pinion. This changes ordinary rotational motion into linear motion.

Used in Design Library base models
Push



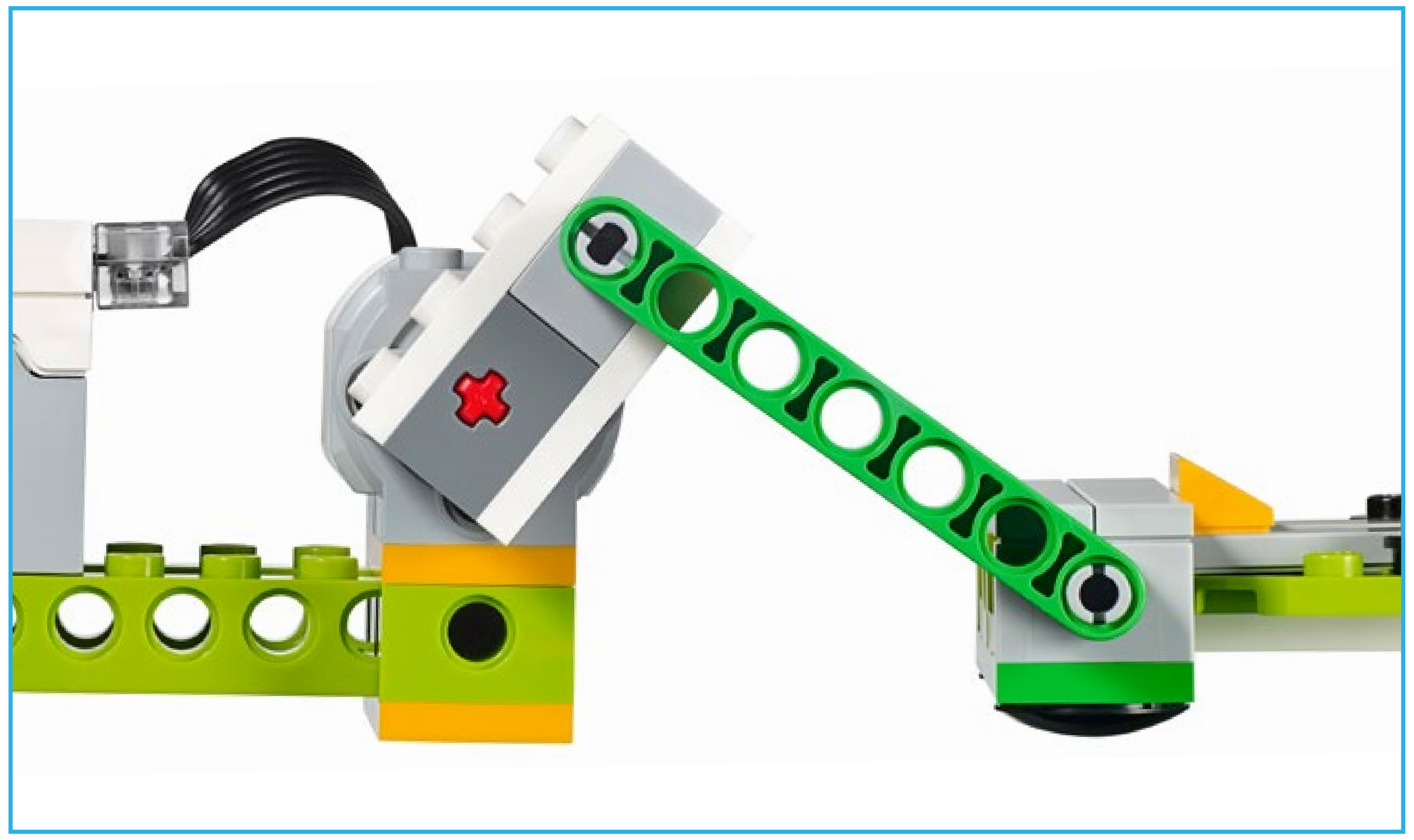
Name of the part: Worm gear
A worm is a continual spiral groove like a screw, which meshes with a gear.
The worm is designed to turn a normal gear, but the gear cannot turn the worm, therefore, it functions as a brake.

Used in Design Library base models
Revolve



Base models exploration

Name of part: Beam
A beam attached to a rotating part will become a piston. A piston is a moving component of a machine, transferring the energy created by the motor into an up/down or forward/backward motion. The piston can push, pull, or drive other mechanical elements of the same machine.



Used in Design Library base models
Crank

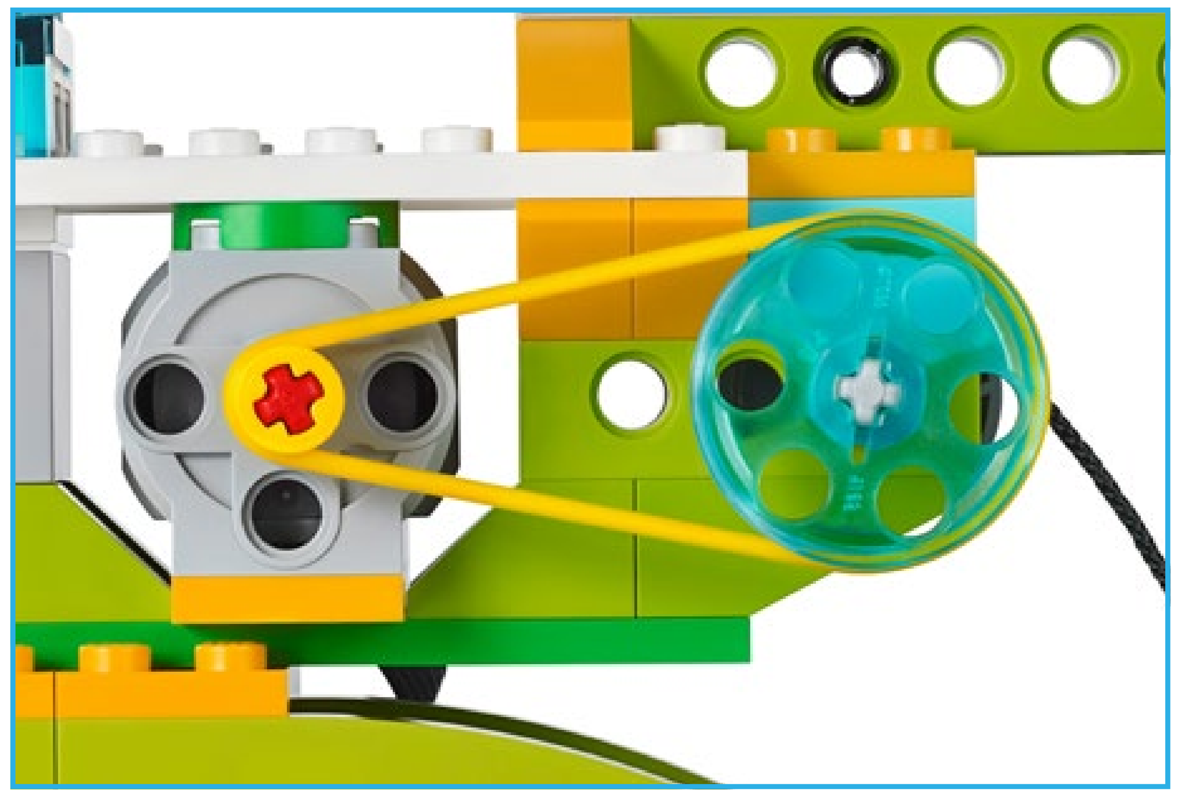
Name of the part: Wheels
A circular element that rotates on an axis to produce propelling movement.

Used in Design Library base models
Wobble, Drive, Steer

Base models exploration

Name of the part: Pulley

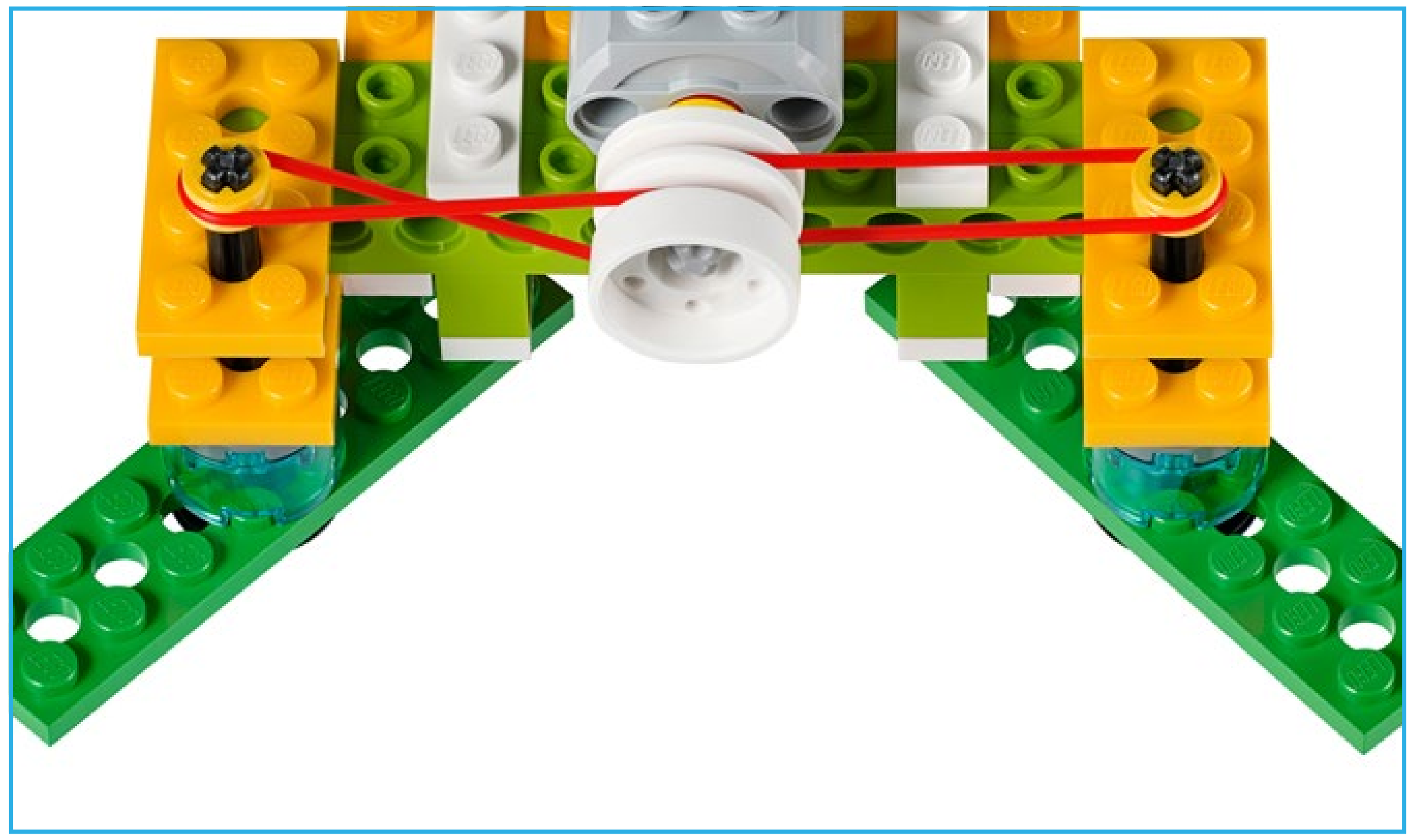
The pulley is a wheel with a grooved rim that accommodates the belt. The belt is a small rubber band, which connects to a part of the model that is rotating, transferring the rotation to a different part of the model.



Pulley up: A large pulley drives a small pulley to produce more rotations.
Pulley down: A small pulley drives a large pulley to produce fewer rotations.
Pulley twist: Used to make shafts that are parallel but rotate in opposite directions.

Used in Design Library base models

Reel, Lift, Drive, Sweep, Revolve, Grab



Important

Using a pulley in a mechanism will prevent the model from breaking when it meets resistance, as the belt will slip in the pulley.

Electronic parts

Smarthub

The Smarthub acts as a wireless connector between your device and the other electronic parts, using Bluetooth Low Energy. It receives and executes program strings from each device.

The Smarthub features:

- Two ports to connect sensors or motors
- A light
- A power button

The Smarthub uses AA batteries or the supplementary Rechargeable Battery as a power source.

The Bluetooth connection procedure between the Smarthub and your device is explained in the WeDo 2.0 Software.

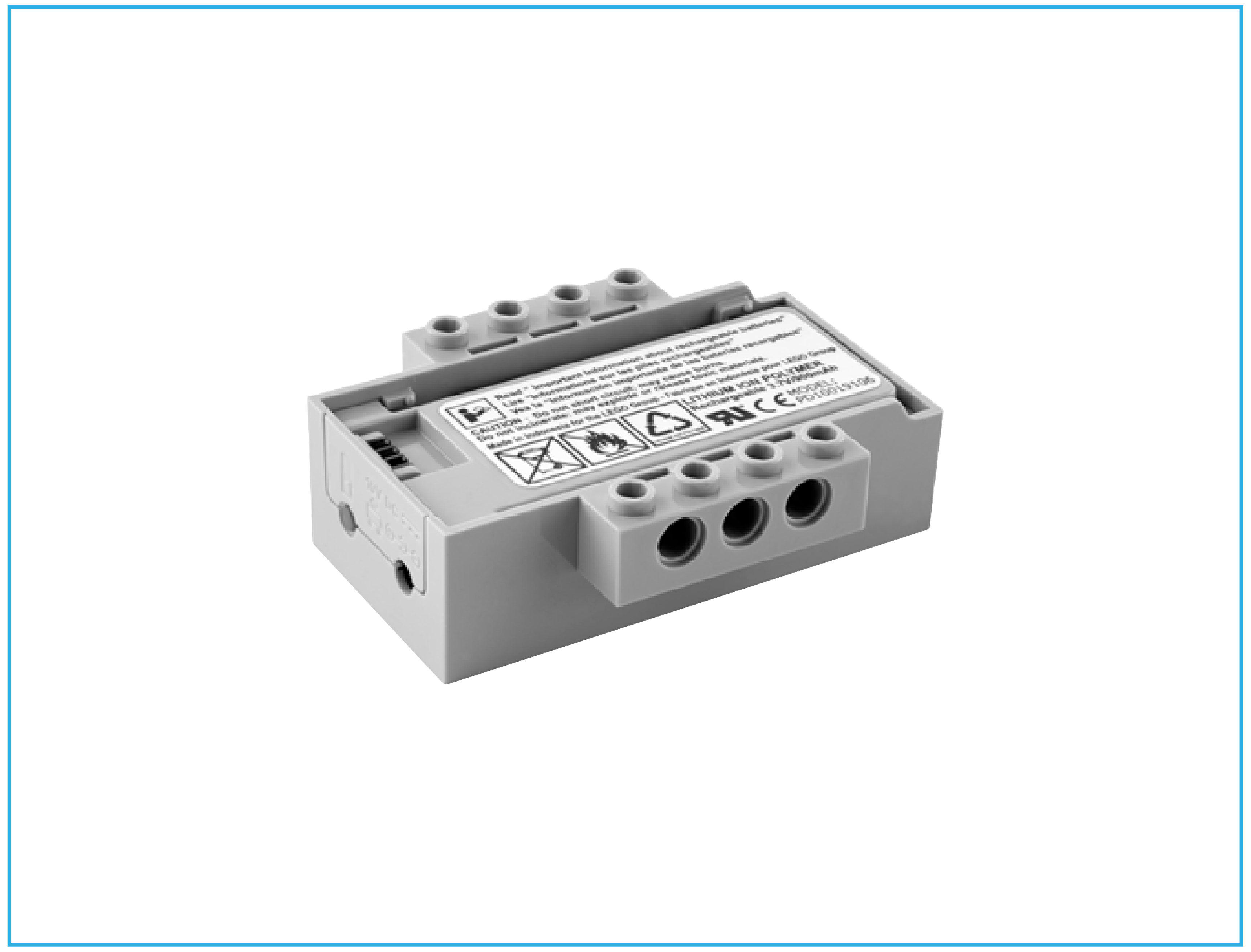
The Smarthub will use colour patterns to signal messages:

- Flashing white light: Waiting for a Bluetooth connection.
- Blue light: Bluetooth connection is established.
- Flashing orange light: The power provided to the motor is at its limit.

Electronic parts

Smarthub Rechargeable Battery
(supplementary item)
Here are some guidelines for the Smarthub Rechargeable Battery:

- To maximise the hours of play available without the adaptor connected, make sure that the battery is fully charged before you begin.
- There are no special requirements for charging patterns.
- Preferably, store the battery in a cool place.
- Recharging is recommended If the battery has been installed in the Smarthub, without use, for more than one month.
- Do not let the battery charge for an extended period of time.



Medium Motor
A motor makes other things move. This Medium Motor uses electricity to make an axle rotate.

The motor can be started in both directions, can be stopped, and can run at different speeds for a specified amount of time (seconds).

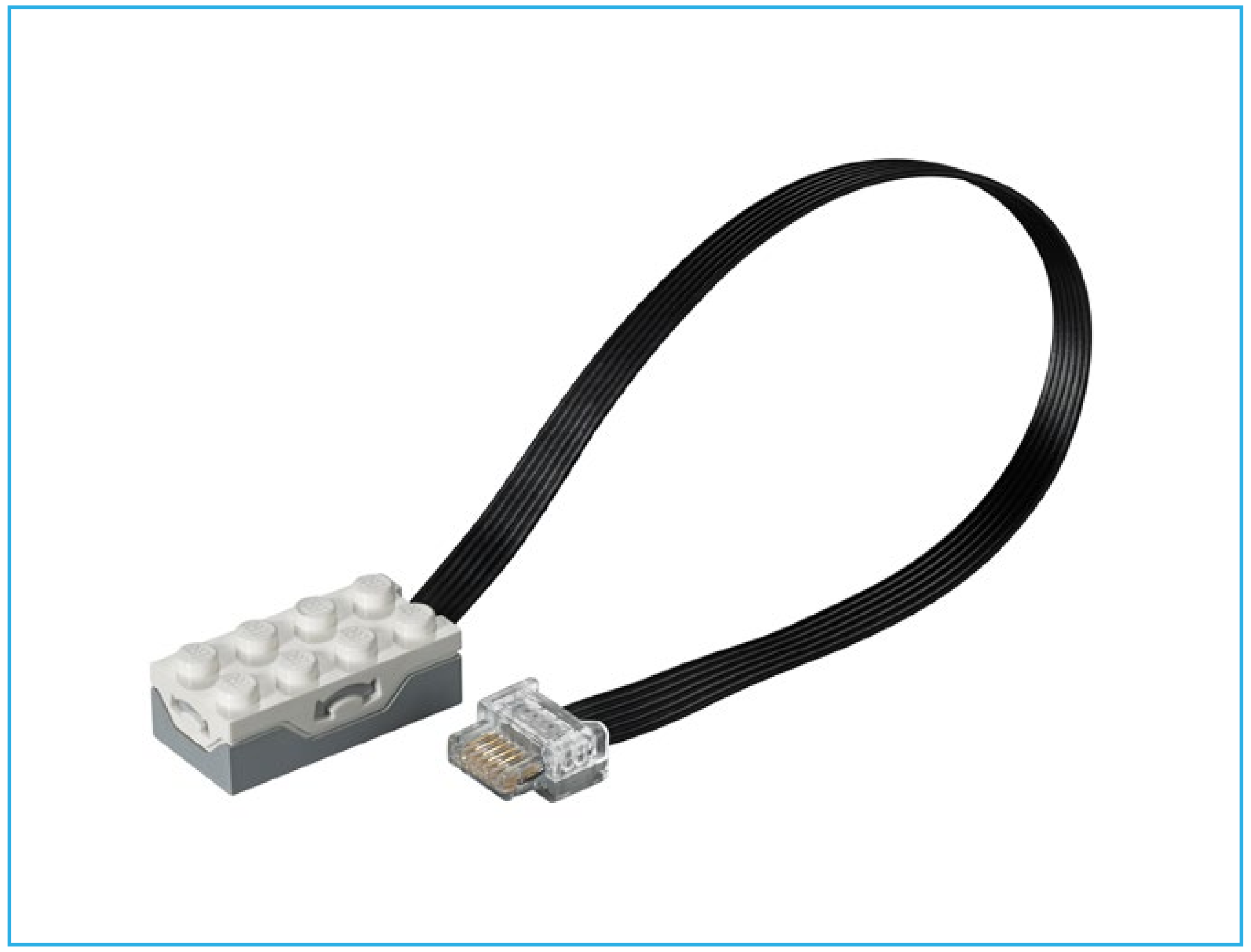
Electronic parts: sensors

Tilt Sensor

To interact with this sensor, tilt the part in different directions, following the arrows.
The sensor can detect changes in six different positions:

- Tilt this way
- Tilt that way
- Tilt up
- Tilt down
- No tilt
- Any tilt

Make sure that the icon in your program corresponds to the position you are trying to detect.



Motion Sensor

This sensor detects changes in distance from an object within its range,
in three different ways:

- Object moving closer
- Object moving further away
- Object changing position

Make sure that the icon in your program corresponds to the position you are trying to detect.

Part names and primary functions

As pupils use the bricks, you may want to discuss proper vocabulary as well as functions for each part in the set.

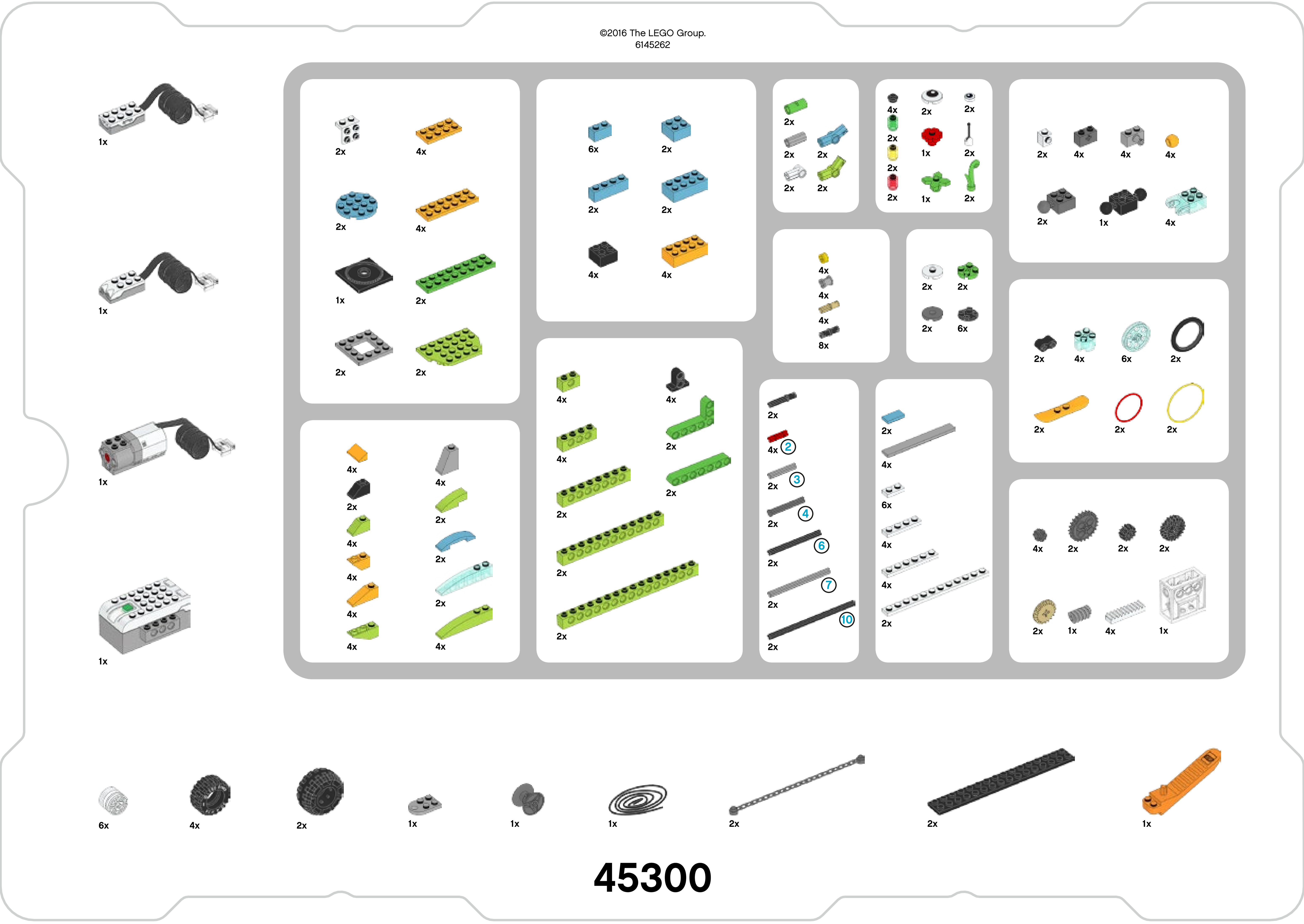
- Some of them are structural parts that hold your model together.
- Some parts are connectors that link elements to each other.
- Some parts are used to produce movement.

Important

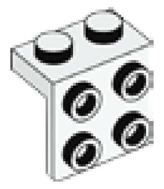
Remember that these categories are guidelines. Some parts have many functions and can be used in many ways.

Suggestion

Use the cardboard box when sorting the parts in the WeDo 2.0 storage box. This will help you and your pupils when viewing and counting the parts.



Structural parts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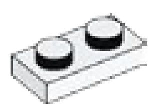
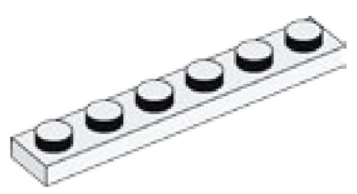
white. No.6117940


6x - Plate, 1x2,
white. No.302301


4x - Plate, 1x4,
white. No.371001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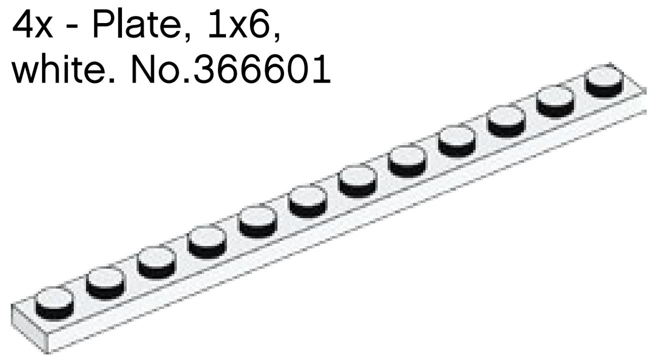
white. No.366601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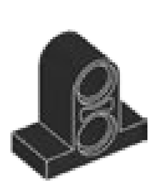
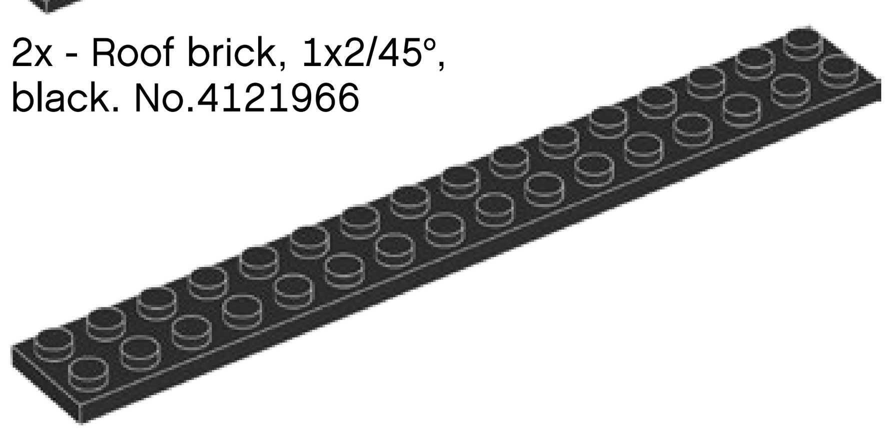
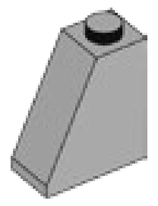
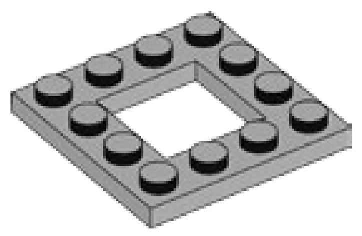
white. No.4514842

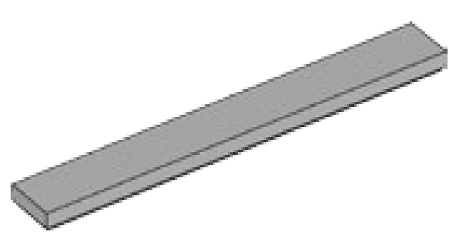

4x - Beam with plate, 2-modules,
black. No.4144024

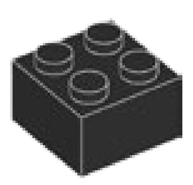

2x - Roof brick, 1x2/45°,
black. No.4121966


2x - Plate, 2x16,
black. No.428226


4x - Roof brick, 1x2x2,
grey. No.4515374

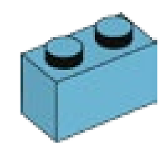

2x - Frame plate, 4x4,
grey. No.4612621

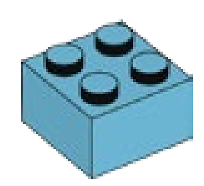

4x - Tile, 1x8,
grey. No.4211481

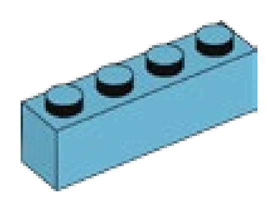

4x - Brick, 2x2,
black. No.300326

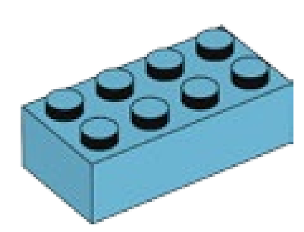

1x - Bottom for turntable, 4x4,
black. No.4517986

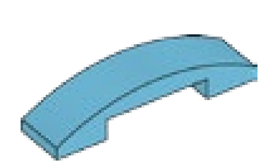
2x - Tile, 1x2,
azure blue. No.4649741

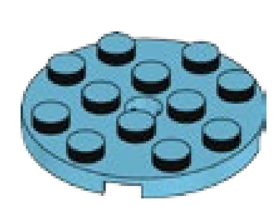

6x - Brick, 1x2,
azure blue. No.6092674

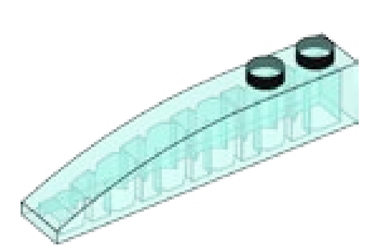

2x - Brick, 2x2,
azure blue. No.4653970

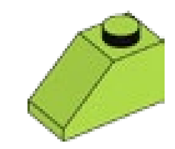

2x - Brick, 1x4,
azure blue. No.6036238


2x - Brick, 2x4,
azure blue. No.4625629

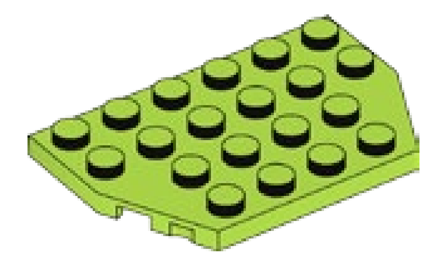

2x - Curved plate, 1x4x2/3,
azure blue. No.6097093

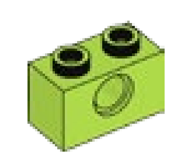

2x - Round plate, 4x4,
azure blue. No.6102828

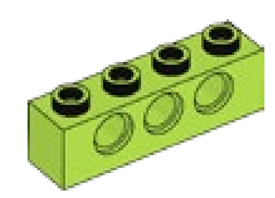

2x - Curved brick, 1x6,
transparent light blue. No.6032418

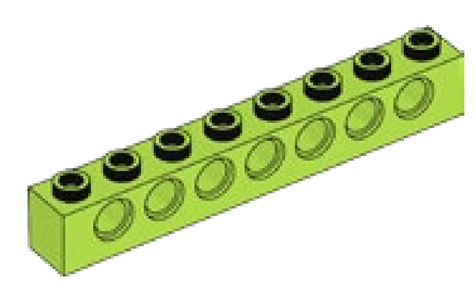

4x - Roof brick, 1x2/45°,
lime green. No.4537925

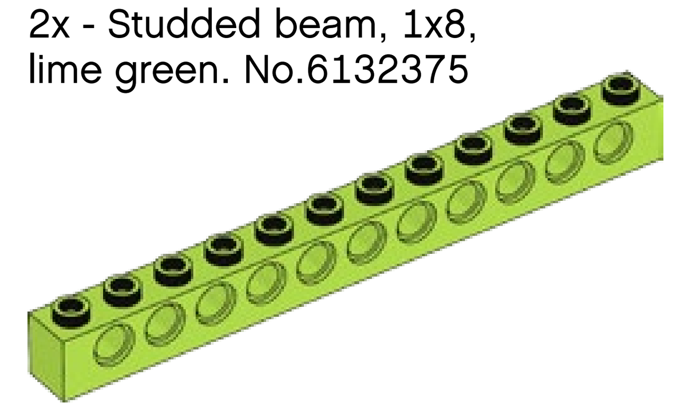

4x - Inverted roof brick, 1x3/25°,
lime green. No.6138622

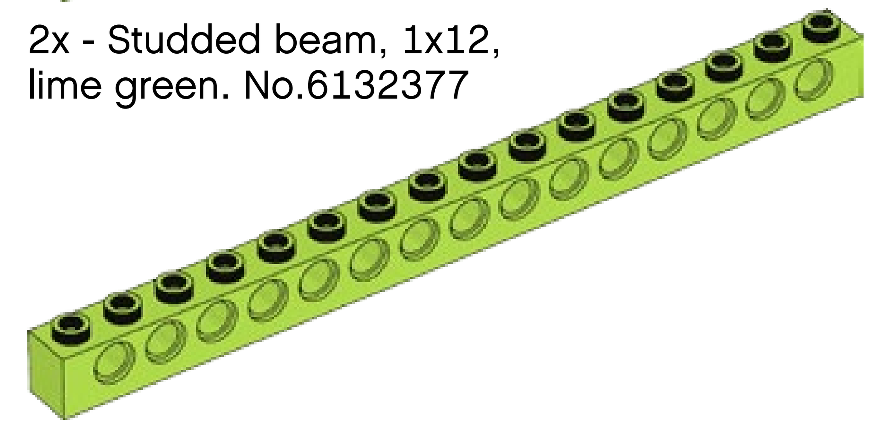

2x - Plate, 4x6/4,
lime green. No.6116514

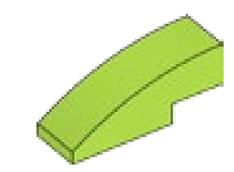

4x - Studded beam, 1x2,
lime green. No.6132372

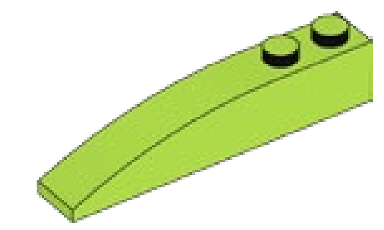

4x - Studded beam, 1x4,
lime green. No.6132373

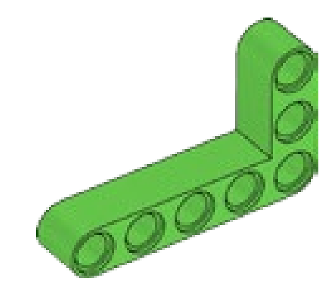

2x - Studded beam, 1x8,
lime green. No.6132375

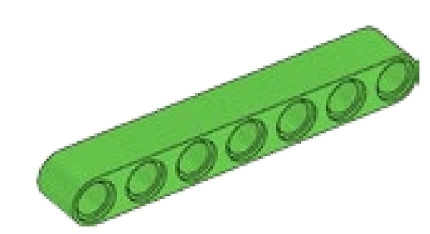

2x - Studded beam, 1x12,
lime green. No.6132377

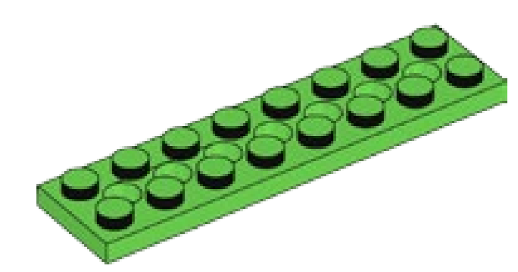

2x - Studded beam, 1x16,
lime green. No.6132379

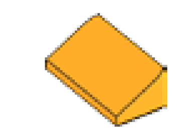

2x - Curved brick, 1x3,
lime green. No.4537928

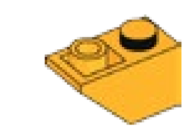

4x - Curved brick, 1x6,
lime green. No.6139693

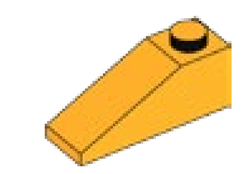

2x - Angular beam, 3x5-modules,
bright green. No.6097397

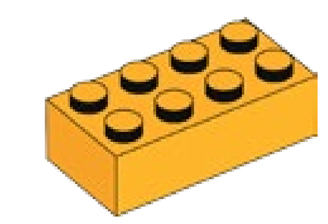

2x - Beam, 7-modules,
bright green. No.6097392

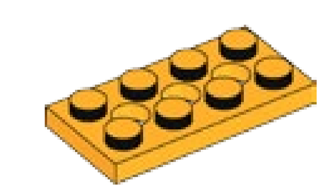

2x - Plate with holes, 2x8,
bright green. No.6138494

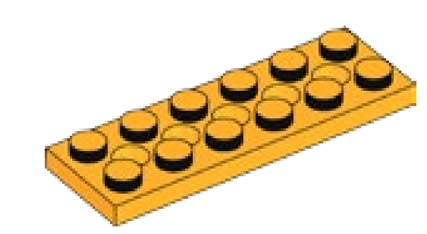

4x - Roof brick, 1x2x2/3,
bright orange. No.6024286

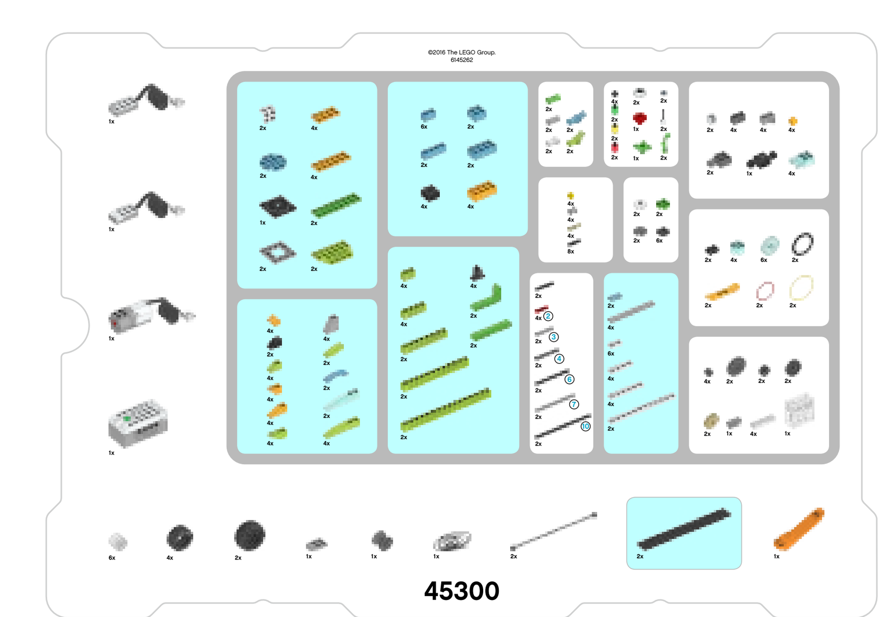

4x - Inverted roof brick, 1x2/45°,
bright orange. No.6136455


4x - Roof brick, 1x3/25°,
bright orange. No.6131583

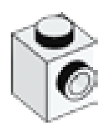

4x - Brick, 2x4,
bright orange. No.6100027


4x - Plate with holes, 2x4,
bright orange. No.6132408

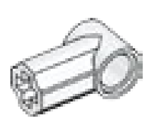

4x - Plate with holes, 2x6,
bright orange. No.6132409



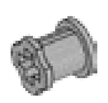
Connecting parts



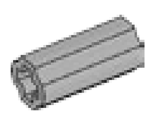
2x - Brick with stud on side, 1x1,
white. No.4558952



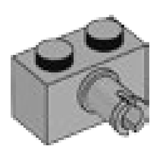
2x - Angular block 1, 0°,
white. No.4118981



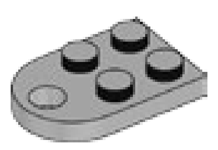
4x - Bushing, 1-module,
grey. No.4211622



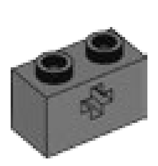
2x - Bushing/axle extender, 2-module,
grey. No.4512360



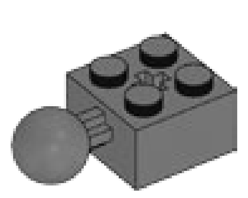
4x - Brick with connector peg, 1x2,
grey. No.4211364



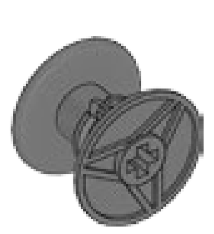
1x - Plate with hole, 2x3,
grey. No.4211419



4x - Studded beam with crosshole,
1x2, dark grey. No.4210935

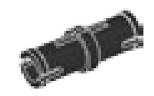


2x - Brick with 1 ball joint, 2x2,
dark grey. No.4497253

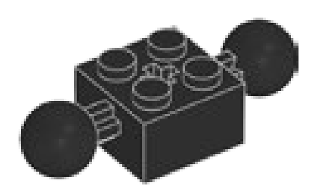


1x - Bobbin,
dark grey. No.4239891

2x - Chain, 16-modules,
dark grey. No.4516456

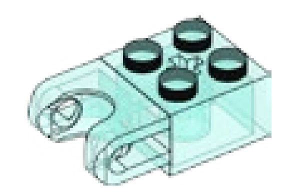


8x - Connector peg, with friction,
2-modules, black. No.4121715

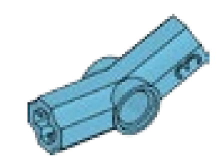


1x - Brick with 2 ball joints, 2x2,
black. No.6092732

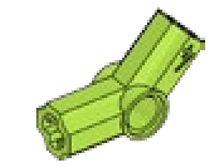
1x - String, 50 cm,
black. No.6123991



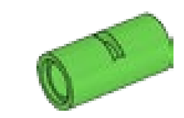
4x - Brick with ball bearing, 2x2,
transparent light blue. No.6045980



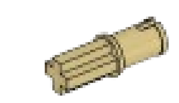
2x - Angular block 3, 157,5°,
azure blue. No.6133917



2x - Angular block 4, 135°,
lime green. No.6097773



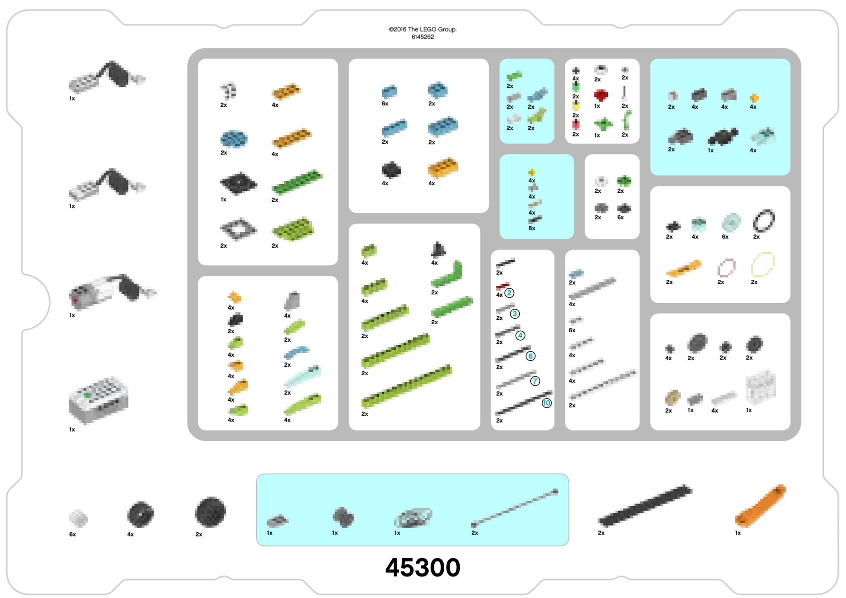
2x - Tube, 2-modules,
bright green. No.6097400



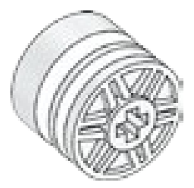
4x - Connector peg, without friction/
axle, 1-module/1-module,
beige. No.4666579

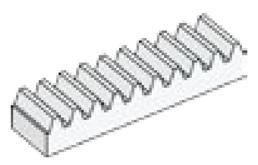
4x - Ball with crosshole,
bright orange. No.6071608

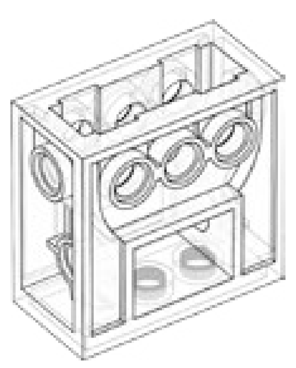
4x - Bushing/pulley, ½-module,
yellow. No.4239601



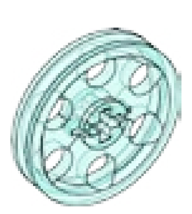
Movement parts

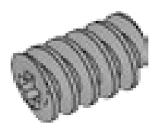

6x - Hub/pulley, 18x14 mm,
white. No.6092256


4x - Gear rack, 10-tooth,
white. No.4250465

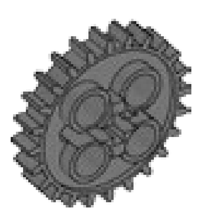

1x - Gear block,
transparent. No.4142824

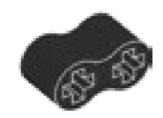

4x - Round brick, 2x2,
transparent light blue. No.4178398

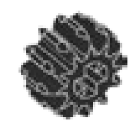

6x - Hub/pulley, 24x4 mm,
transparent light blue. No.6096296


1x - Worm gear,
grey. No.4211510


4x - Gear, 8-tooth,
dark grey. No.6012451


2x - Gear, 24-tooth,
dark grey. No.6133119

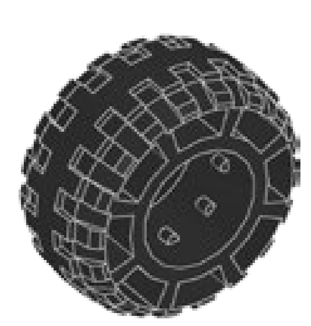

2x - Rubber beam with crossholes,
2-modules, black. No.4198367

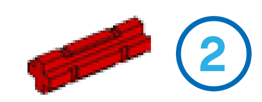

2x - Double bevel gear, 12-tooth,
black. No.4177431


2x - Double bevel gear, 20-tooth,
black. No.6093977


2x - Tyre, 30.4x4 mm,
black. No.6028041

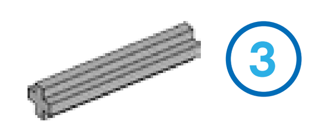

4x - Tyre, 30.4x14 mm,
black. No.4619323


2x - Tyre, 37x18 mm,
black. No.4506553

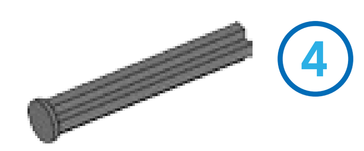


4x - Axle, 2-modules,
red. No.4142865

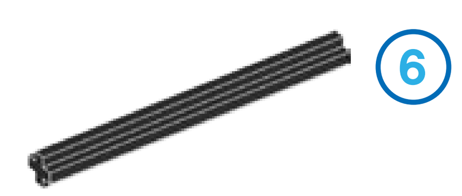
2x - Connector peg with axle,
3-modules, black. No.6089119



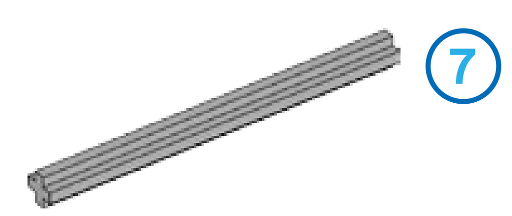
2x - Axle, 3-modules,
grey. No.4211815



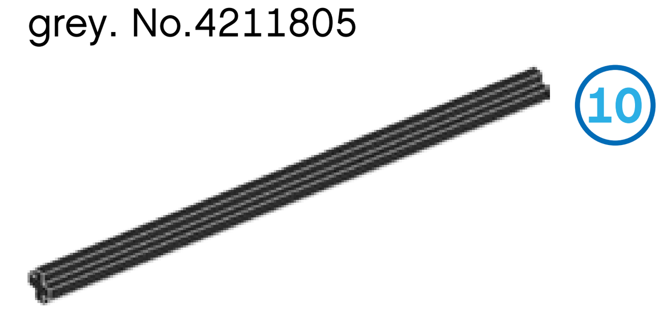
2x - Axle with stop, 4-modules,
dark grey. No.6083620



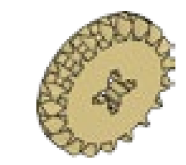
2x - Axle, 6-modules,
black. No.370626

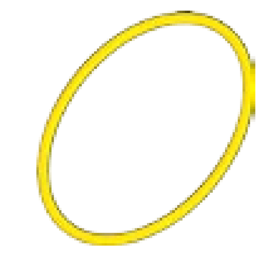


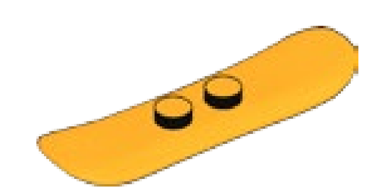
2x - Axle, 7-modules,
grey. No.4211805

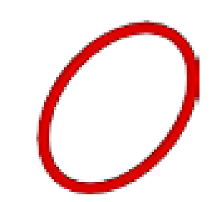


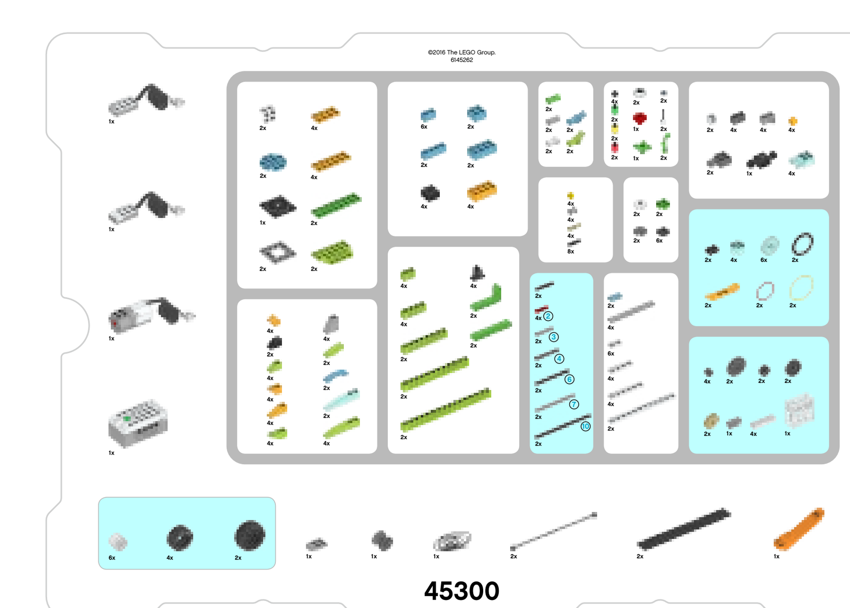
2x - Axle, 10-modules,
black. No.373726


2x - Bevel gear, 20-tooth,
beige. No.6031962


2x - Belt, 33 mm,
yellow. No.4544151


2x - Snowboard,
bright orange. No.6105957


2x - Belt, 24 mm,
red. No.4544143

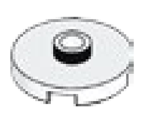


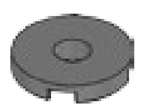
Decorative parts


2x - Antenna,
white. No.73737


2x - Round tile with eye, 1x1,
white. No.6029156


2x - Round tile with eye, 2x2,
white. No.6060734

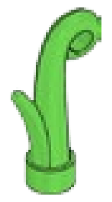

2x - Round plate with 1 stud, 2x2,
white. No.6093053


2x - Round tile with hole, 2x2,
dark grey. No.6055313


4x - Round plate, 1x1,
black. No.614126


6x - Skid plate, 2x2,
black. No.4278359


2x - Round brick, 1x1,
transparent green. No.3006848

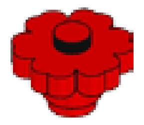

2x - Grass, 1x1,
bright green. No.6050929


2x - Round plate, 2x2,
bright green. No.6138624

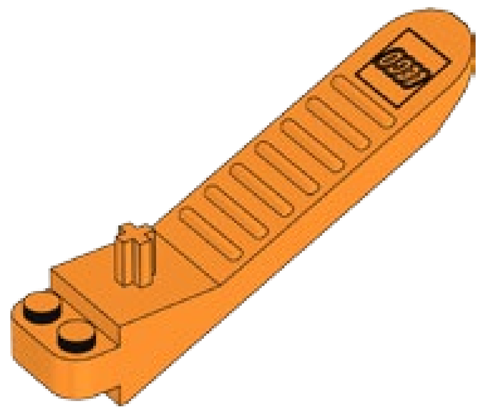

1x - Leaves, 2x2,
bright green. No.4143562

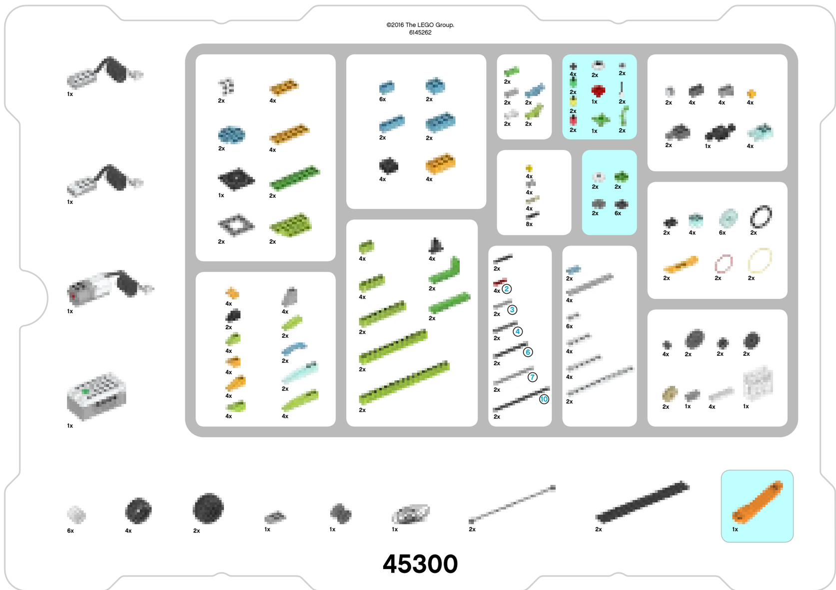

2x - Round brick, 1x1,
transparent yellow. No.3006844


2x - Round brick, 1x1,
transparent red. No.3006841

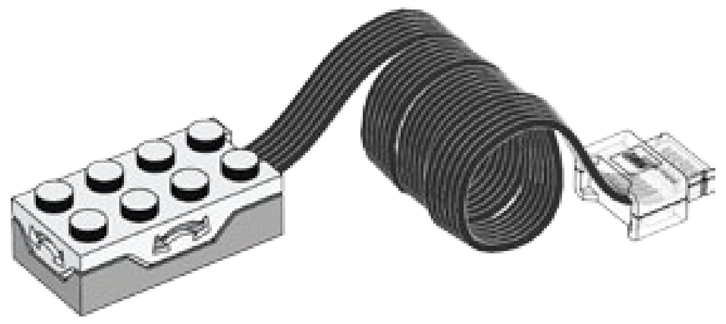

1x - Flower, 2x2,
red. No.6000020

Brick separator

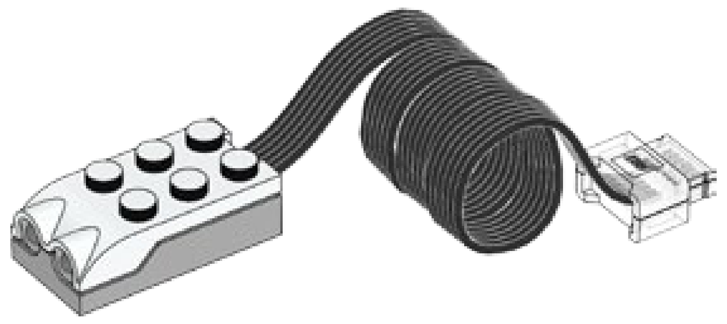

1x - Element separator,
orange. No.4654448



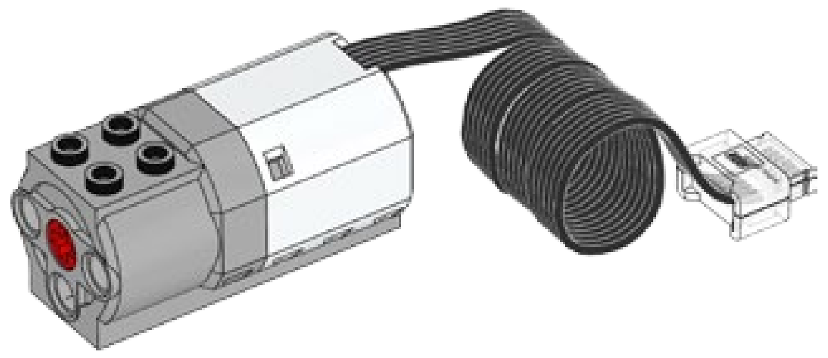
Electronic parts



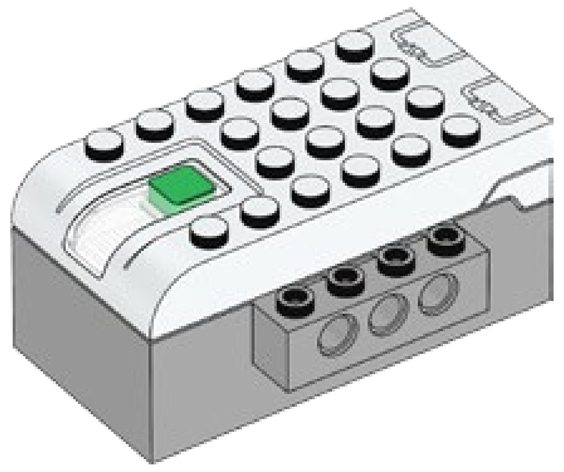
1x - Tilt Sensor,
white. No.6109223



1x - Motion Sensor,
white. No.6109228



1x - Medium Motor,
white. No.6127110



1x - Smarthub,
white. No.6096146

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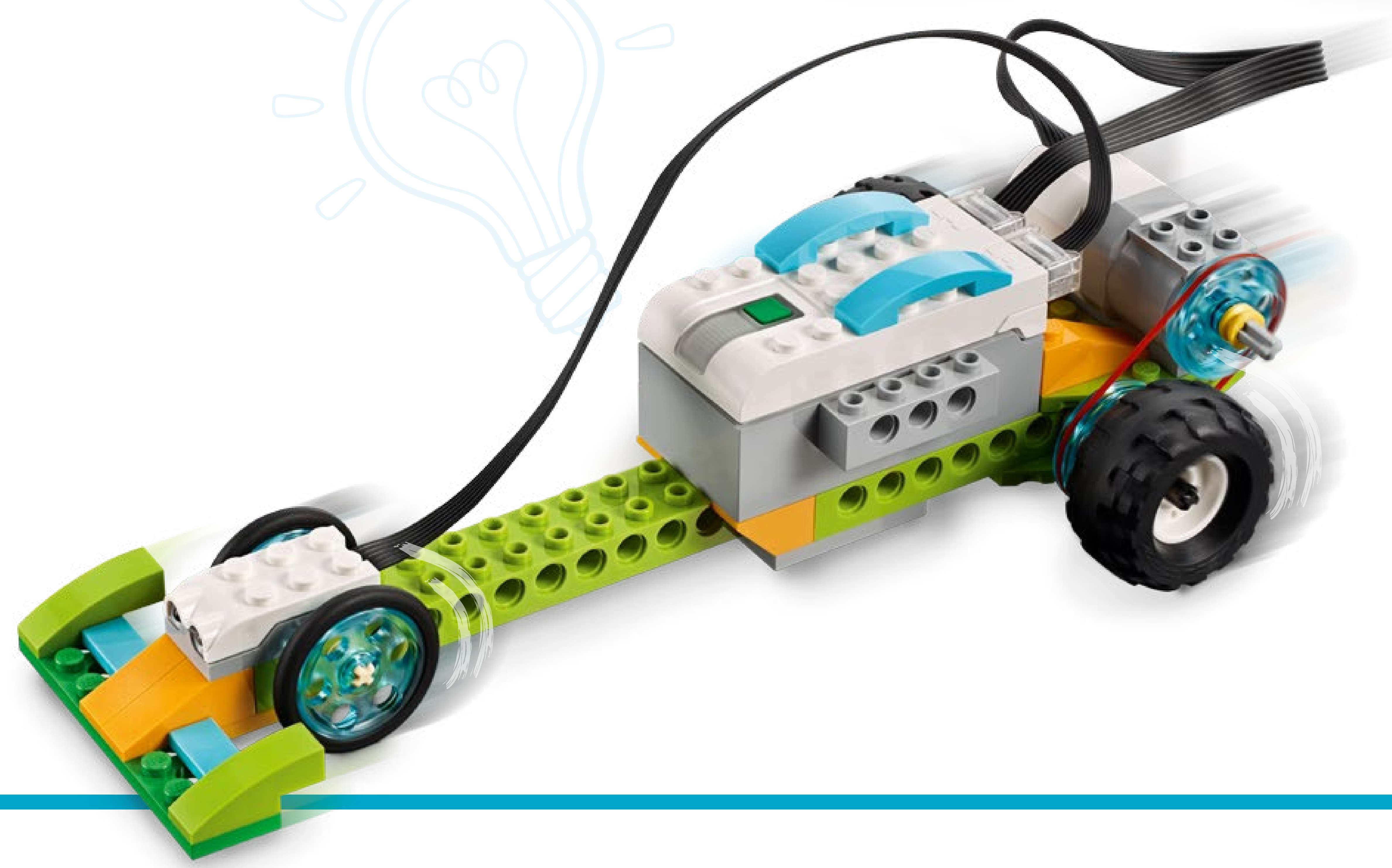

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