1. Introduction to the Maker Lessons

The LEGO® MINDSTORMS® Education EV3 Maker Lessons have been developed to engage and motivate secondary school pupils, piquing their interest in learning about design, engineering and coding using motorised models and simple programming.

Each lesson provides an initial brief as a starting point. The open-ended prompts allow for unlimited answers and enable the pupils to express a wide range of creative solutions as they sketch, build and test prototypes of the designs that they create.

The teacher's role in these lessons is to provide the pupils with the tools and necessary freedom to connect with and define a problem, make a solution and share what they have made.

Use your creativity to adapt these activities to suit the needs of your pupils.

> *"The role of the teacher is to create the conditions for invention rather than provide ready-made knowledge."*
>
> *– Seymour Papert*

Classroom Management Tips

Required Materials
• LEGO® MINDSTORMS® Education EV3 Core Set
• Lesson plan
• Student Worksheet for each activity
• Inspirational images for each activity
• Modelling materials already available in your classroom

How much time do you need?
Each lesson is designed to take 90 minutes. If you work in shorter class periods you can break this down into two 45 minute sessions.

Preparation
It is important to establish work groups for the pupils. Groups of two work well. Ensure that each of the pupils has a copy of the Student Worksheet for recording their design process. Alternatively, they can use their own preferred method for recording their design journey. They will also need the LEGO MINDSTORMS Education EV3 Core Set (one set for every two pupils is recommended).

The LEGO® Education Maker (Design) Process

Defining the Problem
It is important for the pupils to define a real problem to solve or to find a new design opportunity from the start. The "Connect" images are provided to help the pupils to think about the design of their solutions. At this stage of the process it is important that you do not show examples of a final or sample solution.

Brainstorm
Brainstorming is an active part of making. Some pupils will find it easier to explore their thoughts through tinkering (i.e. hands-on experimentation) with the LEGO® bricks and others will prefer to record sketches and notes. Group work is essential, but it is important to allow time for the pupils to work alone before sharing their ideas with their groups.

Define the Design Criteria
Discussing and reaching an agreement about the best solution to build can involve a lot of negotiation and may require different techniques that are dependent on the pupils' skills. For example:
• Some pupils draw well.
• Others may build part of a model and then describe what they mean.
• Other pupils may be good at describing a strategy.

Encourage an ethos where pupils can share anything, no matter how abstract it might sound. Be active during this phase and ensure that the ideas that the pupils choose are achievable.

It is important for the pupils to set clear design criteria. Once the solution to the problem has been made, the pupils will return to these criteria, which will then form the basis for testing how well their solution works.

Design criteria example:
The design must…
The design should…
The design could…

Go Make
The pupils must make one of their ideas using the LEGO® set, they can also use other materials if if this is necessary. If they are finding it difficult to build their idea, encourage them to break problems down into smaller parts. Explain that they do not have to come up with the whole solution from the start. Remind the pupils that this process is iterative and they must test, analyse and revise their idea as they go.

Using this Maker process does not mean that you are following an inflexible set of steps. Instead, think of it as a set of practices.

For example, brainstorming may be prominent at the beginning of the process. However, the pupils may also need to brainstorm ideas when they are trying to figure out ways to improve their idea or when they have a bad test result and must change a feature of their design.

Review and Revise Your Solution
In order to help the pupils to develop their critical thinking and communication skills, you may wish to have the pupils from one group observe and critique another group's solution. Peer review and formative feedback helps both the pupils giving, and the pupils receiving the feedback to improve their work.

Communicate Your Solution
The Student Worksheet is helpful for basic documentation of the activity. The pupils can also refer to it when presenting their work in front of the class. You may also wish to use the Student Worksheet as a portfolio for performance evaluations or for the pupils' self-evaluation.

The LEGO® Education Maker (Design) Process

Define the Problem
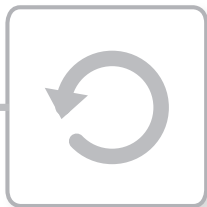
Brainstorming

Define the Design Criteria
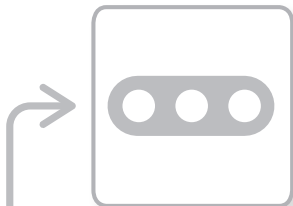
Go Make

Review and Revise Your Solution

Communicate Your Solution

Assessment

Where can I find the assessment materials?
Assessment materials are provided on the following page for the first three projects.

What learning goals are assessed?
The pupils use the Student Worksheet assessment rubric to evaluate their design work according to the learning goals. Each rubric includes four levels: Bronze, Silver, Gold and Platinum. The intention of the rubric is to help the pupils to reflect on what they have done well in relation to the learning goals and what they could have done better. Each rubric can be linked to engineering-related learning goals.

Share It

We encourage you to share your pupils' brilliant projects on the appropriate social media platforms using the hashtag **#LEGOMaker**.

The pupils can also share their own projects if they are over 13 years old and if it complies with the rules of your school/Maker space.

#LEGOMAKER

The Maker Activities
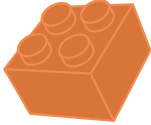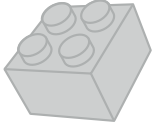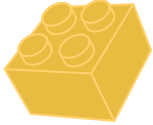Start your Maker journey with the following three activities:
• Sound Machine
• Security Gadget
• Puppet

Self-Assessment

Name(s): _____ **Date:** _____

GOALS	**BRONZE**	**SILVER**	**GOLD**	**PLATINUM**
Maker task: **Sound Machine** **Designing Solutions**	• We have successfully built and tested one design based upon a single design criterion and design idea. ☐	• We have successfully used two design criteria and ideas to build a solution to a defined problem. ☐	• We have achieved Silver and refined our idea, improving it further through testing, revising and retesting. ☐	• We have achieved Gold and successfully met all three design criteria. ☐
Maker task: **Security Gadget** **Defining Problems**	• We have understood the design problem. ☐	• We have defined a design problem and used one design criterion and idea to build our solution. ☐	• We have achieved Silver and used two design criteria and ideas to build our solution. ☐	• We have achieved Gold and used three design criteria and ideas to build an effective solution. ☐
Maker task: **Puppet** **Obtaining, Evaluating and Communicating Information**	• We have drawn and labelled the different parts of our design. ☐	• We have achieved Bronze and identified the location of the key component parts that are responsible for making our design work. ☐	• We have achieved Silver and included a diagram showing how our design works. ☐	• We have achieved Gold and used words and a diagram to explain how our new design works. ☐

Notes:

Well done! What will you make next?