Introduction

LEGO® Education is pleased to bring you the 'Advancing with Simple & Powered Machines', a curriculum pack filled with motivating and learning rich investigations and explorations into the world of machines and mechanisms.

Who is it for?

The material is designed for middle school grades, although it can be relevant both prior to and after middle school. Working in pairs, students can build, investigate and learn from the models and activities.

Please refer to the Next Generation Science Standards (NGSS) and the Common Core State Standards grids in the 'Curriculum' section of this curriculum pack to see which activities match your current teaching program.

What is it for?

The curriculum pack is for teachers who want to promote a challenging classroom environment and actively engage students in inquiry, reasoning and critical thinking. It is designed to apply the students' prior learning in science, technology, and mathematics together with engineering skills, creativity and intuition to actively create new knowledge.

The 'Advancing with Simple & Powered 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 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?

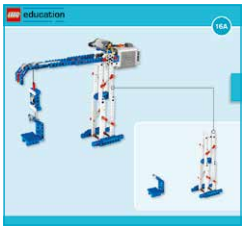
The 9686 Brick Set

The 'Advancing with Simple & Powered Machines' curriculum pack is designed to be used with the Simple & Powered Machines Set (9686). This set consists of 396 elements, including a motor, and full color Building Instructions booklets for fourteen activity models and thirty-seven principle models. The curriculum pack includes building instructions for four additional activity models. Some of the building instructions booklets can also be used with other LEGO® Education curriculum packs.

Included is a sorting tray and accompanying element overview showing all the different elements in the building set. Everything is stored in a sturdy blue storage box with a transparent lid.

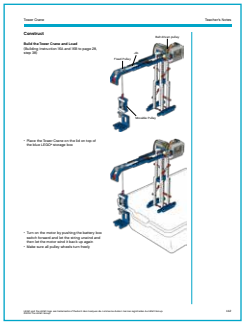
Building Instructions Booklets

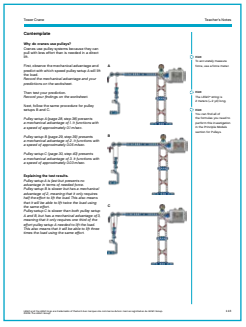
For each of the activity models there are two building instructions, a booklet A and B. The building instructions are designed for two separate building processes, each building only half a model. By combining the two sub-assemblies, students work together to create a single, sophisticated and powerful model.



Teacher's Notes

In the Teacher's Notes you will find all the information, tips and clues you need to set up a lesson. Each model the students build has specific key learning focus areas, vocabulary, questions, and answers, and further ideas for investigations.

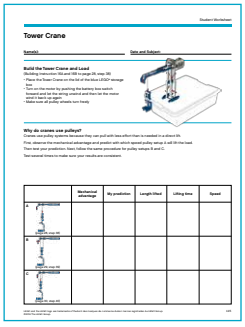


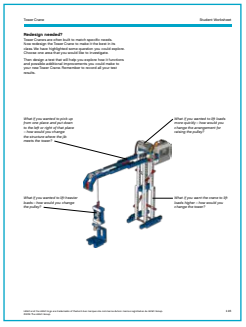


Student Worksheets

Each worksheet guides students to predict, try out, measure and record data, change the models to compare and contrast findings, and draw conclusions.

Let the students work in pairs, predict and test their predictions at least three times to be confident that their results are reliable. Then they record their main data accordingly. At the end of each activity, the students are challenged to design and draw a device that applies the major concepts they have just explored.





Assessments

Three different assessment materials are provided for all four of the activities and the six 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.

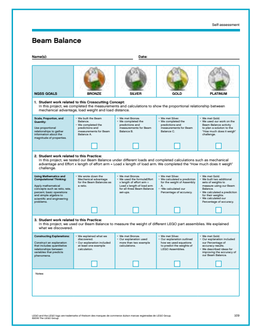
Student Worksheets

The student worksheets should be used to record each student's work throughout each activity. These worksheets are an easy-to-use assessment tool that will give you a clear picture of each student's level and achievement during each activity. They can also comprise a valuable part of the students' log books.

Rubrics

1. Activity Assessment

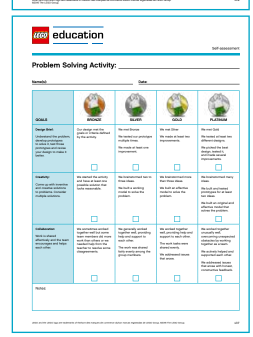
This rubric page can help students to evaluate their activity work according to learning goals based on two science-related NGSS Practices and one theme from the NGSS Crosscutting Concepts.


Beam Balance

2. Problem-Solving Assessment

This rubric can help students to evaluate their problem-solving work according to the engineering-related learning goals from the NGSS and learning objectives that are prominent in both the Common Core State Standards and 21st century skill set, specifically:

- How well did their design meet the requirements of the design brief?
- How creative was their solution?
- How well did their team work together?


education

Problem Solving Activity:

Each rubric includes four levels: Bronze, Silver, Gold, and Platinum. The intention of the rubrics is to help students reflect on what they have done well in relation to the learning goals and what they might have done better. Students can write comments or questions in the 'Notes' section of each rubric.

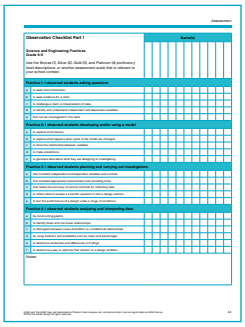
Students should mark the rubric. If you prefer to emphasize formative assessment, ask the students to set their learning goals before they start each activity and to record the dates that correspond to their completion of each level.

You can also use the rubrics as a tool for your own evaluation of your students' work by marking a grade in the appropriate column and writing optional comments in the 'Notes' section.

Observation Checklist
If a more science and engineering practices based approach to assessment is required in the problem-solving activities, you can use the Observation Checklist provided in the Teacher's Notes to assess students individually, in pairs, or in groups.

You can either use the Bronze (1), Silver (2), Gold (3), and Platinum (4) proficiency level descriptions, or use other assessment criteria that are relevant to your school context.

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



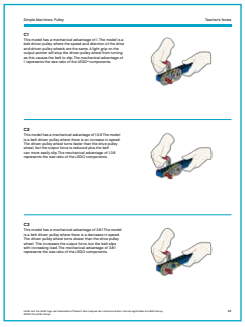
Three Levels of Progression

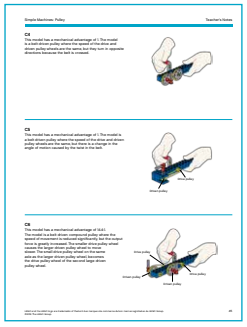
The 'Advancing with Simple & Powered Machines' curriculum pack consists of thirty-eight principle models, four activities, and six problem-solving activities. Each of these three components represents one level of progression, and each is described in more detail below.

Principle Models

The principle models let students experience the mechanical and structural principles normally hidden away inside everyday machines and structures. The many easy-to-build models each present a hands-on demonstration of one of the concepts of simple machines, mechanisms and structures in a clear, straight-forward manner.

The principle models are a pathway for students to understand and integrate mechanical and structural principles applied in their own models.

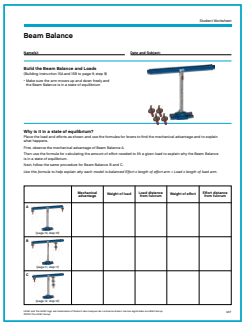




Activities

The four activities allow students to apply and develop their knowledge of science and engineering design. These activities create a positive learning environment and offer a complete scientific learning process in which students are able to make predictions, build models, run tests, record data, make comparisons, and improve their models in order to create a better solution.

These four activities connect with the concepts introduced by the principle models and help students to prepare for the increasingly difficult challenges they will meet in the problem-solving activities.



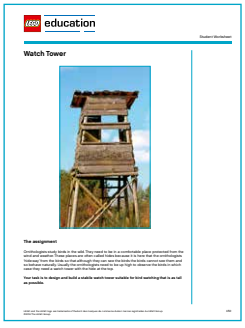
Problem-Solving Activities

The six problem-solving activities all feature real-life problems that can be solved in several ways. Students will be able to test and integrate more than just one principle at a time.

The problem descriptions and the closely-defined design briefs are provided in the student worksheet. Descriptions of learning focus areas, materials needed, extra challenges and how to progress can be found in the Teacher's Notes.

The Teacher's Notes for each challenge provides tips on what and how to measure while at the same time carrying out fair testing of the solutions.

As a support we have included suggested solutions to the problems posed. Use these as 'tips and tricks', or print them and hang them as posters as inspiration for the students. The suggested problem-solving model solutions are only meant as guiding principles for any workable solution the students will come up with themselves.



Classroom Management Tips

For Your First LEGO® Education Activity, and Beyond

1. Before Class
- Open one of the LEGO® brick sets and sort the bricks according to the sorting suggestion on the back of the top card.
- Label the boxes so that you can recognize which box belongs to which student(s).
- Download the curriculum pack from the URL that is printed on the lid of each set.
- Try to complete the activity using the student worksheets.

2. During Class
- Let the students sort their LEGO brick sets at the beginning of the first lesson.
- Have the students use the lid of their set as a working tray.
- Use a jar to collect stray pieces.
- Make adjustments in order to challenge the students who are ready to improve and develop new skills.

3. After Class
- Plan to stop the lesson with enough time to allow the students to tidy up.
- 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.
- Book a LEGO Education training session if you need further inspiration.

How much time do I need?
A 90-minute class period is ideal to be able to explore, build, and test in depth all the extension ideas built into the material and for the students to make any creative variations of their own.

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

You can also ask your students to download the building instructions booklets from the URL that is printed on the lid of each set, and save them to their devices.

What's needed in my classroom?
Tables may be pushed aside to let models roll across a smooth floor. Ideally, a computer or computers should be available for students to explore the Jack and Jill animated activity briefings.

Students need to be able to construct in pairs facing each other or side-by-side. From teachers and classrooms we have learned that cafeteria-type trays are ideal to build on, and to stop elements rolling onto the floor. It is also an advantage to have a cupboard or shelves to store the sets lying flat with any unfinished models on top of them.

LEGO® Education 4C Approach

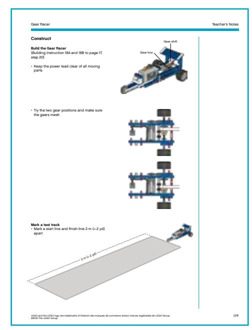
The activities follow LEGO® Education's 4C approach; Connect, Construct, Contemplate, and Continue. This enables you to progress naturally through the activities.

Connect

Creating a connection between a past and new learning experience stimulates the growth of new knowledge. Each activity therefore provides a short text with insights into the purpose and function of the specific model. The text is supported by a short video of a real-life machine similar to the LEGO model. Use the text and video as a starting point for a class discussion or you could draw on your own experiences to provide an engaging introduction to the activity.

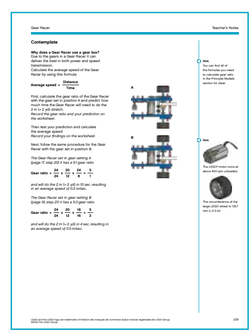
Construct

The construction of models engages both hands and minds. Using the building instructions, students build models embodying the concepts related to the key learning areas. Tips are provided for testing and ensuring each model functions as intended.



Contemplate

Contemplating is the opportunity to deepen the understanding of previous knowledge and new experiences. Based on scientific method, the activities encourage the students to discuss and reflect on their investigations, and adapt their ideas to the task at hand.



Each activity requires the students to predict an outcome, test, calculate and record their findings. We suggest encouraging the students to present their findings together with their explanations and rationales to each other.

We suggest stimulating the students' reflections on their investigations by having them consider patterns or trends in their findings, identify variables and describing advantages and disadvantages in model function and design.

This stage in the student's work process provides an opportunity for you to begin evaluating the learning outcome and progress of the individual student.

Continue

Learning is always more enjoyable and creative when it is adequately challenging. Maintaining this challenge and the pleasure of accomplishment naturally inspires the continuation of more advanced work. The open-ended continue activities challenge the students through a series of 'what if' questions to focus on particular features of the model that might be re-designed to give improved and optimized performance.