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Introduction

LEGO Education is pleased to bring you the 9656 Early Simple Machines set that provides ideal opportunities for young children to develop an understanding of science concepts through investigation and hands-on activities.

Who is it for?
The material is designed for use by teachers of grades K-2. No prior science training is required – only creativity and enthusiasm.

Working alone or in pairs, children of all abilities from 5 years and up can build, enjoy and learn from the 8 models and activities.

What is it for?
LEGO Education Science and Technology solutions enable young children to behave as young scientists, by providing them with tools and tasks that promote scientific enquiry. Using our solutions, children are encouraged to pose 'What if...?' questions. They make predictions, test the behaviour of their models, and then record and present their findings.

What is it?
The 9656 Early Simple Machines set comes in a practical and durable storage box. Inside the storage box you will find the 101 bricks, 8 building instructions numbered 1-8, and an element survey that displays the set’s unique mix of LEGO® DUPLO® bricks. Exclusive for this product is a plastic punch-out sheet with eyes, sails, scales and wings. The activity pack contains 8 main activities and 4 problem-solving activities.

The 9656 Early Simple Machines set is designed for easy use, easy classroom management, and lots of fun!
Introduction

How to use it?

Building instructions
The 8 building instructions support the children’s building process step-by-step with clear instructions on how to build each model. To interpret the 2D building instructions and turn them into a 3D model can be a demanding task and some children may need your help and encouragement.

We recommend children try to build the exact models from the cards to ensure that the model will perform as intended for the activity. The building instructions will support the development of technical knowledge and understanding.

Teacher’s Notes
In the Teacher’s Notes you will find 8 activities, including connect stories, and questions and further ideas for investigating – all ready for you to introduce to your children.

Every activity is carefully linked to the overall objectives of the Science, and Design and Technology curriculum. At the start of each activity, we list outcomes unique to that particular activity. The outcomes that are common to all activities are listed in the section called ‘What are the curriculum highlights’.

We also list the specific vocabulary focus and the additional materials needed for each activity.

The lessons follow LEGO Education’s well-tested methodology – the 4C approach: Connect, Construct, Contemplate and Continue. This enables you to progress naturally through the activities.

Connect
A short story introduces Sam and Sara and provides the children with the opportunity to help identify the problem and investigate how best to come up with a solution.

You may choose to read the story or retell it in your own words. Please also draw on your own experience and current events from both near and far to set the scene for the children.

Construct
Using the building instructions, children build models embodying the concepts related to the key learning areas. Tips are provided for testing and making sure each model functions as intended.
Introduction

Contemplate
This involves children carrying out scientific investigations with what they have constructed.
Through their investigations the children will learn to identify and compare test results. The activities will introduce them to the concepts of measurement, speed, balance, mechanical movement, structures, force and energy. They will be encouraged to describe the outcomes of their investigations. You will find all test results presented in the same chart as in the worksheet.
It may be a good idea to carry out the tests several times as test results may vary.
A series of questions are included to further deepen the children’s experience and understanding of the investigation.

This phase also includes the possibility for you to start evaluating the learning and the progress of the individual child.

Continue
Ideas are provided for further investigations drawing on the children's creativity and previous experiences. The children will experiment, design additions or changes to their models, and invent related games.

Worksheets for the children
The illustrations in the worksheets will guide the children to use and explore their models without too much assistance. The children will predict, test and describe outcomes using words presented in the worksheet. These words will encourage the children to use the correct vocabulary to describe concepts such as balance, direction, distance, speed and time.

The worksheets can also help you in assessing the individual child's level and achievement. They also form a valuable part of the children's log books.

Problem-solving activities
Each of the 4 problem-solving activities starts off with a short story supported by an illustration featuring the problem that needs solving. To solve the problem a design brief states a number of criteria the children have to incorporate into their model solution.
The ‘Fair testing and fun’ questions and suggested answers help focus the models to meet the design brief criteria and support the test situation. A suggested model solution helps you, the teacher, help the children. It is not the one and only solution to the problem! Children must always be encouraged to build their own solution to a given problem.

If possible, take a picture of the children's model solution and have them explain how they have solved the problem. Keep the picture as inspirational material for future problem solvers.
How much time do I need?
Each activity can be carried out within a lesson. A double lesson
is ideal for more in-depth investigations of the key learning area
and to allow children to make creative variations of their own.
For the open-ended problem-solving activities children may need
more time to build and explain their models.

Enjoy!
LEGO Education
What are the curriculum highlights?

The process of children actively building, exploring, investigating, enquiring and communicating develops a wide range of skills, knowledge and understanding. For more details see the curriculum grid on the next page. Here is an overview:

Science
Investigating energy, force, speed, the effect of friction, reading scales, fair testing, predicting and measuring, collecting data, and describing outcomes.

Design and Technology
Investigating gears, wheels, axles, levers and pulleys; matching solutions to needs, choosing appropriate materials; designing, making and testing; using instructions in 2 dimensions to create 3-dimensional models; working cooperatively in a team; and evaluating.

Mathematics
Both non-standard and standard measurement of distance, time, weight (mass) and reading scales. Counting, calculating, shape and problem-solving.
## Key Science Curriculum
Scientific enquiry including investigating the effect of variables on the performance of simple machines, predicting and estimating the performance of simple machines. Careful observation, describing and presenting results, plus:

## Key D&T Curriculum
Working with different mechanical and structural components to develop specific knowledge and understanding. Evaluating products against technical criteria; developing design skills, plus:

<table>
<thead>
<tr>
<th>#</th>
<th>Project</th>
<th>Science Topics</th>
<th>Design Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pinwheel</td>
<td>Investigating wind power, Investigating area</td>
<td>Properties of materials, Designing</td>
</tr>
<tr>
<td>2</td>
<td>Spinning Top</td>
<td>Investigating gearing, Investigating rotation</td>
<td>Designing mechanical toys, Structures and stability</td>
</tr>
<tr>
<td>3</td>
<td>Seesaw</td>
<td>Investigating balance, Investigating weight</td>
<td>Levers, Designing mechanical toys</td>
</tr>
<tr>
<td>4</td>
<td>Raft</td>
<td>Investigating wind power, Investigating area</td>
<td>Properties of materials</td>
</tr>
<tr>
<td>5</td>
<td>Car Launcher</td>
<td>Investigating pushes, Investigating friction, Investigating inclined plane</td>
<td>Mechanisms: wheels and axles</td>
</tr>
<tr>
<td>6</td>
<td>Measuring Car</td>
<td>Reading scales to measure distance, Investigating forces</td>
<td>Mechanisms: worm gear, Mechanisms: wheels and axles</td>
</tr>
<tr>
<td>7</td>
<td>Ice Hockey Player</td>
<td>Investigating gearing, Investigating forces</td>
<td>Levers, Designing mechanical toys</td>
</tr>
<tr>
<td>8</td>
<td>Sam's New Dog</td>
<td>Investigating pulley drive and gearing</td>
<td>Designing mechanical toys, Mechanisms: pulley wheels</td>
</tr>
</tbody>
</table>
# Early Science & Technology Learning Grid

<table>
<thead>
<tr>
<th>Science</th>
<th>9656</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientific inquiry</td>
<td>Pinwheel</td>
</tr>
<tr>
<td>Conduct simple investigation</td>
<td>Spinning Tops</td>
</tr>
<tr>
<td>Using simple equipment and tools to gather information</td>
<td>Raft</td>
</tr>
<tr>
<td>Communicate investigations and explanations</td>
<td>Car Launcher</td>
</tr>
<tr>
<td>Fair testing</td>
<td>Measuring Car</td>
</tr>
<tr>
<td>Properties of materials</td>
<td>Ice Hockey Player</td>
</tr>
<tr>
<td>Describing position and direction</td>
<td>Crossing Crocodile River</td>
</tr>
<tr>
<td>Describing way of movement</td>
<td>Hot Day</td>
</tr>
<tr>
<td>Pushes and pulls</td>
<td>Swing</td>
</tr>
<tr>
<td>Observations</td>
<td>Scarecrow</td>
</tr>
<tr>
<td>Reasoning</td>
<td></td>
</tr>
<tr>
<td>Sharing findings</td>
<td></td>
</tr>
<tr>
<td>Teamwork</td>
<td></td>
</tr>
</tbody>
</table>

# Technology

<table>
<thead>
<tr>
<th>Technology</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventing and turning ideas into action</td>
<td></td>
</tr>
<tr>
<td>Solve problems through design</td>
<td></td>
</tr>
<tr>
<td>Constructing and testing</td>
<td></td>
</tr>
<tr>
<td>Making improvements</td>
<td></td>
</tr>
<tr>
<td>Discover how things work</td>
<td></td>
</tr>
<tr>
<td>Energy comes in many different forms</td>
<td></td>
</tr>
<tr>
<td>Transportation</td>
<td></td>
</tr>
<tr>
<td>Vehicles</td>
<td></td>
</tr>
<tr>
<td>Structures</td>
<td></td>
</tr>
<tr>
<td>Purposeful use of tools</td>
<td></td>
</tr>
<tr>
<td>Expressing ideas to other</td>
<td></td>
</tr>
</tbody>
</table>

# Engineering

<table>
<thead>
<tr>
<th>Engineering</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifying need or problem</td>
<td></td>
</tr>
<tr>
<td>Modeling in two and three dimensions</td>
<td></td>
</tr>
<tr>
<td>Test and evaluate</td>
<td></td>
</tr>
<tr>
<td>Redesigning</td>
<td></td>
</tr>
<tr>
<td>Meeting design constraints</td>
<td></td>
</tr>
</tbody>
</table>

# Math

<table>
<thead>
<tr>
<th>Math</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole number relationships</td>
<td></td>
</tr>
<tr>
<td>Using standard and non-standard units</td>
<td></td>
</tr>
<tr>
<td>Adds and subtracts whole numbers</td>
<td></td>
</tr>
<tr>
<td>Estimating</td>
<td></td>
</tr>
<tr>
<td>Counting</td>
<td></td>
</tr>
<tr>
<td>Timing</td>
<td></td>
</tr>
<tr>
<td>Measuring</td>
<td></td>
</tr>
<tr>
<td>Checking estimates against measurements</td>
<td></td>
</tr>
<tr>
<td>Common language of spatial sense</td>
<td></td>
</tr>
<tr>
<td>Organizing lists or tables of information</td>
<td></td>
</tr>
<tr>
<td>Organizing and displaying data</td>
<td></td>
</tr>
</tbody>
</table>
1. Pinwheel
2. Spinning Tops

Science
• Energy
• Fair testing
• Measuring
• Movement

Design and Technology
• Combining materials
• Evaluating
• Game design
• Gears

Vocabulary
• Gearing up
• Speed
• Spin
• Stable
• Unstable

Other materials required
• Colored pencils or markers
• Paper
• Scissors
• Several square yards of smooth, flat floor space
• Timer or clock
Connect

One day at the park Sam and Sara saw some other children playing with spinning tops. Their tops spun for a long time before falling over. Great fun! Sam and Sara thought about how to make some tops themselves and in no time they were spinning their own tops. But their tops didn’t spin for long and soon their fingers started to hurt from all the spinning. They needed a device that could make the spinning tops spin faster and better!

Can you help Sam and Sara build a device that can make the spinning tops spin? Let’s find out!
Construct

Build the Launcher and the Spinning Top using building instruction no. 2

- Hold the launcher and place the gear end of the launcher over the blue gear axle
- The blue gear should mesh with the big yellow gear and spin as you turn the handle

- To launch the top, turn the handle and lift the launcher straight upwards

Tip:
Launching tops requires good coordination skills! Try it yourself.

Idea:
It may be a good idea to let younger children play with the top and launcher before embarking on serious testing.
Contemplate

Long or longer?

The top can work in two ways. The yellow gear of the launcher can mesh with both the blue and the red gears of the top. Find out which top will spin longest.

First predict which top will spin for a long time and which top will spin even longer. Write down your predictions using the words on the worksheet.

Next, test how long the tops will spin first using the blue 8-tooth gear and then the red 24-tooth gear. Write down your findings using the words on the worksheet.

Have the children reflect on their tests by asking questions such as:

- What did you predict would happen and why?
- Describe what happened.
- Was this a fair test? Did you turn the handle in tests A and B at the same speed? Did you test all the tops on the same surface?
- Describe how the model works.

Tip:
To accurately time how long the tops spin, use a standard measuring timer.

Did you know?
The blue gear has 8 teeth, the red has 24 teeth and the yellow gear has 40 teeth!
Can you design your own spinning top?

Design and make your own spinning tops.

Consider which materials and shapes would be best.
Create amazing optical effects and tops for all sorts of games.
On the worksheet, draw your best spinning top design.
Spinning Tops

Name(s): ____________________________________________

Long or longer?

<table>
<thead>
<tr>
<th></th>
<th>My prediction</th>
<th>What I discovered</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A

Long

B

Longer
Can you design your own spinning top?

Draw your best spinning top design
3. Seesaw
## Glossary

We have tried to make the glossary as understandable and practical as possible without getting stuck in difficult equations and long explanations.

<table>
<thead>
<tr>
<th>Letter</th>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Angle</td>
<td>The space between two lines or planes that intersect; the inclination of one line to another; measured in degrees or radians.</td>
</tr>
<tr>
<td>A</td>
<td>Area</td>
<td>Area is a quantity expressing the size of a region of space.</td>
</tr>
<tr>
<td>A</td>
<td>Axle</td>
<td>A rod through the center of a wheel, or through different parts of a cam. It transmits force, via a transmission device, from an engine to the wheel in a car or from your arm via the wheel to the axle if you are winding up a bucket on a rope.</td>
</tr>
<tr>
<td>B</td>
<td>Balanced force</td>
<td>An object is balanced and does not move when all the forces acting on it are equal and opposite.</td>
</tr>
<tr>
<td>B</td>
<td>Belt</td>
<td>A continuous band stretched around two pulley wheels so one can turn the other. It is usually designed to slip if the follower pulley suddenly stops turning.</td>
</tr>
<tr>
<td>B</td>
<td>Buoyancy</td>
<td>Buoyancy is an upward force on an object enabling it to float. If the buoyancy exceeds the weight, then the object floats; if the weight exceeds the buoyancy, the object sinks.</td>
</tr>
<tr>
<td>D</td>
<td>Driver</td>
<td>The part of a machine, usually a gear, pulley, lever, crank or axle, where the force first comes into the machine.</td>
</tr>
<tr>
<td>E</td>
<td>Efficiency</td>
<td>A measure of how much of the force that goes into a machine comes out as useful work. Friction often wastes a lot of energy, thus reducing the efficiency of a machine.</td>
</tr>
<tr>
<td>E</td>
<td>Energy</td>
<td>The capacity to do work. You get energy from food. The Ice Hockey Player and Spinning Top get their energy from you.</td>
</tr>
<tr>
<td>F</td>
<td>Fair testing</td>
<td>Measuring the performance of a machine by comparing its performance under different conditions.</td>
</tr>
<tr>
<td>F</td>
<td>Follower</td>
<td>Usually a gear, pulley or lever driven by another one. It can also be a lever driven by a cam.</td>
</tr>
<tr>
<td>F</td>
<td>Force</td>
<td>A push or a pull.</td>
</tr>
<tr>
<td>F</td>
<td>Friction</td>
<td>The resistance met when one surface is sliding over another, e.g. when an axle is turning in a hole or when you rub your hands together.</td>
</tr>
<tr>
<td>F</td>
<td>Fulcrum</td>
<td>See pivot.</td>
</tr>
</tbody>
</table>
### Glossary

<table>
<thead>
<tr>
<th><strong>G</strong></th>
<th><strong>Gear</strong></th>
<th>A gear is a toothed wheel. A way to classify gears is by the number of teeth they have, e.g. an 8-tooth gear or a 40-tooth gear. Gears can be used to transfer force, increase or reduce speed, and change the direction of rotary motion.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Gear, crown</strong></td>
<td>Has teeth that stick out on one side, making it look like a crown. Mesh it with a second crown gear or a regular spur gear to turn the angle of motion through 90°.</td>
</tr>
<tr>
<td></td>
<td><strong>Gear, worm</strong></td>
<td>A gear with one spiral tooth resembling a screw. Mesh it with another gear to deliver large forces very slowly.</td>
</tr>
<tr>
<td></td>
<td><strong>Gearing down</strong></td>
<td>A small gear turns a larger gear and amplifies the force from the effort. But the follower turns more slowly.</td>
</tr>
<tr>
<td></td>
<td><strong>Gearing up</strong></td>
<td>A large gear turns a small gear and reduces the force from the effort. But the follower turns more quickly.</td>
</tr>
<tr>
<td><strong>L</strong></td>
<td><strong>Lever</strong></td>
<td>A lever is a device that makes work easier. It is one of the most widely used of the simple machines. Seesaws, scissors, nail clippers, tongs, pianos, parking meters, pliers and wheelbarrows all use levers to operate.</td>
</tr>
<tr>
<td><strong>M</strong></td>
<td><strong>Mass</strong></td>
<td>Mass is the quantity of matter in an object. On Earth, gravitational force pulling your matter makes you weigh say 50 lbs. In orbit, you feel weightless – but you still have a mass of 50 lbs. Often confused with weight.</td>
</tr>
<tr>
<td><strong>P</strong></td>
<td><strong>Pivot</strong></td>
<td>In a seesaw, the pivot point is in the middle. The pivot point does not always have to be in the middle of the lever. In some types or classes of levers, the pivot point may be at one end, such as in a wheelbarrow.</td>
</tr>
<tr>
<td></td>
<td><strong>Power</strong></td>
<td>The strength and speed at which a machine does work.</td>
</tr>
<tr>
<td></td>
<td><strong>Pulley</strong></td>
<td>A pulley is a simple machine which usually consists of a grooved wheel round which a rope, cable or chain is placed. A pulley is used to transfer force, alter speed or to turn another wheel.</td>
</tr>
<tr>
<td><strong>R</strong></td>
<td><strong>Resetting</strong></td>
<td>Turning a pointer on a scale back to zero again. For instance, resetting the Measuring Car’s scale.</td>
</tr>
<tr>
<td></td>
<td><strong>Rotation</strong></td>
<td>Turning or moving about a central fixed point. Rotation is the movement of a body in such a way that the distance between a certain fixed point and any given point of that body remains constant.</td>
</tr>
<tr>
<td><strong>S</strong></td>
<td><strong>Speed</strong></td>
<td>Speed describes the change in position in a certain period of time.</td>
</tr>
<tr>
<td><strong>U</strong></td>
<td><strong>Unbalanced force</strong></td>
<td>A force that is not opposed by an equal and opposite force. An object feeling an unbalanced force must begin to move in some way; for instance the unbalanced seesaw.</td>
</tr>
<tr>
<td><strong>W</strong></td>
<td><strong>Weight</strong></td>
<td>See Mass.</td>
</tr>
</tbody>
</table>
### LEGO® Element Survey

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Item Description</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1x</td>
<td>LEGO® DUPLO® girl</td>
<td>4271511</td>
</tr>
<tr>
<td>4x</td>
<td>Brick with arch, 2x3, red</td>
<td>230221</td>
</tr>
<tr>
<td>3x</td>
<td>Brick, 2x2, yellow</td>
<td>343724</td>
</tr>
<tr>
<td>2x</td>
<td>Brick, 2x2, red</td>
<td>343721</td>
</tr>
<tr>
<td>3x</td>
<td>Brick, 2x2, green</td>
<td>343728</td>
</tr>
<tr>
<td>2x</td>
<td>Brick, 2x8, red</td>
<td>419921</td>
</tr>
<tr>
<td>2x</td>
<td>Brick with holes, 2x10, red</td>
<td>75350</td>
</tr>
<tr>
<td>1x</td>
<td>LEGO® DUPLO® boy</td>
<td>4502103</td>
</tr>
<tr>
<td>4x</td>
<td>Brick with holes, 2x4, red</td>
<td>75349</td>
</tr>
<tr>
<td>5x</td>
<td>Brick, 2x4, yellow</td>
<td>301124</td>
</tr>
<tr>
<td></td>
<td>Brick, 2x4, yellow</td>
<td>301121</td>
</tr>
<tr>
<td>3x</td>
<td>Brick, 2x4, green</td>
<td>301128</td>
</tr>
<tr>
<td>2x</td>
<td>Plate, 2x4, yellow</td>
<td>4160152</td>
</tr>
<tr>
<td>2x</td>
<td>Bridge element, 2x4x2, yellow</td>
<td>4221004</td>
</tr>
<tr>
<td>2x</td>
<td>Beam, 7-module, yellow</td>
<td>652424</td>
</tr>
<tr>
<td>4x</td>
<td>Beam, 11-module, yellow</td>
<td>652524</td>
</tr>
<tr>
<td>2x</td>
<td>String with hook, yellow</td>
<td>75536</td>
</tr>
</tbody>
</table>
LEGO® Element Survey

2x Gear, 24-tooth crown, blue 4501054

2x Gear, 24-tooth crown, red 652921

2x Gear, 40-tooth crown, yellow 4501044

15x Hub / pulley wheel, yellow 4271570

1x Worm gear, blue 4271573

4x Axle with gear, 5-module, 8-tooth, blue 652323

2x Axle with gear, 8-module, 8-tooth, blue 4113296

2x Axle with gear, 8-module, 8-tooth, blue 4113296

1x Gear block, transparent 4113297

6x Connector peg, handle, yellow 4493718

7x Axle, 6-module, grey 4211534

2x Belt, blue 71059

5x Axle, 8-module, green 652128

1x Plate, 6x12, green 4281607

1x Plastic forms sheet, green 4520270

4x Tyre, black 4514411

6x Connector peg, handle, yellow 4493718

10x Hub / pulley wheel, yellow 4271570

5x Axle, 8-module, green 652128

1x Gear block, transparent 4113297

4x Axle with gear, 5-module, 8-tooth, blue 652323

2x Axle with gear, 8-module, 8-tooth, blue 4113296

2x Axle with gear, 8-module, 8-tooth, blue 4113296

1x Gear block, transparent 4113297
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