Introduction

LEGO® Education is pleased to bring you the “Simple Machines” curriculum pack.

Who is it for?

This material is designed for use by teachers of students in grades three through five, who wish to introduce their students to the following simple machines:

- Gears
- Wheels and Axles
- Levers
- Pulleys

Working in pairs, students of any academic background can build, learn and investigate using the models and activities included in this curriculum pack.

What is it for?

LEGO Education STEM solutions enable students to work as young scientists and engineers, helping them to investigate and understand the operation of simple and compound machines found in everyday life. The materials promote an enjoyable but challenging classroom environment in which students can develop skills such as creative problem-solving, communication of ideas, and teamwork. The activities lead students to make initial use of scientific method through observation, reasoning, prediction, and critical thinking.

The “Simple Machines” curriculum pack enables you to partially cover the following Crosscutting Concepts and overall Science and Engineering Practices, which have been set forth in the Next Generation Science Standards (NGSS).

Science and Engineering Practices:
- Asking questions (for science) and defining problems (for engineering)
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations (for science) and designing solutions (for engineering)
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

Crosscutting Concepts:
- Patterns
- Cause and effect: Mechanism and explanation
- Scale, proportion, and quantity
- Systems and system models
- Energy and matter: Flows, cycles, and conservation
- Structure and function
- Stability and change

What is in it?

The 9689 Brick Set

The set consists of four full-color sets of building instructions for the four simple machines, including building instructions for both the principle models and the main models, and 204 LEGO® elements, including an element (brick) separator. The main models and the principle models described in this curriculum pack can all be built from the elements in the set, though only one at a time.

9689

The 9689 Curriculum Pack

This curriculum pack contains teaching suggestions and materials that will enable teachers to make effective use of the Simple Machines Set in class. The curriculum pack is divided into the following sections:

Curriculum:

Please refer to the NGSS and Common Core State Standards grids in the 'Curriculum' section of this curriculum pack to see which of the main activities and problem-solving activities match your current teaching program.

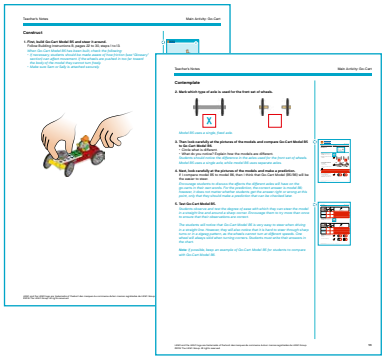
The four simple machine sections:

These sections provide information and activities for the four simple machines: gears, wheels and axles, levers, and pulleys. All four simple machine units are presented in the same way.

- An overview of the simple machine in focus is given. The overview starts with an introduction and with ideas for establishing the concept and providing the vocabulary relevant to the simple machine. A brief outline for using the principle models is also included.
- Following this is an overview of relevant images from Images for Classroom Use, a collection of photographs, pictures, drawings, and illustrations that can be used to support the teaching of simple machines. These images are intended to help students understand the links between the models they build and the real world. There is also an overview of the elements used for building both the principle models and the main models.
- Each unit then introduces the Teacher's Notes and student worksheets for the principle models, the related main model, and the problem-solving activity.

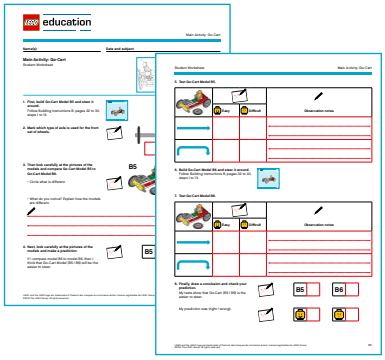
Teacher's Notes
There are detailed Teacher's Notes for each simple machine section. In some cases, additional materials will be necessary for the main activities and investigations; these are listed. The Teacher's Notes indicate key learning areas, give suggestions for carrying out each main activity, provide hints, questions, and vocabulary specific to the main activity, and suggest further ideas for investigation. The answers to questions asked on the Student Worksheets, together with comments to the teacher, are written in blue italics in the Teacher's Notes.

In the Teacher's Notes you will find eight main activities, each of which includes including student worksheets, assessment tools, 'Connect' stories, and questions and ideas for for further investigation. You will also find four problem-solving activities, which also include assessment tools and 'Connect' stories, as well as a design brief and a possible design solution – all ready for you to introduce to your students.



Main Activities and Student Worksheets
The student worksheets help students to work individually, in pairs, or in groups to apply the knowledge they have acquired about the simple machine concept through building or discussion activities. The student worksheets can be copied as required. Writing is kept to a minimum on the student worksheets for the principle models—students only need to mark choices, draw lines to label illustrations, or write numbers.

On the student worksheets for the main models students will be challenged to predict an outcome, which they will then investigate, and finally they will document their findings.



Text on the student worksheets is kept to a minimum, but nevertheless early readers may need help in understanding the written instructions. Icons have been included on the student worksheets to help students through the main activity in focus; these symbolize, for example, that something must be marked or drawn, circled, or joined, or that students are asked to write in a number.

Problem-Solving Activities
These problem-solving activities are intended to encourage students to apply the knowledge they have gained from both the different principle models and/or the main model concerning the simple machine in focus. The suggested problem-solving model solution that is included is only meant as a guiding principle to solving the problem posed.

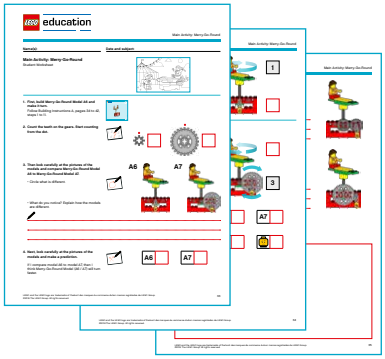
If possible, take a picture of each of the students' model solutions and have the students explain how they have solved the problem. Keep the pictures as inspirational material for future problem solvers.

Assessments

Assessment materials are provided for all four of the main activities and the four problem-solving activities. These materials define clear learning goals before the students start each activity and motivate the students to challenge themselves throughout the learning process. You can also use these materials to assess your students' development in different learning areas.

Student Worksheets

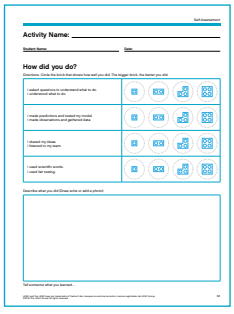
The student worksheets should be used to document each student's work and to support them throughout each of the main activities. These worksheets are an easy-to-use tool for assessing each student's level and achievement during the activities. They can also comprise a valuable part of the each student's logbook or portfolio.



Student Self-Assessment Tools

There are two generic student self-assessment rubrics. One has been developed for use during the main activities, and the other is intended for use with the problem-solving activities. These rubrics help students to reflect on and evaluate their work during each lesson.

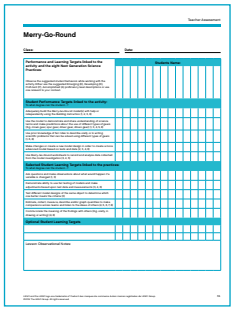
Using these rubrics, students assess themselves according to the 'Four Bricks Scale' in which the biggest brick represents the highest rating. In certain situations, you might also consider asking your students to assess themselves using only two of the four bricks.



Teacher Assessment Tools

The Observation Checklists are linked directly to each of the main activities and the problem-solving activities. You can use these checklists to assess the science and engineering practices of your students individually, in pairs, or in groups.

You either can use the Emerging, Developing, Proficient, or Accomplished proficiency level descriptions described on the next page, or use other assessment criteria that are relevant to your school context.



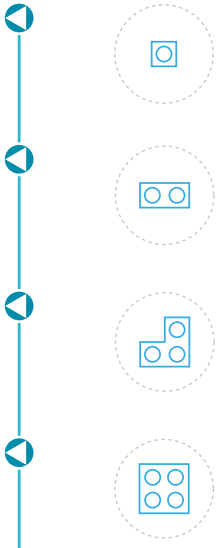
Emerging
The student is at the beginning stages of development in terms of content knowledge, ability to understand and apply content, and/or demonstration of coherent thoughts about a given topic.

Developing
The student is able to present basic knowledge only (e.g., vocabulary), and cannot yet apply content knowledge or demonstrate comprehension of the concepts being presented.

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

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.

Where can I find the assessment materials?
You can find the assessment materials in the Teacher's Notes for each of the main activities and problem-solving activities.



Classroom Management Tips

For Your First LEGO® Education Activity, and Beyond

1. Before Class
- Download the curriculum pack from the URL that is printed on the lid of each LEGO® brick set.
- Open one of the sets, sort the bricks, and get to know the bricks by working with one of the principle models, followed by a main activity. Use the relevant student worksheets and assessment tools.

2. During Class
- At the beginning of the first lesson, allow the students some time to get to know the LEGO brick set.
- Use a jar to collect stray pieces.
- Make adjustments in order to challenge the students who are ready to improve and develop new skills.
- Label the boxes so that you can recognize which box belongs to which student(s).
- Plan to stop the lesson with enough time to allow the students to tidy up.

3. After Class
- If you did not finish the activity, store the LEGO sets and the models so that they are ready for the next lesson.
- Evaluate the lesson.

How much time is needed?
There are many ways to use the Simple Machines Set in your classroom, and many different ways to plan your class schedule. Activities can be completed by individuals or by small teams or groups, depending upon the number of sets that are available to your class.

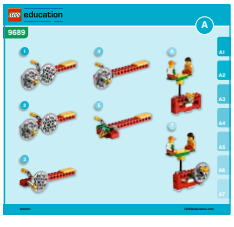
If you choose to introduce the principle models of one simple machine, 2-3 of the models can be built, investigated, and explored, and the parts put away again, within a single 45-minute lesson if the students are already experienced LEGO builders.

Hint
We suggest students work together in pairs, sharing a set between them.

However, if you choose to continue with a main activity, then at least two more class periods will be needed, depending on the time spent on discussion, the building skills of your students, and the time you allow for experimentation. A double lesson is ideal to be able to explore, build, and investigate in depth most of the (optional) extension ideas built into the main activity, and especially for the students to make any creative variations of their own.

In the case of the problem-solving activities, students should be able to tackle the challenge within a sequence of two lessons.

How do I organize the building instructions?
For easy classroom management we suggest storing the building instructions in binders so that they are close at hand and ready to use at the beginning of each lesson.



What's needed in my classroom?
Tables may be pushed aside to let models roll across a smooth floor and boxes may be needed for a ramp.

Students need to be able to construct in pairs facing each other or side-by-side. It is also an advantage to have a cupboard or shelves where you can store the sets lying flat with any unfinished models on top of them.

LEGO® Education's 4C approach

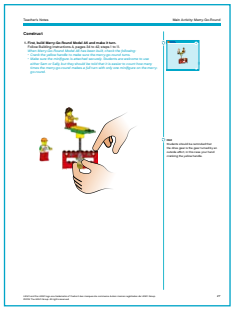
The main activities in the "Simple Machines" curriculum pack follow LEGO® Education's 4C approach: Connect, Construct, Contemplate, and Continue. This enables you to progress naturally through the main activities.

Connect

The Connect story places the characters Sam and Sally in real-life surroundings, linking an object/item from the real world that most students will recognize to the simple machine concept under consideration. This real-world object will closely resemble the LEGO models students will work with and build. In the Connect passage the language is more child-oriented, as it is intended for you to read aloud.

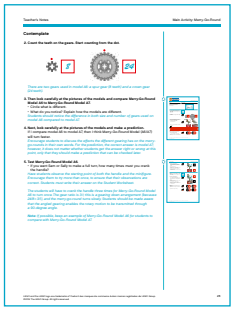
Construct

Using the building instructions, students build models covering the concepts related to the simple machine in focus. Tips are provided for testing and for making sure that each model functions as intended.



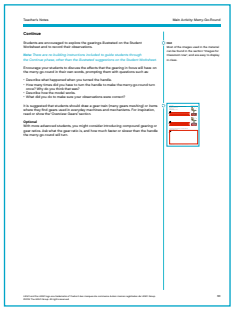
Contemplate

This stage involves students investigating the models they have constructed. Through these investigations, students will learn to observe and compare results from tests that they make, and to report on their observations. They will be encouraged to describe the outcomes of their investigations. Questions are included that are designed to further deepen students' experience and understanding of the investigation. This phase provides the opportunity for you to begin evaluating learning outcomes and the progress of individual students, especially by looking at their worksheets and talking to them about their reflections and answers.



Continue

Continued learning is always more enjoyable and creative when it is sufficiently challenging. Extension ideas are therefore provided to encourage the students to change or add features to their models and to investigate further—always with the key learning area in mind. This phase encourages students to experiment and to apply their knowledge creatively.



What Are Simple Machines?

We use simple machines every day—when we open a door, turn on a faucet, open a tin can, or ride a bike. Simple machines make it easy for us to do work. A force (a push or a pull effort) makes something (a mass or load) move a distance.

Simple machines have only one part to do the work and they have very few or even no moving parts. A lever is an example of such a simple machine. You can use a lever, for example a crowbar, to move a large load with a smaller effort than you would need if you did not have a machine to help you. The force applied to the lever makes the load move, but the effort needed is less than if the force was applied directly to the load. The work is thus easier to do.

The terms *load* and *effort* are used in describing how simple machines work. The load is the object that is moved, e.g., a box. The effort is the force used to do the work. In the situation illustrated, the effort is the force that someone will apply to the moving dolly to move (or lift) the load (the box).

Simple machines have very few parts; compound machines are made up of two or more simple machines. A moving dolly is one example of a compound machine. It has combined two simple machines. The handles are levers that help lift the load, and the wheel and axle help move the load forward easily. The same principle applies to a wheelbarrow.

Machines help us do many things: they help us lift, pull, split, fasten, cut, carry, mix, etc. All machines are made up of simple machines. More complicated machines (compound machines) are made up of a number of simple machines that function together to help do the work. Gears are sometimes categorized as compound machines, but in this material we have regarded them as simple machines.

Did you know?

A crowbar is a simple machine called a lever.

Did you know?

A wheelbarrow is a compound machine.