Preview of selected pages

LEGO® Education WeDo 2.0

Curriculum Pack

Designing
Investigating
Modeling
Computing

LEGO® Education
WeDo 2.0

NATIONAL CURRICULUM STANDARD COMPLIANT

WeDo 2.0
2045300

LEGO education

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The LEGO® Education community is an online community for teachers, administrators, and other professionals in education.
It is to connect and share ideas, engage in discussions, and share lesson plans and projects.
The LEGO Education community is only 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 needed 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 elementary students' interest in learning science- and engineering-related subjects. This is done through the use of motorized LEGO models and simple programming.

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

Students learn by asking questions and solving problems. This material does not tell students 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:

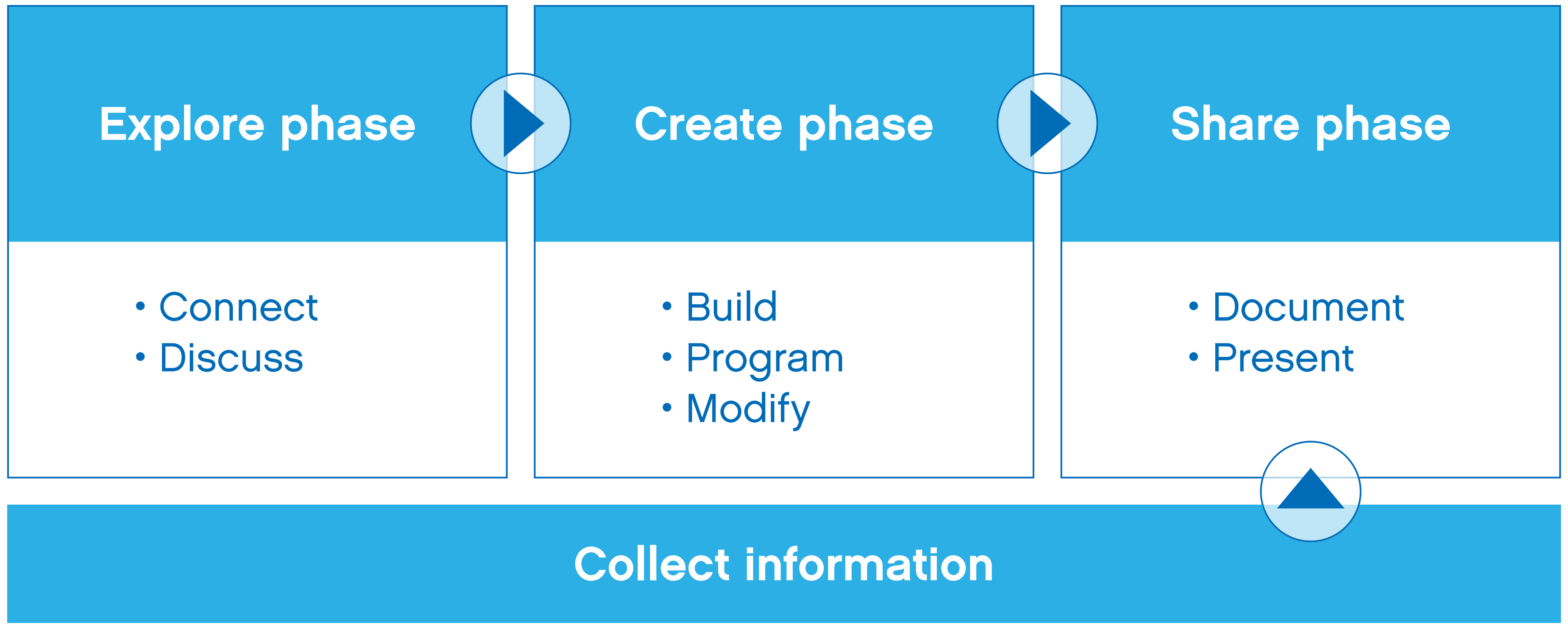
- 1 Getting Started Project divided in 4 parts, to learn the basic functions of WeDo 2.0
- 8 Guided Projects linked to the curriculum standards, with step-by-step instructions for the complete project
- 8 Open Projects linked to the curriculum standards, with a more open experience

All 16 projects are divided into three phases: the Explore phase, to connect students to the task; the Create phase, to allow students to build and program; and the Share phase, to document and present their project.

Each project should last around three hours. Each phase has an equal importance in the project flow and could last around 45 min., but you can modify the time to spend on each.

How to teach science with WeDo 2.0

WeDo 2.0 uses a project progression defined by three phases.



Explore phase

Students 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

Students 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

Students present and explain their solutions using their LEGO models and the document they have created with their findings with the integrated Documentation tool.

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

Important

During each of these phases, students 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 set the scene and facilitate the learning experience. The Guided Projects should build your students' confidence and provide the foundations necessary for success.

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

With every project teachers' notes have been provided that include:
- Curriculum links
- Detailed preparation
- Assessment grids
- Differentiation techniques and notes on possible student misconceptions.
- Explore, Create and Share Help panel

See the "Guided Projects" chapter to discover 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 students understand the approach and methodology. A good Guided Project to start with is called Pulling.

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 upon.

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 students. You will find teacher support about Open Projects in the "Open Projects" chapter.

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

The Design Library, located in the software, has been designed to provide inspiration for students to build their own solution. Therefore, the goal is not to replicate the model but to get help on how to build a function, such as to lift or walk. Students will find building instructions for the 15 base models in the Design Library and pictures for inspirational models.

Suggestion

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

Document projects

Having your students document their work is one of many ways you can keep track of their work, identify where they need more help, and evaluate their progress.

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

1. Take pictures of important steps of their prototype or their final models.
2. Take pictures of the team working on something important.
3. Record a video explaining a problem they are facing.
4. Record a video explaining their investigation.
5. Write critical information within the Documentation tool.
6. Find supporting pictures on the Internet.
7. Take a screen capture of their program.
8. Write, draw, or sketch on paper and take a photo of it.

Suggestion

Depending on the age group you work with, the combination of paper and digital documentation can be the richest.

Share projects

At the end of the project, students will be excited to share their solutions and findings. It will be a great opportunity to develop their communication ability.

Here are different ways you can have your students share their work:

1. Have students create the display where the LEGO® model will be used.
2. Have students describe their investigation or diorama.
3. Have a team of students present their best solution to you, to another team, or in front of the class.
4. Have an expert (or some parents) come to your class to listen to your students.
5. Organize a science fair at your school.
6. Have students record a video to explain their project and post it online.
7. Create and display posters of the projects in your school.
8. E-mail the project document to parents or publish in student portfolios.

Suggestion

To make this experience even more positive, have students give one positive comment or ask one question about others' work when they take part in the sharing session.

The Science Lab

Max and Mia's virtual WeDo 2.0 Science Lab is a great place for students 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 new topics, and he is really creative when it is time to invent something new.

Mia is thrilled by any discoveries. She is 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 Curriculum

The LEGO® Education WeDo 2.0 solution combines LEGO bricks with Next Generation Science Standards (NGSS). The projects are designed to develop student 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 science and engineering practices from the NGSS in mind.

These practices represent NGSS's expectations for students to learn scientific knowledge as well as the practical skills. The practices are not to be seen as separate, rather as an interconnected set of expectations for students.

The crosscutting themes are also important, and teachers are encouraged to view NGSS documents for those themes as well as specific content area standards.

Both English Language Arts and Math Common Core State Standards (CCSS) 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 found throughout the practices and standards for all grade levels. The habits of mind are centered 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 upon the habits of mind and interconnected throughout the practices and standards.

Develop science and engineering practices with WeDo 2.0

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

The progression and difficulty level in the projects allow students 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. Analyze 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 student should engage in all of these practices across the projects in each grade.

Science practices and the engineering habits of mind

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

The following identifies the basic principles of these practices and gives examples on how they are used in WeDo 2.0 projects.

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

2. Develop and use models.
This practice focuses upon students' prior experiences and the use of concrete events in modeling 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 students learn and follow directions for an investigation to formulate probable solution ideas.

4. Analyze and interpret data.
The focus of this practice is to learn ways 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 realize the role of numbers in data-gathering processes. Students 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 share ideas based upon evidence that it is an important feature of science and engineering. This practice is about how students begin to share their ideas and demonstrate proof to others in a group.

8. Obtain, evaluate, and communicate information.
Teaching children 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 students 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 students in all science and engineering practices. Refer to the practices grid of this chapter to get the 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
Students represent and describe their ideas using the bricks.

Students 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 modeling project, encourage students 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 modeling Guided Projects are:
- Frog's Metamorphosis
- Plants and Pollinators

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

When implementing an investigation project, you should encourage students 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
Students design solutions for a problem for which there is no single answer. The problem may require students to design a combination of plans, models, simulations, programs, and presentations. Going through the design process will require students to constantly adjust and modify their solutions to meet criteria.

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

When you implement a design project, encourage students 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 students 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
- Organizing and analyzing data
- Modeling and simulations
- Using computers to assist in testing models and ideas
- Using algorithms to sequence actions

Its application in science and engineering projects enables students to use powerful digital tools to carry out investigations and build and program models, which might otherwise be tricky to do. Students 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 what factors can make a car go faster to help predict future motion.

3. Robust Structures
Investigate what characteristics of a building would help make it resistant to an earthquake 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 a weather-related hazard.

8. Sort to Recycle
Design a device to use 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 behaviors of several predators and their prey.

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

11. Extreme Habitats
Model a LEGO representation of the influence of the habitat on the survival of some 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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Curriculum overview of Guided Projects organized by NGSS disciplinary core ideas

	1 Pulling	2 Speed	3 Robust Structures	4 Frog's Metamor-phosis	5 Plants and Pollinators	6 Prevent Flooding	7 Drop and Rescue	8 Sort to Recycle
Life Sciences				3-LS1-1 3-LS3-1 3-LS3-2	2-LS2-2 4-LS1-1			
Earth and Space Sciences			4-ESS3-2			2-ESS2-1 3-ESS3-1 3-ESS2-1 4-ESS2-2	3-ESS3-1	2-PS1-1
Physical Sciences	3-PS2-1	3-PS2-2 4-PS3-1						
Engineering, Technology, and Applications of Science	3-5-ETS-1-2		3-5-ETS-4-3			3-5-ETS-1-2	3-5-ETS-1-2	K-2-ETS-1-2

Curriculum overview of Open Projects organized by NGSS disciplinary core ideas

	9 Predator and Prey	10 Animal Expression	11 Extreme Habitats	12 Space Exploration	13 Hazard Alarm	14 Cleaning the Ocean	15 Wildlife Crossing	16 Moving Materials
Life Sciences	3-LS4-3	3-LS4-2 4-PS4-3 4-LS1-2	2-LS4-1 3-LS3-2 3-LS4-1				2-LS4-1 3-LS4-4	
Earth and Space Sciences					3-ESS3-1			
Physical Sciences								2-PS1-3
Engineering, Technology, and Applications of Science				3-5-ETS1-2 3-5-ETS1-3	3-5-ETS1-2	3-5-ETS1-1 3-5-ETS1-2	K-2-ETS1-1 K-2-ETS1-3	K-2-ETS1-2

NGSS performance expectations: Grade 2

Life science

2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow.
2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.
2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats.

Physical science

2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.
2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.
2-PS1-3. Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a wholly new object.
2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

Earth and space science

2-ESS1-1. Use information from several sources to provide evidence that earth events can occur quickly or slowly.
2-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the physical shape of the land.
2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area.
2-ESS2-3. Obtain information to identify where water is found on earth and understand that it can be solid or liquid.

Engineering

K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change in order to define a simple problem that can be solved through the development of a new or improved object or tool.
K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a problem.
K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

NGSS performance expectations: Grade 3

Physical science

3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
3-PS2-2. Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
3-PS2-3. Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.
3-PS2-4. Define a simple design problem that can be solved by applying scientific ideas about magnets.

Earth and space science

3-ESS2-1. Represent data in tables and graphic displays to describe typical weather conditions expected during a particular season.
3-ESS2-2. Obtain and combine information to describe climates in different regions of the world.
3-ESS3-1. Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.

Engineering

3-5-ETS1-1. Define a simple design problem reflecting a need that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2. Generate and compare multiple, possible solutions to a problem based on how well each meets the criteria and constraints of the problem.
3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Life science

3-LS2-1. Construct an argument that some animals from groups that help members survive.
3-LS4-1. Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.
3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
3-LS4-4. Make a claim about the merit of a solution to a problem that is caused when the environment changes and the types of plants and animals that live there may also change.
3-LS1-1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.
3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variations of these traits exist in a group of similar organisms.
3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment.
3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.

NGSS performance expectations: Grade 4

Energy

4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.
4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.
4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
4-ESS3-1. Obtain and combine information to describe the fact that energy and fuels are derived from natural resources and that their use will affect the environment.

Structure, function, and information processing

4-PS4-2. Develop a model to describe how light reflecting from objects and entering the eye of a sighted person allows objects to be seen.
4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support their survival, growth, behavior, and reproduction.
4-LS1-2. Use a model to describe how animals receive different types of information through their senses, then process the information in their brain, and respond to the information in a range of different ways.

Waves: Waves and information

4-PS4-1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.
4-PS4-3. Generate and compare multiple solutions that use patterns for the transfer of information.

Earth's systems: Processes that shape the earth

4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.
4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.
4-ESS2-2. Analyze and interpret data from maps to describe patterns of earth's features.
4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural earth processes on humans.

Engineering

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2. Generate and compare possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Curriculum overview of Guided Projects organized by NGSS practices

	1 Pulling	2 Speed	3 Robust Structures	4 Frog's Metamor-phosis	5 Plants and Pollinators	6 Prevent Flooding	7 Drop and Rescue	8 Sort to Recycle
Practice 1: Ask questions and define problems	●	●	●	●	●	●	●	●
Practice 2: Develop and use models				●	●			
Practice 3: Plan and carry out investigations	●	●	●					
Practice 4: Analyze and interpret data	●	●	●					
Practice 5: Use mathematics and computational thinking	●	●	●	●	●	●	●	●
Practice 6: Construct explanations and design solutions						●	●	●
Practice 7: Engage in argument from evidence	●	●	●	●	●	●	●	●
Practice 8: Obtain, evaluate, and communicate information	●	●	●	●	●	●	●	●

Curriculum overview of Open Projects organized by NGSS practices

	9 Predator and Prey	10 Animal Expression	11 Extreme Habitats	12 Space Exploration	13 Hazard Alarm	14 Cleaning the Ocean	15 Wildlife Crossing	16 Moving Materials
Practice 1: Ask questions and define problems	●	●	●	●	●	●	●	●
Practice 2: Develop and use models	●	●			●			
Practice 3: Plan and carry out investigations								●
Practice 4: Analyze and interpret data								
Practice 5: Use mathematics and computational thinking	●	●	●	●	●	●	●	●
Practice 6: Construct explanations and design solutions			●	●		●	●	●
Practice 7: Engage in argument from evidence	●	●	●	●	●	●	●	●
Practice 8: Obtain, evaluate, and communicate information	●	●	●	●	●	●	●	●

Assess with WeDo 2.0

There are many ways you can monitor and assess your students' progress through a WeDo 2.0 project. Here are explicit assessment tools you could use, including:

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

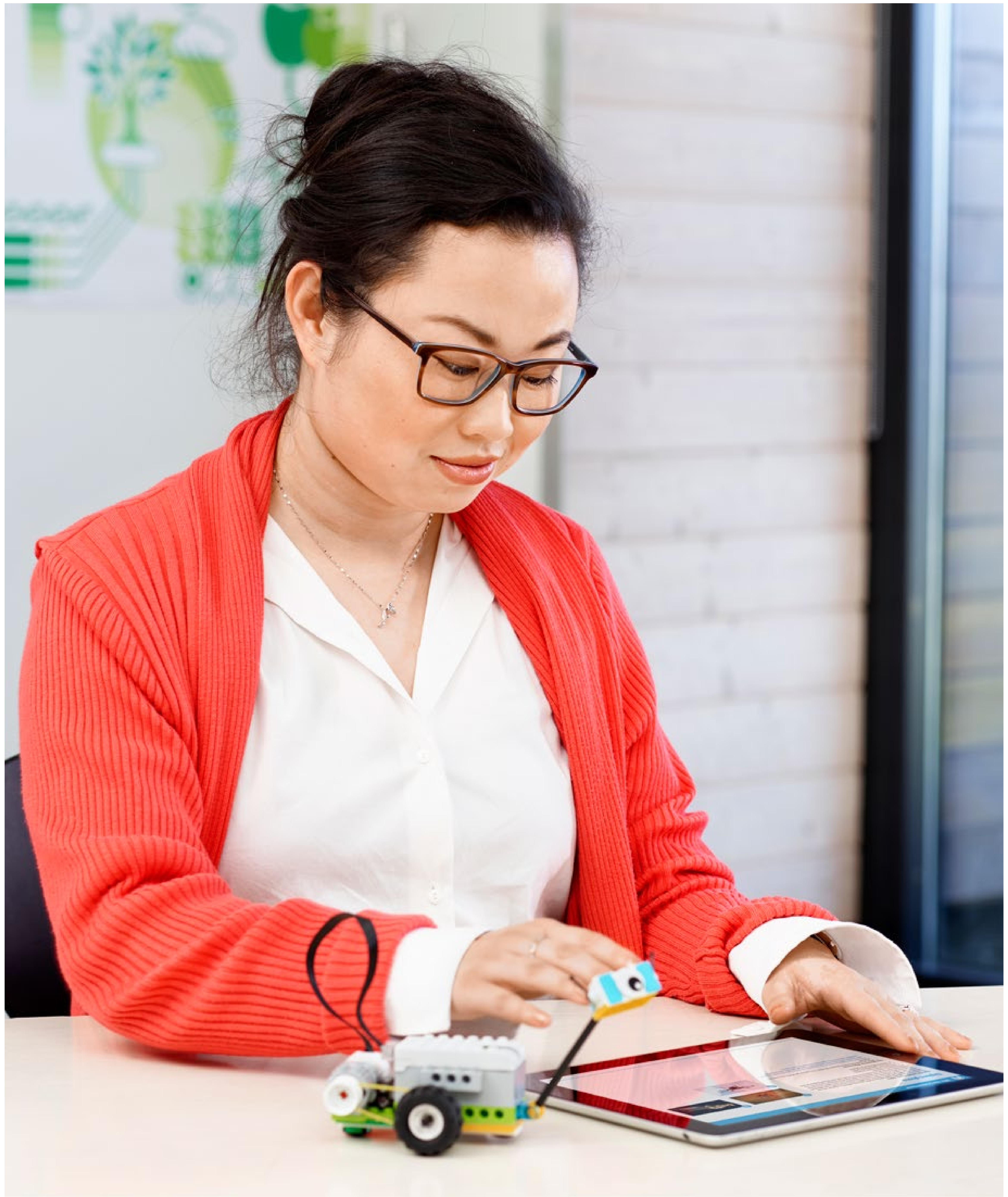
Teacher-led assessment

Developing students' science and engineering practices takes time and feedback. Just as in the design cycle, in which students should know that failure is part of the process, assessment should provide feedback to students 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 building upon and testing ideas.

Anecdotal record grid

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



Anecdotal record grid

Name: Class: Project:

Emerging	Developing	Proficient	Accomplished

Notes:

Teacher-led assessment

Observation rubrics

An example of rubrics has been provided for every Guided Project. For every student, or every team, you can use the Observation rubrics grid to:

- Evaluate student performance at each step of the process.
- Provide constructive feedback to help the student 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 student 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 student 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 student 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 student can take concepts and ideas to the next level, apply concepts to other situations, and synthesize, 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 students' progress.

Observation rubrics grid

Class:		Project																	
		NGSS			ELA														
	Students' names	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).

Student-led assessment

Documentation pages
Each project will ask students to create documents to summarize their work. To have a complete science report, it is essential that students:
- Document with various types of media.
- Document every step of the process.
- Take the time to organize and complete their document.

It is most likely that the first document your students will complete will not be as good as the next one:
- Allow them time and feedback to see where and how they can improve some parts of it.
- Have your students share the documents with each other. By communicating their scientific findings, students are engaged in the work of scientists.

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

Student 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 gave 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 upon for next time is:

Classroom Management

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

The secret for success resides in some key elements:

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

Prepare the material

Prepare the material

1. Install the software on computers or tablets.
2. Open each LEGO® Education WeDo 2.0 core set and sort the elements.
3. Attach the labels to the relevant compartments in the sorting tray.
4. You may want to identify and label the box, Smarthub, motor, and sensors with a number. That way, you can sign out a numbered kit to each student 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 strongly improve your classroom experience, it is recommended that you give a name to each Smarthub from the list in the Connection Center.

When you access the Connection Center:

1. Press on the button on the Smarthub.
2. Locate the Smarthub name in the list.
3. Long Press on the name you want 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.

By doing this, it will be easier for the students to connect with the right Smarthub.

Before you start a project

Classroom disposition

1. Organize a cabinet, a wheeled cart, or other space to store the sets between sessions.
2. If not already available in your classroom, prepare a box of measuring tools, including rulers or measuring tapes and paper, for collecting data and making charts.
3. Ensure there is enough space in the classroom for the project to happen.
4. When planning the projects, ensure enough time for the students to store their models or put the parts back in the box at the end of a session.

Teacher preparation

1. Spend some time exploring the bricks in the set, and decide on a few key expectations to determine what to do when the WeDo 2.0 materials are used in class.
2. Set aside an hour and try the Getting Started Project as if you were a student.
3. Read the overview and projects description in the "Open Projects" chapter and select the project you wish to do.
4. Review the planning of the project you have selected.

Now you are good to go!

Student 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 students working together.
- Have students work to their strengths in their groups.
- Make adjustments for challenging teams who are ready to develop new skills and improve further.
- Assign or have students determine specific roles for each team member.

Suggestion

Assign a role to each student so the team can foster collaboration and cooperation skills. Here are some roles you could use:

- Builder, brick picker
- Builder, brick assembler
- Programmer, creating the program strings
- Documenter, taking photos and videos
- Presenter, explaining the project
- Team captain

It is also a good idea to rotate roles, to let every student experience all components of the project, and, therefore, get the chance to develop a range of skills.

Getting Started Projects

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 link

NGSS performance expectation
3-PS2-1: Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

Common Core State Standards for English Language Arts
CCSS.ELA-Literacy.W.3.7: Conduct short research projects that build knowledge about a topic.
CCSS.ELA-Literacy.W.3.8: Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.
CCSS.ELA-Literacy.SL.3.1.a: Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.
CCSS.ELA-Literacy.SL.3.1.d: Explain your own ideas and comprehension in light of the discussion.

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 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 students to document their ideas for Max and Mia's questions using the Documentation tool.

Create phase: 45–60 min.

- Get students to build the first model from the provided building instructions.
- Let them program the model with the sample program.
- Allow time for them to test different combinations with different objects. Make sure to explain what is happening in terms of balanced and unbalanced forces.

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

- If you want, use this extra layer of the project for differentiation or for older students.

Share phase: 45 min. or more

- Make sure your students document the results of each test.
- Have students share what they notice based on the evidence gathered during their investigations.
- Ask them to predict the outcome resulting from the addition of weight.
- Have your students create their final presentations.
- Use different ways to let students share results.
- Have students present their project.

Suggestion

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

- 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.

Also, be specific on the way you would like them to present and document their findings (think about having a sharing session among teams, for example).

Investigate more

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

Also, to investigate more, ask your students to compare the strength of their robots by pairing them in a tug-of-war contest. Be ready for excitement!

Students' misconceptions

Students are likely to believe that if something is not moving, there are no forces acting on it. A good example to bring up is when you try to move a car with the hand brake on. Because the car does not move, students think no force is 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: 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 each other and rub together (example: a sled on snow)
Equilibrium
It is the condition in which all forces are balanced or canceled by equal opposing forces. In other words, it's when net force equals 0.

NGSS project 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 the student is actively involved in the discussion, asks and answers questions, and correctly uses the terms push and pull, forces, and friction.

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

Create phase

During the Create phase, make sure the student is working as part of a team, can make predictions about what should happen, and can use the information collected in the Explore phase.

1. The student is unable to work well on a team, make predictions about what should happen, or use information collected.
2. The student is able to work on a team and predict, with help, what might happen in the investigation.
3. The student is able to collect and use information with guidance, work on a team and contribute to the team discussions, make predictions, and collect information to use in a presentation to explain the content.
4. The student is able to work on a team, serve as the leader, and justify predictions to explain the forces of push and pull with information.

Share phase

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

1. The student is unable to engage in the discussion about the investigation, explain the model using the concept of force, or use the information to create a final project.
2. The student 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 student is able to engage in discussions about forces investigation and use the information gathered from testing to produce a final project.
4. The student is able to engage extensively in class discussions about the topic and use the information gathered to create a final project that includes additional required elements.

ELA project 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 the student can effectively explain his/her own ideas and comprehension related to the questions posed.

1. The student is unable to share his/her ideas related to the questions posed during the Explore phase.
2. The student is able, with prompting, to share his/her ideas related to the questions posed during the Explore phase.
3. The student adequately expresses his/her ideas related to the questions posed during the Explore phase.
4. The student 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 the student makes appropriate choices (i.e., screen capture, image, video, text) and follows the established expectations for documenting findings.

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

Share phase

During the Share phase, make sure the student uses evidence from his/her own findings during the investigation to justify his/her reasoning and adheres to established guidelines for presenting findings to the audience.

1. The student does not use evidence from his/her findings in connection with ideas shared during the presentation or does not follow established guidelines.
2. The student 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 student adequately provides evidence to justify his/her findings and follows established guidelines for presenting.
4. The student fully discusses his/her findings and thoroughly utilizes 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 students for this project.

Introductory video

It has been a long time since humans first tried to move large objects around. From ancient civilizations 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 force.
2. When an object starts to move, this means a force is greater in the direction of the movement.
3. On earth, friction has a role to play in this system.
4. On a surface with less friction, it will be easier to pull the same weight than if it is on a rough surface.

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




Explore phase

Questions for discussion

1. What are some ways you can make an object move?
   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.
3. Predict what will happen if the pull force is greater in one direction than the other.
   This answer should be based upon students' predictions in the beginning. This means that at this point, your students' answers can be incorrect. Following the lesson, students should be able to discuss the fact that the motion of the object will be in the direction of the greatest push or pull force.

Have your students collect their answers with text or pictures in the Documentation tool.

Other questions to explore

1. Can you infer the relationship among balanced forces and the objects' 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
Students will follow the building instructions to create a Pull-robot. This Pull-robot will pull some objects placed in his basket. This investigation can be done on various types of surfaces, like wood or carpet. Use the same surface during the entire project.

1. Build a Pull-robot.
The wobble module used in the 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 some sliding bricks to reduce friction.

2. Program the robot to pull.
This program will display numbers 3, 2, 1 before the motor turns on for 2 sec. at motor power 10.

Suggestion
Before your students start their investigation, have them change the parameters of the program so they fully understand it.

Create phase

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

1. Investigate by adding small objects and then heavy objects to the basket until the device stops moving.
It will take around 11 oz. (300 g) on a regular surface to stop the Pull-robot from moving. Students can use any object, but each one should not be too heavy, as the goal of this part is to reach equilibrium. At that point, students have balanced forces in front of them. You can use an arrow to symbolize the direction of the force.

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

2. Using the same amount of bricks, put the big tires on the model and test what happens.
Students will put tires on the Pull-robot. This will cause the friction among 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 the pull force is greater than the forces opposing it, objects should move.

3. Find the heaviest object you can pull with your model when fitted with the tires.
This final step will depend on the friction of the surface the students are working on.

Create phase

Use the "Investigate more" section of the student project as an optional extension. Keep in mind that these tasks extend upon those in the "Investigate" section and are designed for older or more advanced students.

Investigate more

The Pull-robot that students 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.

Let students explore new designs for a pull machine. Let them build their own model, do the same tests as with their original Pull-robot and compare the findings of the two investigations. For inspiration, look in the Design Library.

Collaboration suggestion

Find the strongest machine in the classroom

When you think your teams are done testing, organize a tug-of-war contest:

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

Share phase

Complete the document

Have students document their project in a range of ways (suggestions may include):

- Ask them to take a screen capture of their results.
- Get them to compare these images with real-life images.
- Invite students to record a video of them describing their project to the class.

Suggestions

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

Present results

At the end of this project, students should present the result of their investigation.

To enhance your students' presentation:

- Make sure students 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 explanation in context.
- Ask them to analyze their projects in terms of real-life situations in which they have observed balanced and unbalanced forces.
- Discuss the connection among their findings and these particular situations.

Pulling

One possible way of sharing

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

Open Projects overview

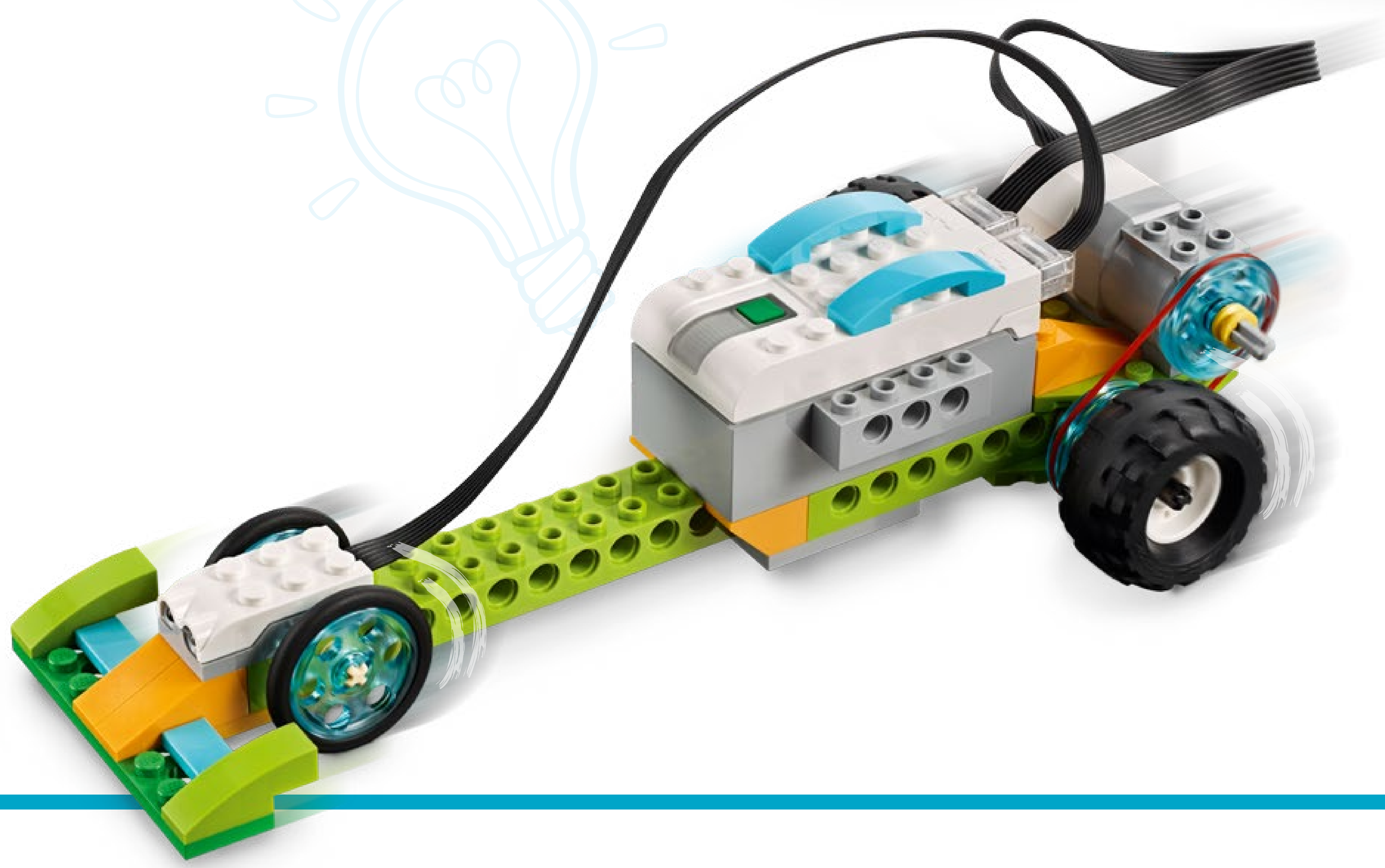







LEGO® Education WeDo 2.0 Toolbox

LEGO® Education WeDo 2.0



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