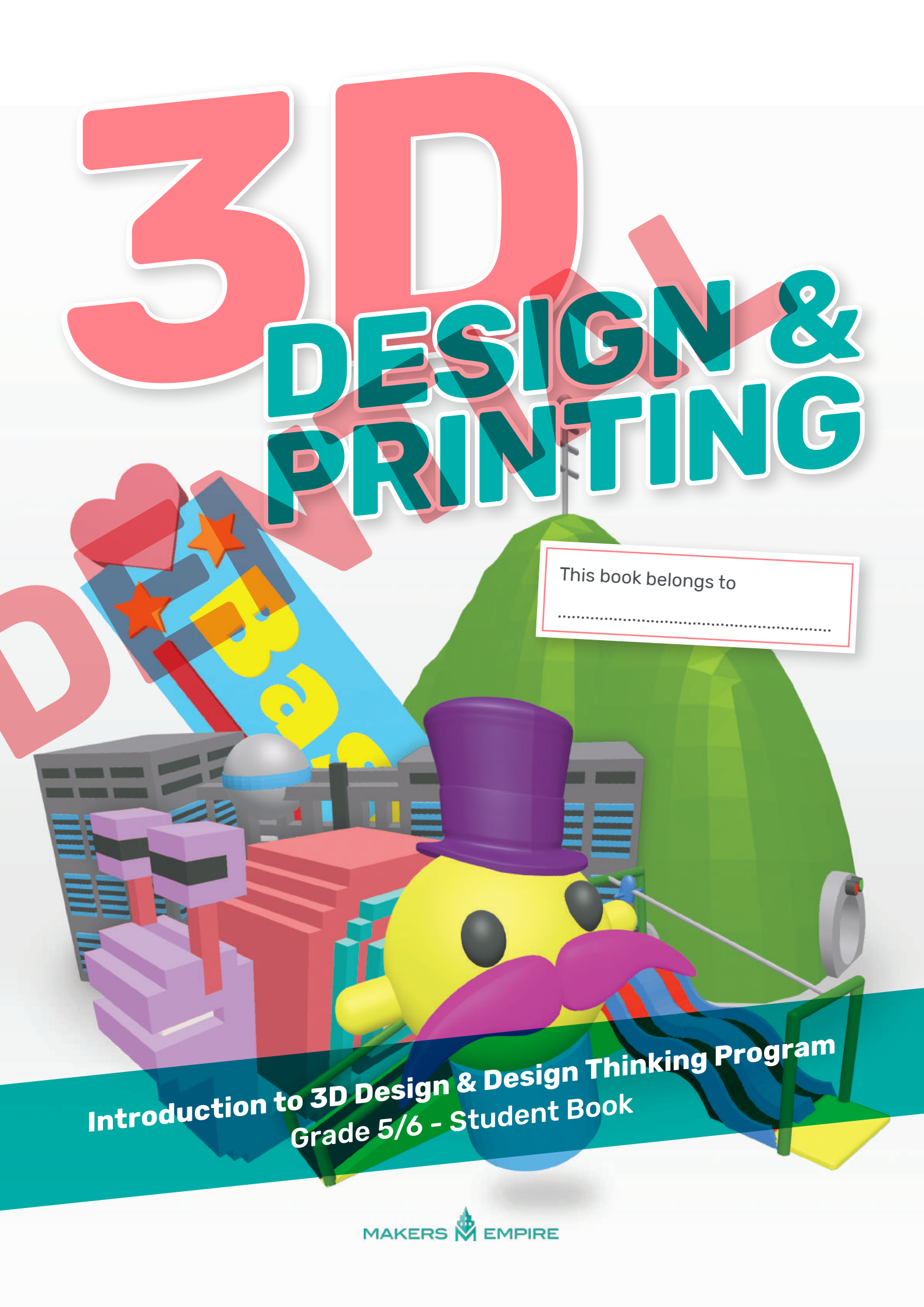


3D DESIGN & PRINTING



Introduction to 3D Design & Design Thinking Program
Grade 5/6 - Student Book

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Contents

Section A: Introduction to 3D printing

1. **Getting started with Makers Empire** 1.
How to log in. Explore Maker World. Training Lab tutorials.
2. **Your first 3D printing project** 10.
Make a pet tag.
3. **All about 3D printing** 17.
What is a 3D printer? How do 3D printers work? What are they used for?

Section B: Designing in 3D

4. **Shaper project** 21.
Design a plant marker using Shaper.
5. **Blocker project** 26.
Design a tricky maze using Blocker.
6. **Our 3D world** 30.
Design a model of a famous building.

Section C: Design thinking in action

7. **Get creative** 36.
Design a magical pocket pet.
8. **Your design brief** 42.
Design a pencil topper.
9. **Empathise and define to solve a problem** 49.
Design a tunnel to solve a problem for a rabbit
10. **3D group challenge** 54.
Design and test prototypes for solving a real-world problem

The lessons in this book are aligned to the Makers Empire International Design Curriculum. This curriculum aligns to international design & technology and engineering curricula around the world including Australian Curriculum and Next Generation Science Standards (USA).

This book has been designed as an introduction to 3D design and printing. It specifically addresses the Grade 3 & 4 curriculum, however, it is also suitable for intermediate students of all ages.

Maker World -

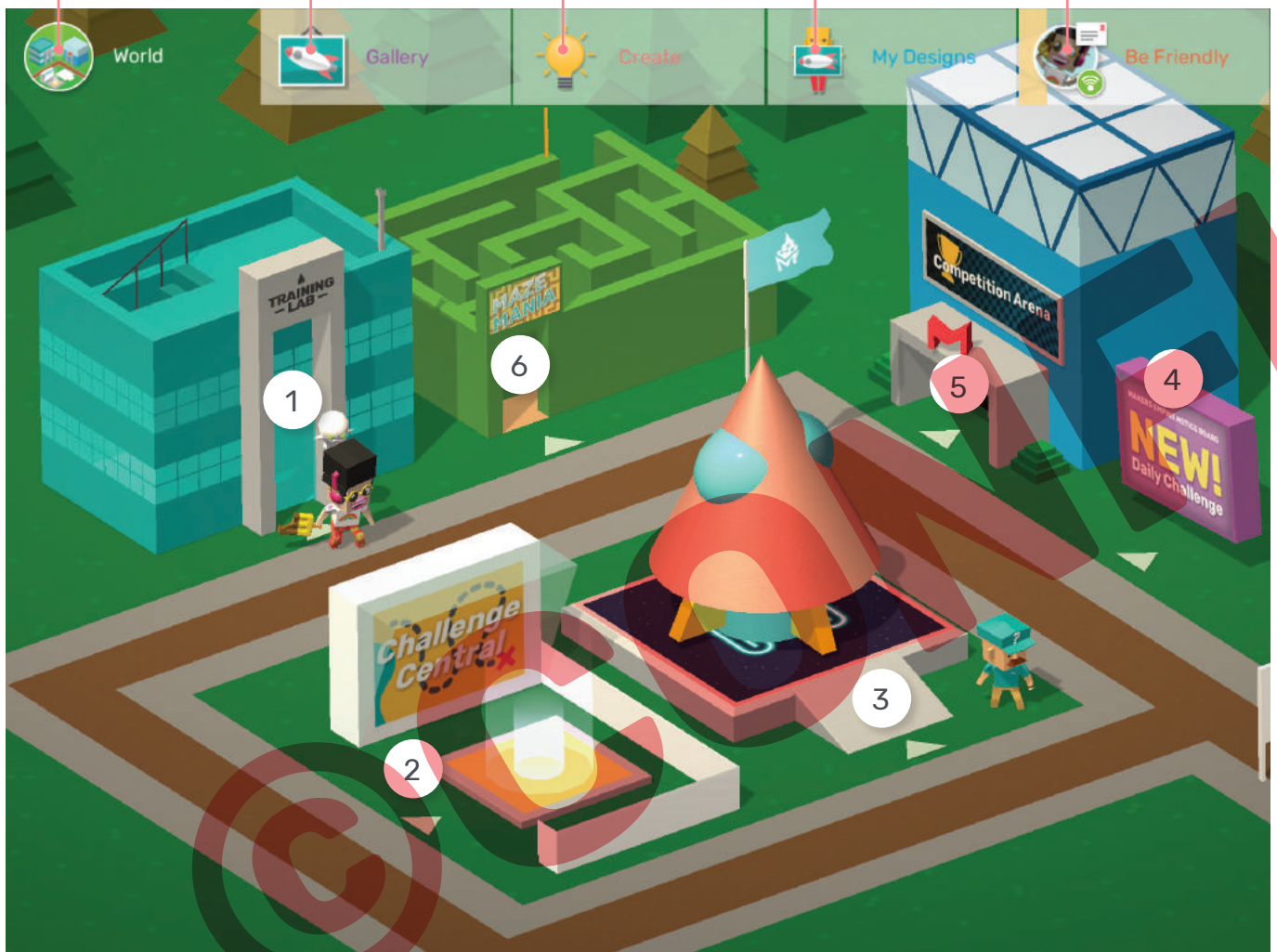
where you can get challenges, create missions and play 3D mazes

Create - to open the free form design tools which you will use for the rest of this course

Me tab - this is where you can check your settings and edit your avatar

Gallery - this is where you can view other people's designs

My Designs - this is where you go to view and edit your own designs



1. Getting Started with Makers Empire

Description

In this lesson you will get started with your 3D learning.

You will learn how to log in to the **Makers Empire 3D** app and create your 3D avatar.

You will work through the tutorials in the **Training Lab** and learn how to use all the different tools in the app.

Welcome to Maker World

1. **Training Lab** - This is where new users go to complete some simple tutorials and quickly learn the basic design tools of Makers Empire 3D.
2. **Challenge Central** - In here you complete design challenges to test your problem solving skills. Your teacher will assess your work and you can get rewards if you do a really good job!
3. **Mission Maker** - You can create your own design missions for others to try., or try one of the thousands of missions other students have made.
4. **Daily Challenges** - You can visit the board if you need a bit of inspiration to start a design. There is a fresh challenge everyday, so there is always something new to try.
5. **Competition Arena** - This is the home of our hotly contested monthly competitions. Students from all over the world submit designs based on a new design problem every month. Winners and runners up receive a Makers Empire trophy and the glory of being crowned a Design Champion!
6. **Maze Mania** - Use your 3D design skills to create unique 3D maze games for their friends. Maze Mania uses Game Based Learning to teach the importance of testing and iteration, and also develops spatial reasoning and the ability to predict outcomes.

Teachers' Notes

1. Before you begin you will need your class list of usernames and passwords.
2. Students will select **Log In** and then enter their details
3. On the next page you'll find a guide to the different tabs and areas in Makers Empire 3D.

Learning Outcomes

- Communicates and records design ideas using technical terms and graphical representation techniques.
- Uses and chooses specific features in digital 3D modelling tools.
- Interprets information and follows instructions using directional language.
- Identifies, names, forms and describes 3D shapes.

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Assessment Rubric

★★★★★	★☆☆☆☆	★★☆☆☆	★★★☆☆	★★★★★
Logs in independently and helps others	Logs in independently	Logs in with minimal help	Logs in with help	Does not log in successfully
Completes all training lab tutorials independently and adds additional details to designs than required to complete each challenge.	Completes all training lab tutorials independently at the level required to complete each challenge.	Completes all training lab tutorials with minimal help.	Completes some training lab tutorials.	Does not complete any training lab tutorials.
Creates an avatar design with complex features and draws at least 3 possible avatar designs with accurately labeled features.	Creates an avatar design with multiple features and draws more than one labeled design idea.	Creates an avatar design and draws a labeled representation of their avatar design.	Creates an avatar design	Does not create an avatar design
Correctly names and describes the attributes of more than four 3D shapes. Gives reasons for selecting shapes related to specific attributes of 3D shapes.	Correctly names and describes the attributes of more than four 3D shapes and gives reasons for selecting particular shapes.	Correctly names at least four 3D shapes and describes their attributes.	Correctly names at least three 3D shapes.	Names but does not describe 3D shapes.

How to Get Started with Makers Empire

Step 1.

You will need to remember your log in details. Record them here to keep them handy.

Username:

Password:

Step 2.

Now you are going to log onto Makers Empire for the first time.

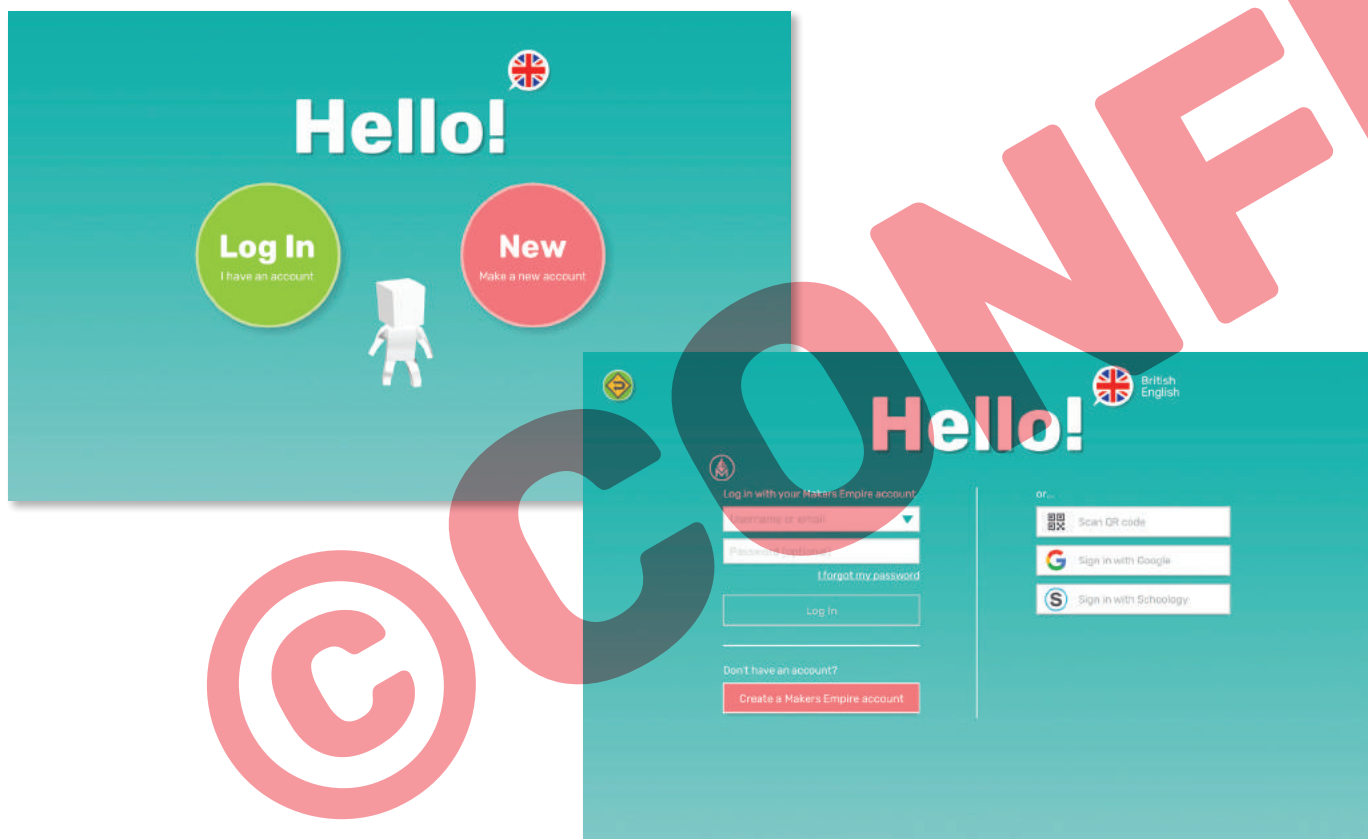
As you work your way through you will be guided step by step.

The first thing you are going to do is log in, create your avatar and then complete nine tutorials.

As you finish each tutorial you will earn tokens and move up levels.

1. Log In

Open Makers Empire 3D and click the green **Log In** button. Enter your **username** and **password**.



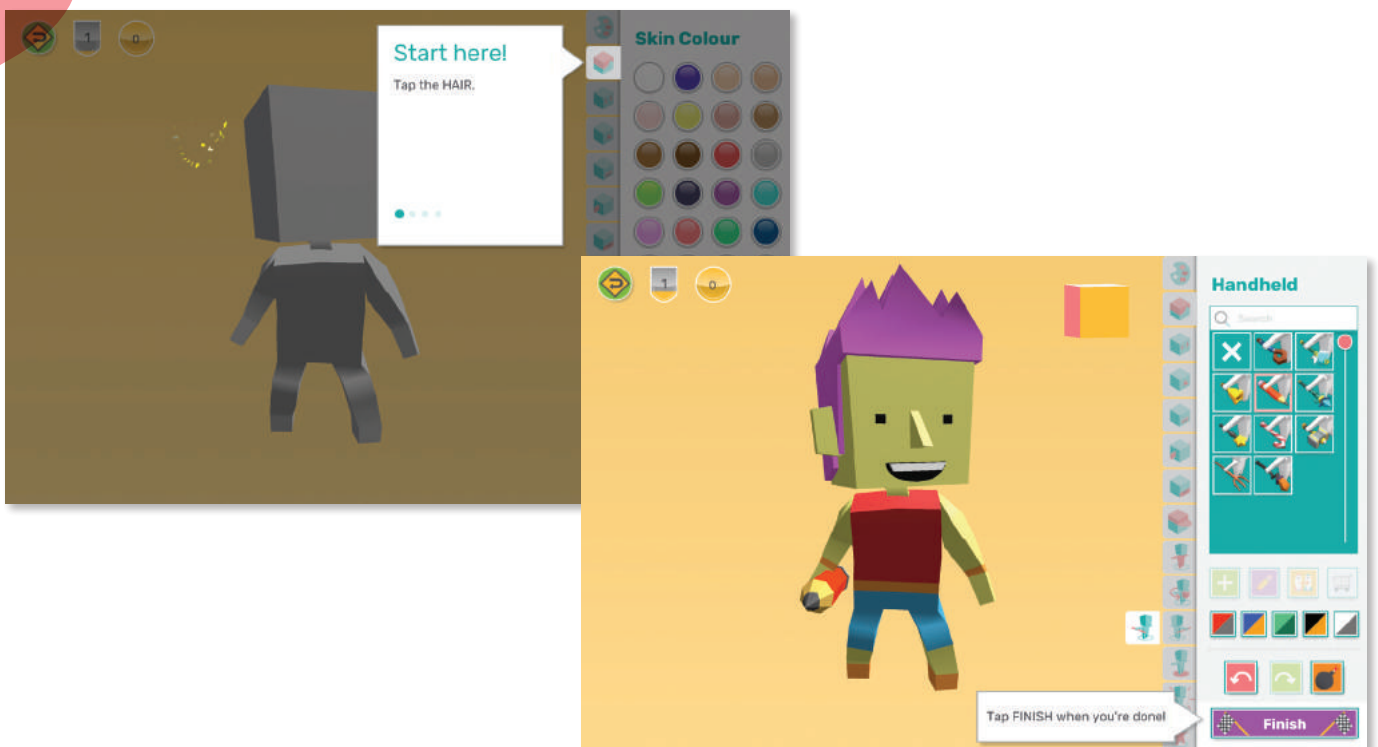
2. Enter the Training Lab and create your avatar

Click on the **Training Lab** building to enter, then click the **green flag** to begin the first tutorial.



Choose body parts, clothes and something to hold in your hand.

Click **Finish** when you are ready



3. Make a tower

You are going to make a tower by using the **Shaper Module**.

You will learn how to add shapes, delete your whole design and undo your last action.



4. Your favorite colors

You are now going to practice using the **color palette** and paint the flower.

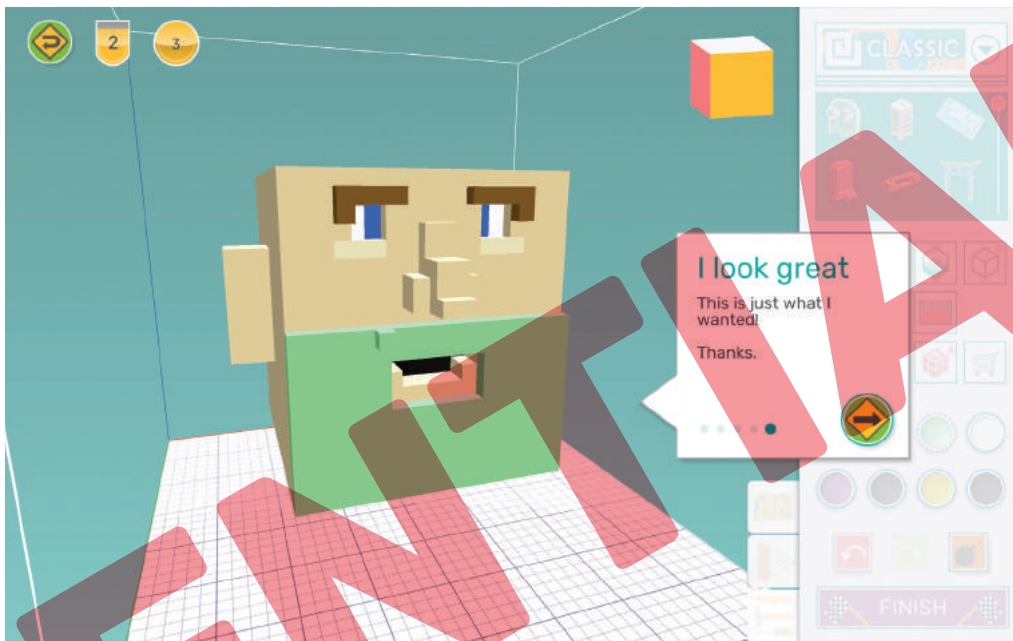
Take your time to learn all about colors.



5. Beard maker

In this challenge you are going to use the **Blocker Module** to add a beard to the face.

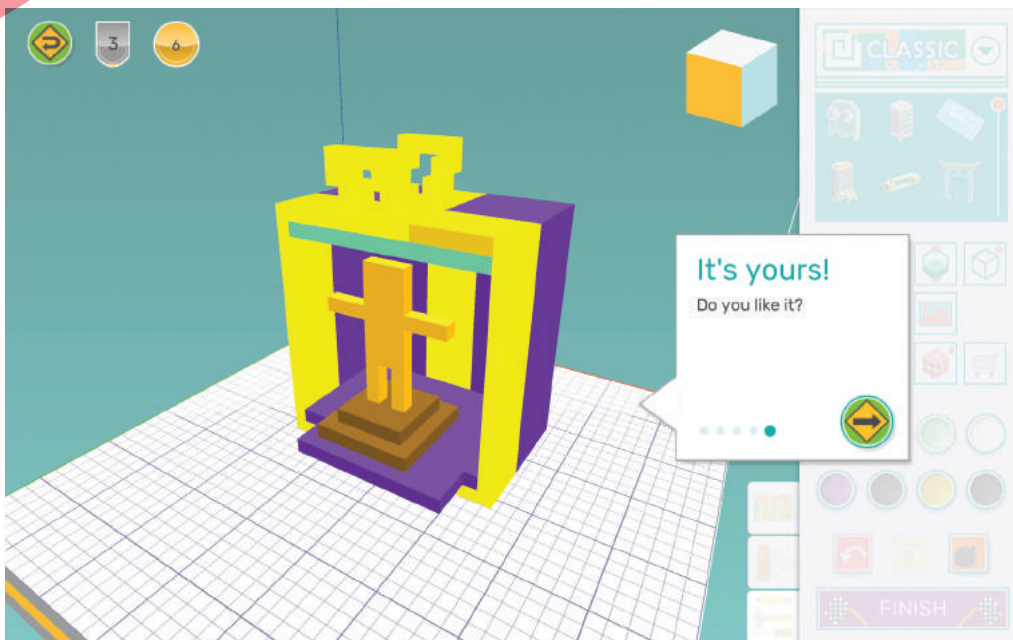
Follow the instructions and have fun creating a block beard.



6. Open a present

In this challenge you will learn how to take blocks away to see what is hidden in the present.

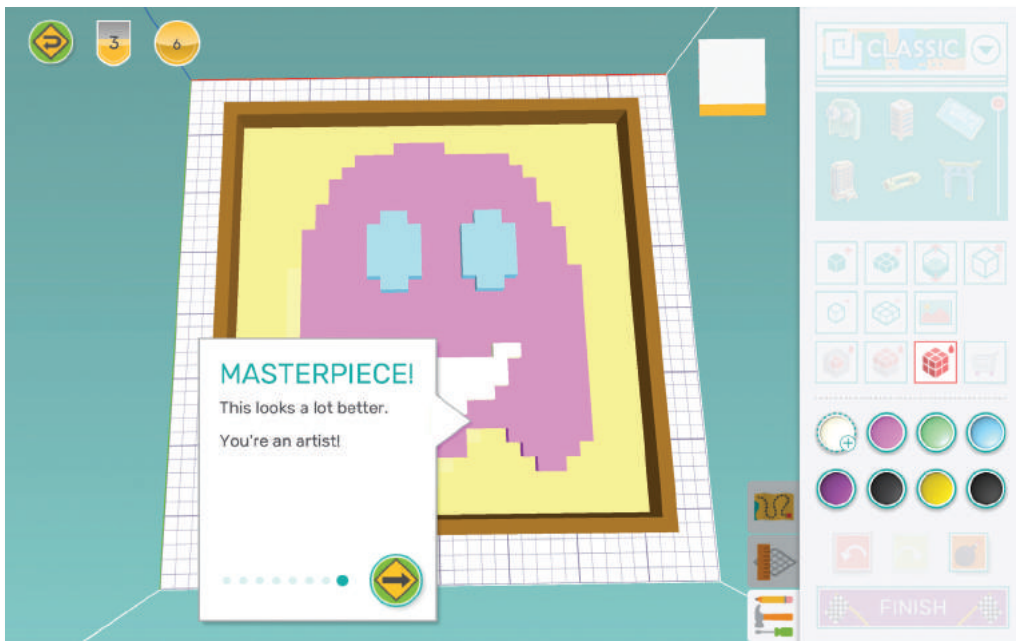
Follow the instructions. What did you find?



7. Spooky Painting

Now for some spooky fun, the spooky painting challenge shows you how to add and change colors in the **Blocker Module**.

Try experimenting with different colors

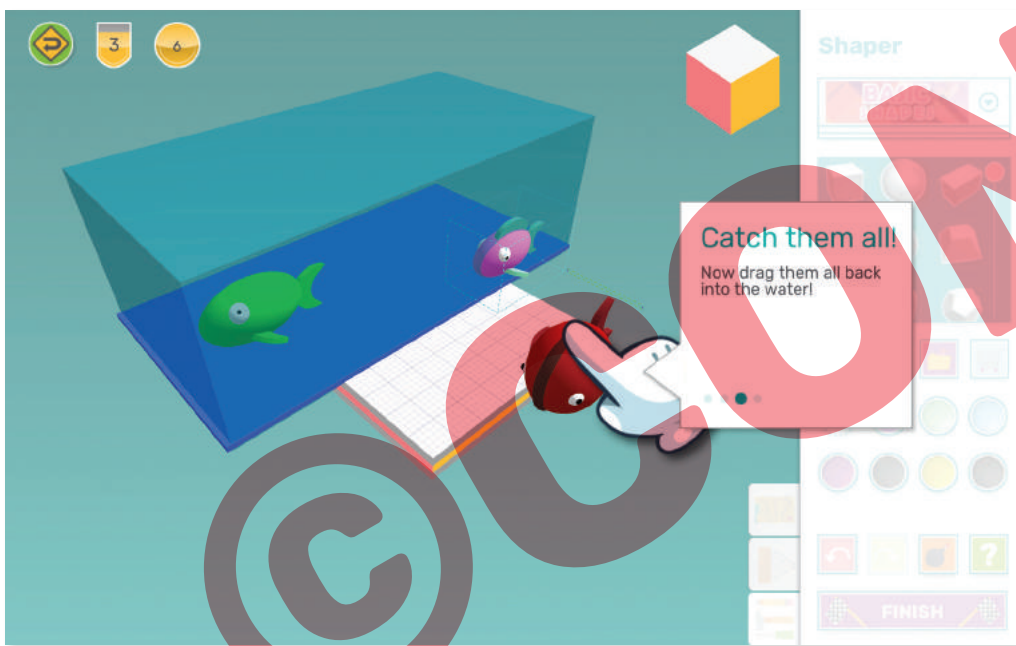


8. Fish Out-of-Water

In this challenge you have to put the fish back into the water.

Someone tipped the tank over!

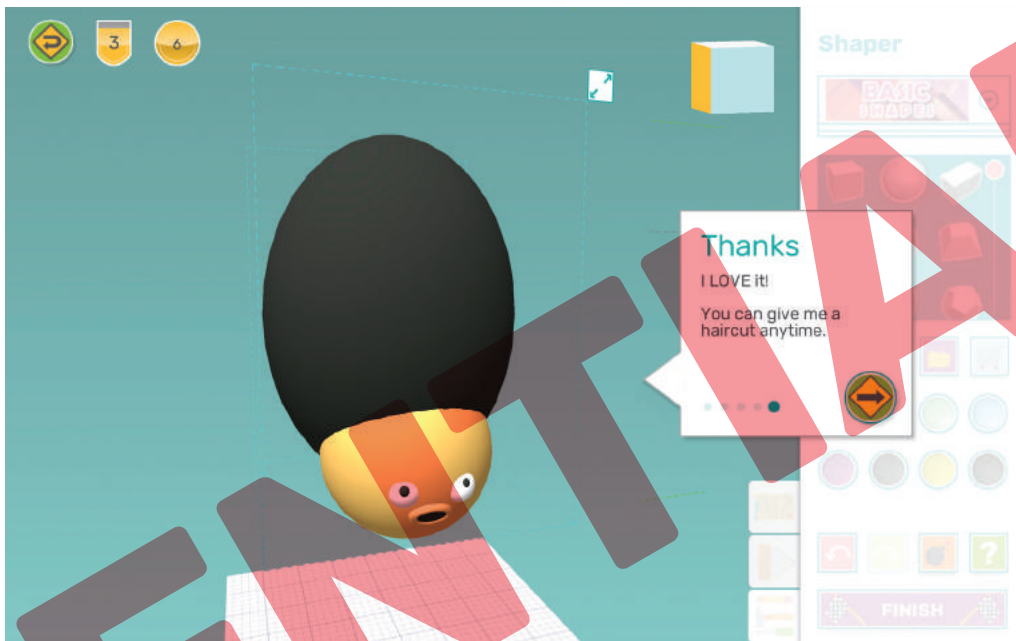
Click on the fish. Then **drag** and drop it into the water.



9. Grow Your Hair

In this challenge you will use the **resize buttons** to make the hair grow bigger.

Drag up and out to make bigger or down and in to make smaller.



10. Bug Catcher

The poor dog is covered in fleas! Use the **zoom** tool to get a closer look, and spin around to find all the pesky fleas.

Use the **delete** tool to remove the fleas and make the dog happy again.

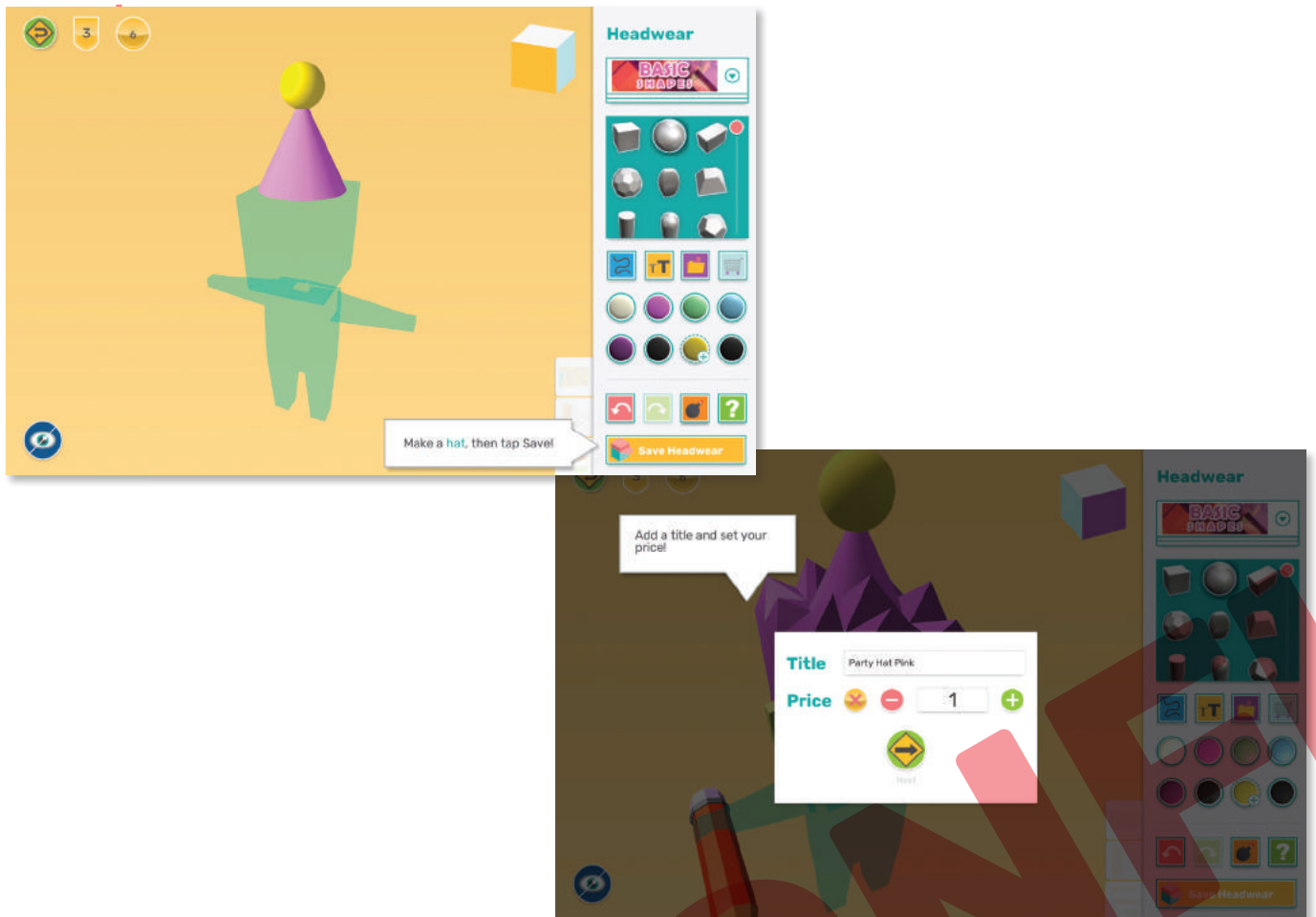


10. Make a hat for your avatar

Combine shapes to make an original hat design. Maybe you'd like a party hat? Or a cowboy hat? What about a helmet? Perhaps a warm wool cap is more your style?

Give your hat design a title, and set a price. Maybe someone will buy it from you!

Once you've learned how to make a hat, you can make any parts you want for your avatar.



Step 3

When you have finished the Training Lab tutorials visit other areas of Maker World and discover what else you can do here.

List 3 new things you found in Maker World:

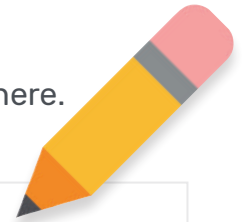
1.

2.

3.

Step 4

Draw your avatar. Label the parts you added to your avatar and the 3D shapes you used. You could also draw some other ideas for your avatar here. You can go back and edit your avatar whenever you like.



2. Your first 3D printing project

Description

In this lesson you will become a 3D designer and make your first 3D printed creation.

You will learn how to use Shaper to make a tag for your pet or another pet that you know.

You will need to think about the information to include on your pet tag.

You will also need to make sure that the tag can be attached securely to the pet's collar and be comfortable for them to wear.

Learning Outcomes

- Communicates and records design ideas using technical terms and graphical representation techniques.
- Interprets information and follows instructions using directional language.
- Uses 3D modelling tools to create structurally sound designs, prototypes and models.
- Identifies, names, forms and describes 2D shapes.

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Assessment Rubric

★★★★★	★☆☆☆☆	★★☆☆☆	★★★☆☆	★★★★★
Draws and labels 3D drawing of more than one pet tag design and names all shapes used.	Draws and labels a 3D drawing of a pet tag design and names shapes used.	Draws and labels design idea for a pet tag.	Draws a design idea for a pet tag	Does not record design ideas
Independently: Selects shapes Resizes shapes Adds text to shape Attaches a ring or uses intersection tool to make a hole Groups shapes	Independently: Selects shapes Resizes shapes Adds text to shape Attaches a ring	With minimal help: Selects shapes Resizes shapes Adds text to shape Attaches a ring	Uses some features in Makers Empire app but does not complete the bag tag project.	Does not use features in Makers Empire app.
Designs a functional pet tag using all original ideas.	Follows instructions to make a pet tag with at least one original idea.	Follows instructions to make a pet tag.	Creates a pet tag with help.	Does not successfully design a pet tag.
Correctly names and describes the attributes of more than four 2D shapes. Gives reasons for selecting shapes related to specific attributes of 2D shapes.	Correctly names and describes the attributes of more than four 2D shapes and gives reasons for selecting particular shapes.	Correctly names at least four 2D shapes and describes their attributes.	Correctly names at least three 2D shapes	Names but does not describe 2D shapes

How to make a pet tag

Step 1.

You are now going to create your very first 3D printed design. This will be a name tag for your own pet or another pet that you know.

The name of the pet I will make a tag for is

.....

Step 2.

Draw a line to join the shapes to their name:

Rectangle

Square

Circle

Triangle

Semi-Circle

Ring

Pentagon

Hexagon



Step 3.

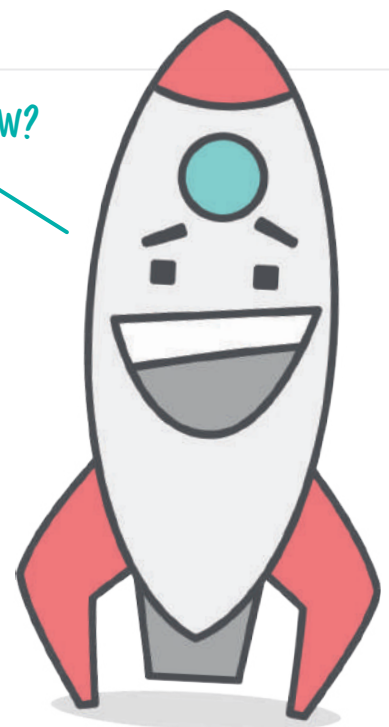
Draw the pet you are going to design a name tag for. Don't forget to write the pet's name on your drawing.

Things to think about:

1. How big is the pet? You will need to design a tag that is a suitable size. Imagine a tiny kitten wearing a tag the size of a dinner plate!
2. What kind of collar does the pet wear? Your tag will need to attach to the pet's collar.
3. Your tag will need to have the pet's name on it. What other information will you include on the tag? What might be helpful if the pet gets lost?



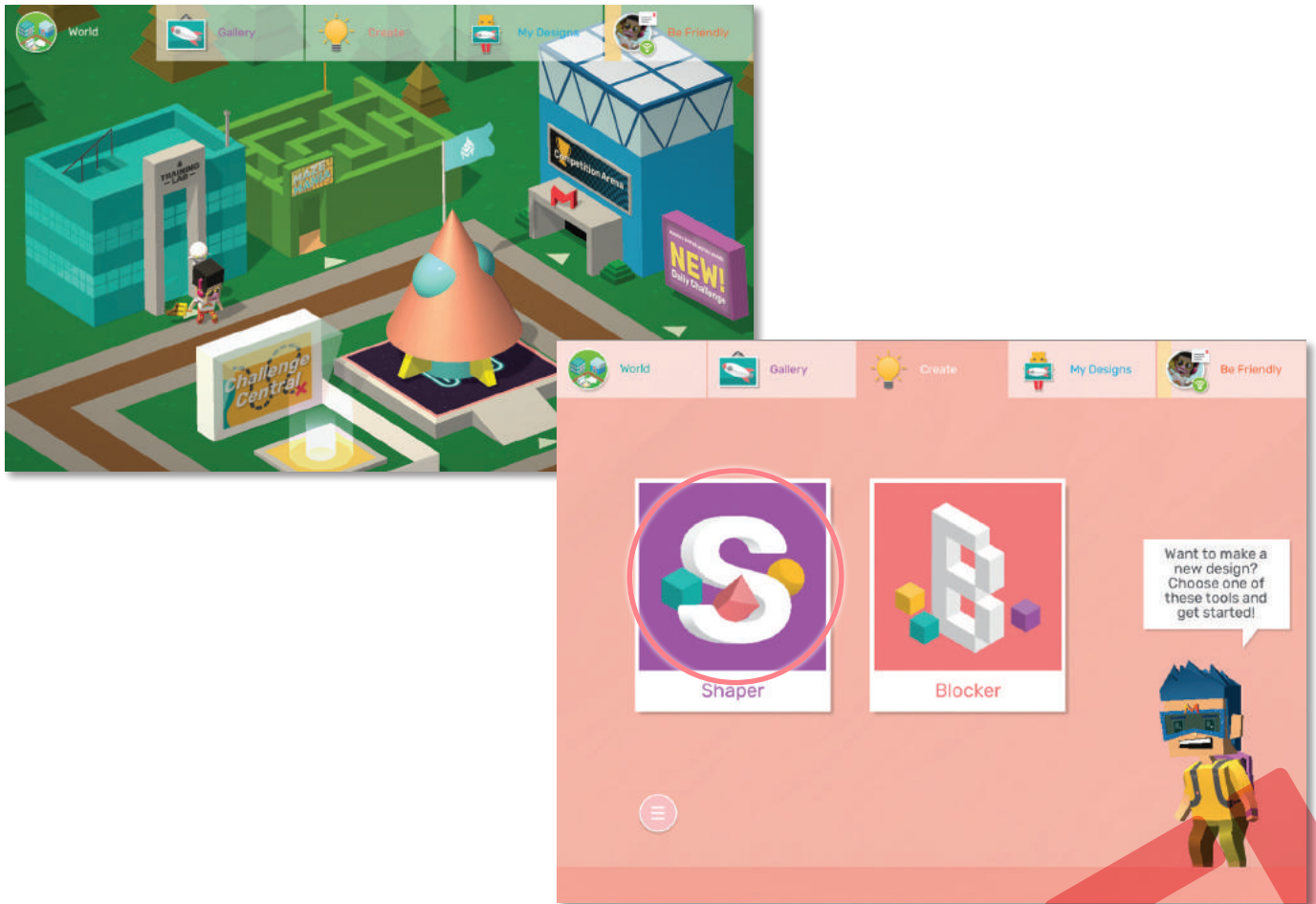
I AM MADE UP OF 2D SHAPES.
HOW MANY 2D SHAPES DO YOU KNOW?



Step 4.

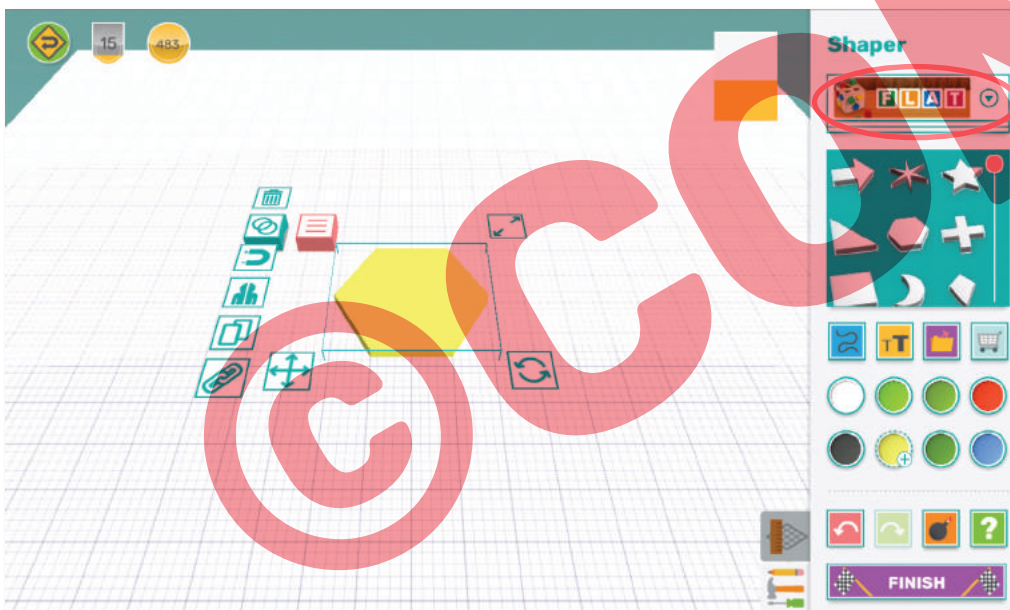
Making a pet tag

1. Log in to Makers Empire 3D and open Shaper



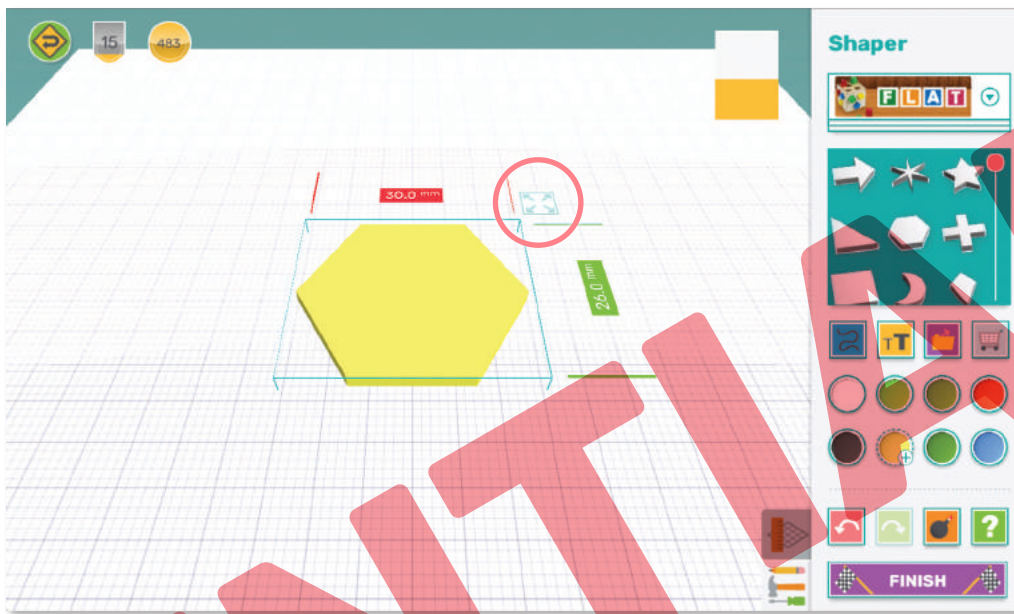
2. Select your base shape

You can use any shape, but **flat shapes** work best.



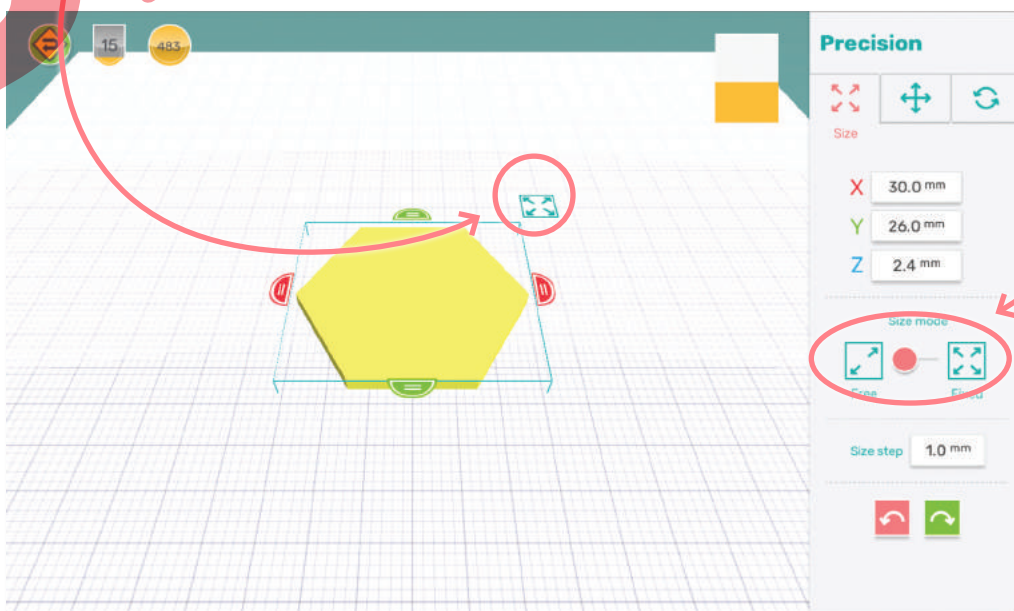
- **Resize base shape**

Think about the size of the pet. Drag the **Size** button to adjust your tag to suit that animal.



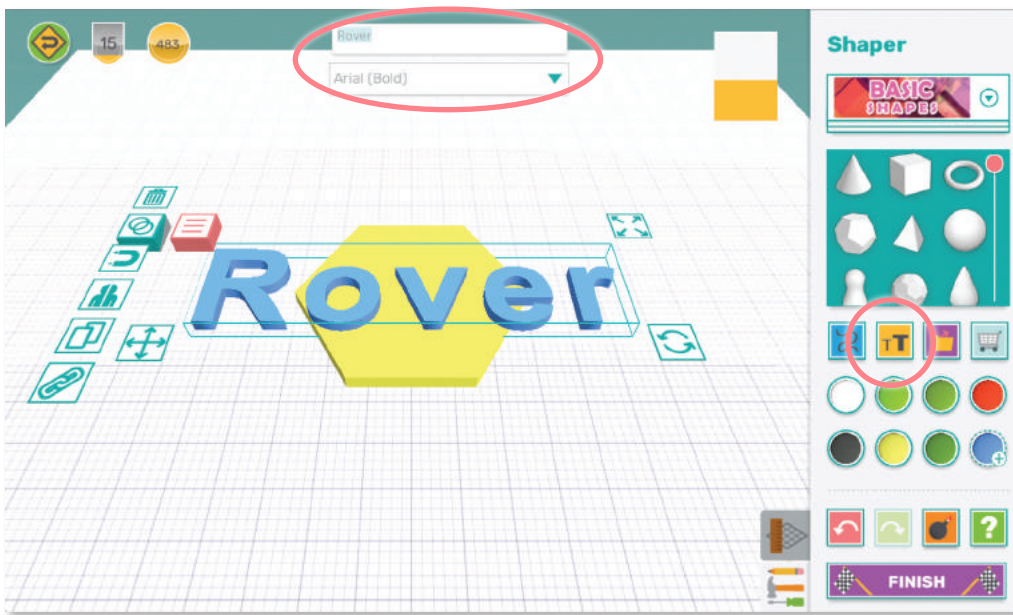
PRO TIP!

- You can click the **Size** button to open **Precision Mode** and accurately control the size of your shape.
- You can choose **Free Resize** to stretch your shape in any direction, or use **Fixed Resize** to change the size but keep the same shape.



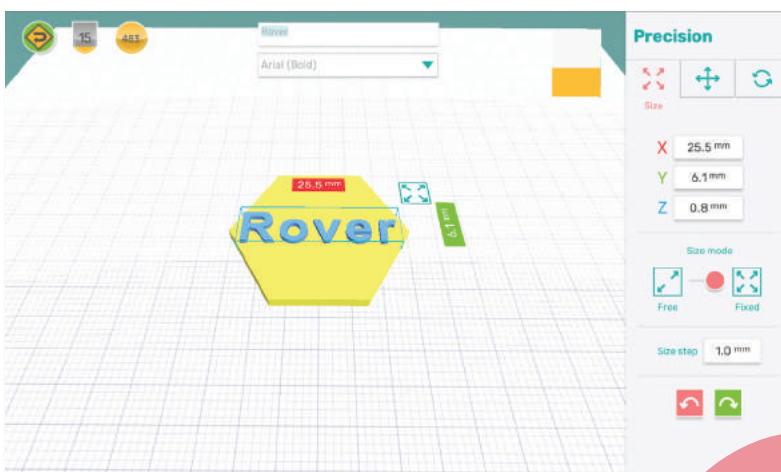
3. Add text

Type your pet's name in the top box. You can choose different fonts (text styles) in the second box.



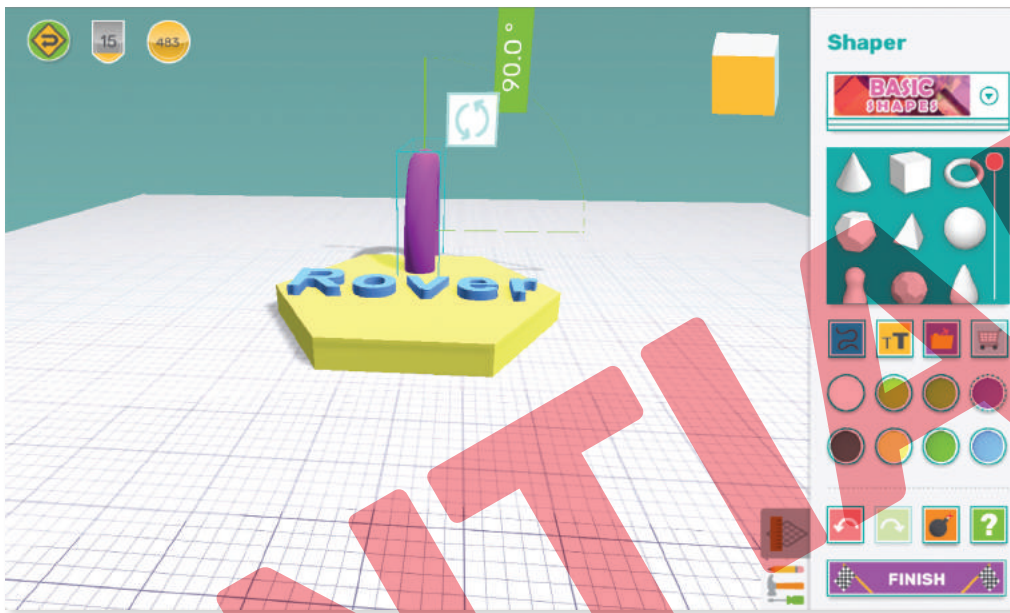
4. Resize your text

Make sure your text fits on your tag and is touching your base shape



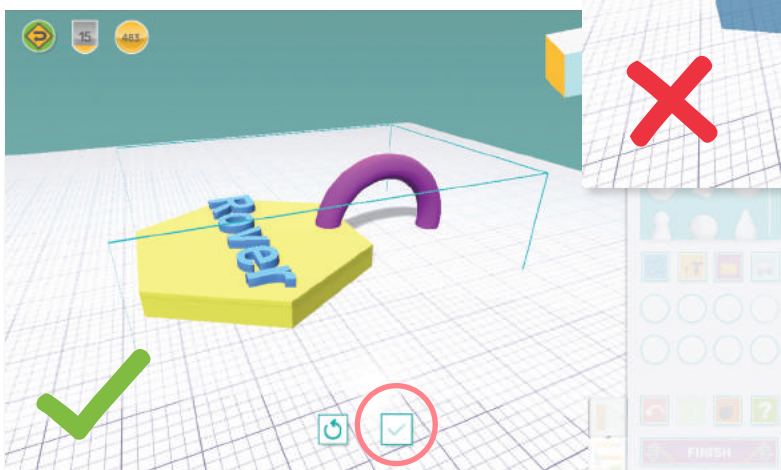
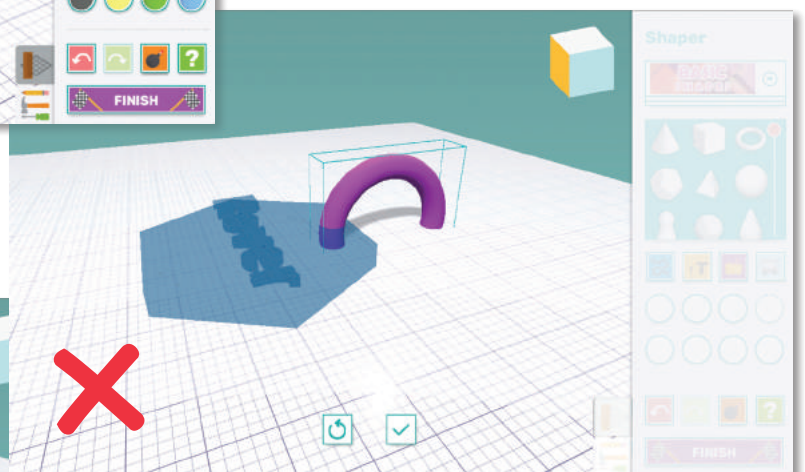
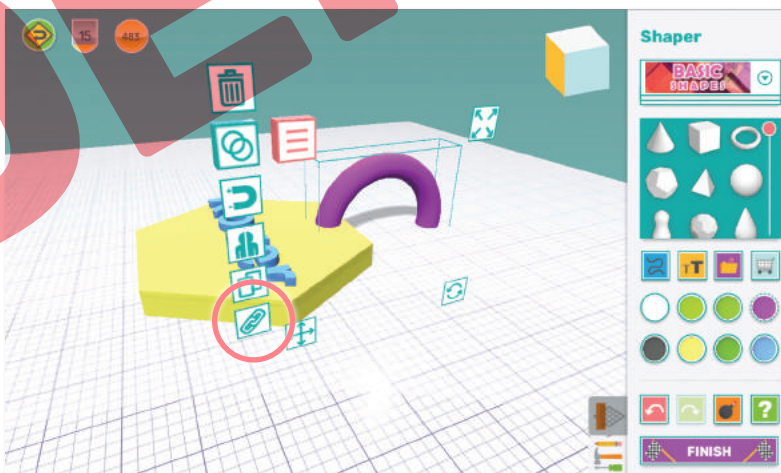
5. Add a ring

You can use a donut shape or a letter like "O" or "D". Use the Rotate tool to make sure the ring is facing the right way.



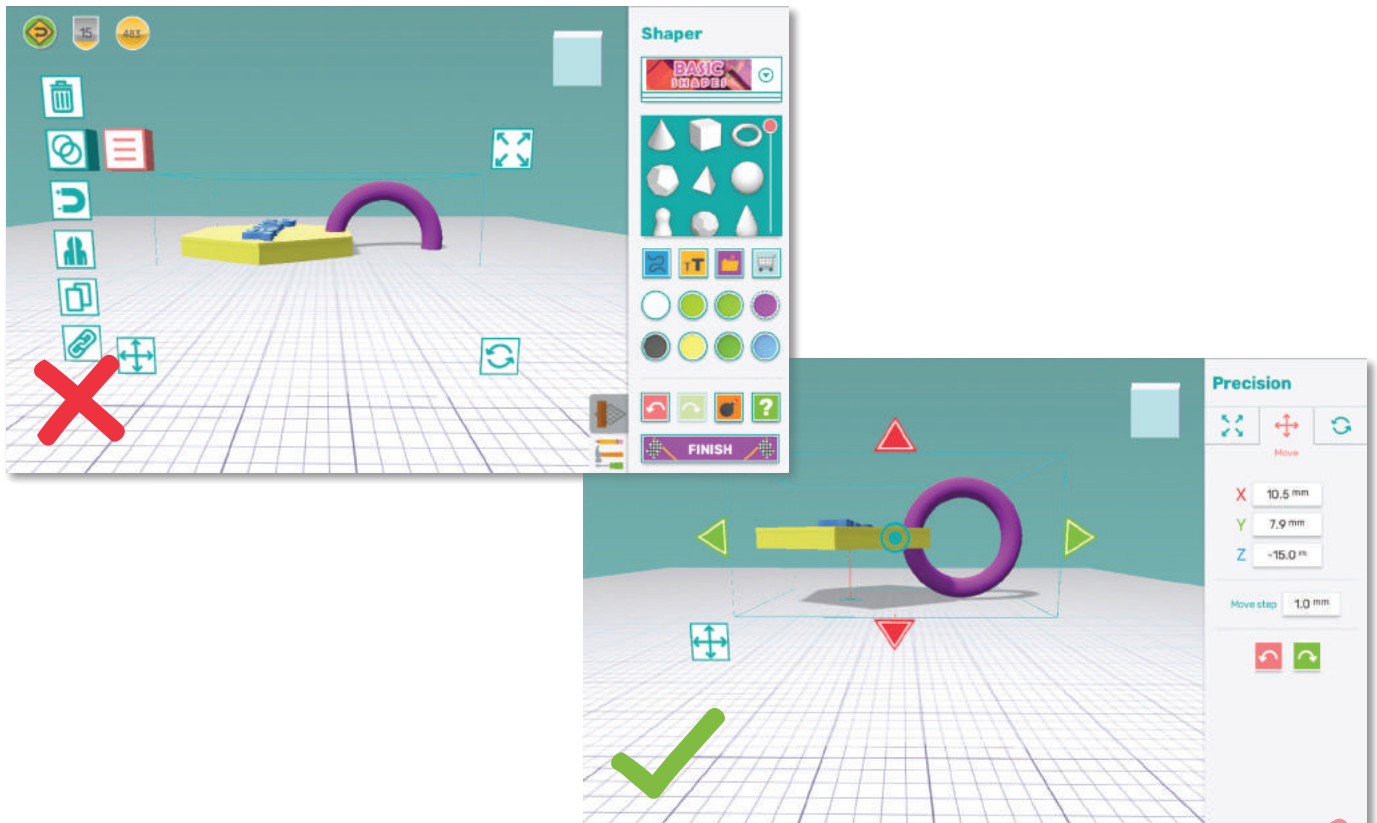
6. Group all your shapes

Click the **Link (Chain)** button. Click all the shapes, then click the **Tick** button.

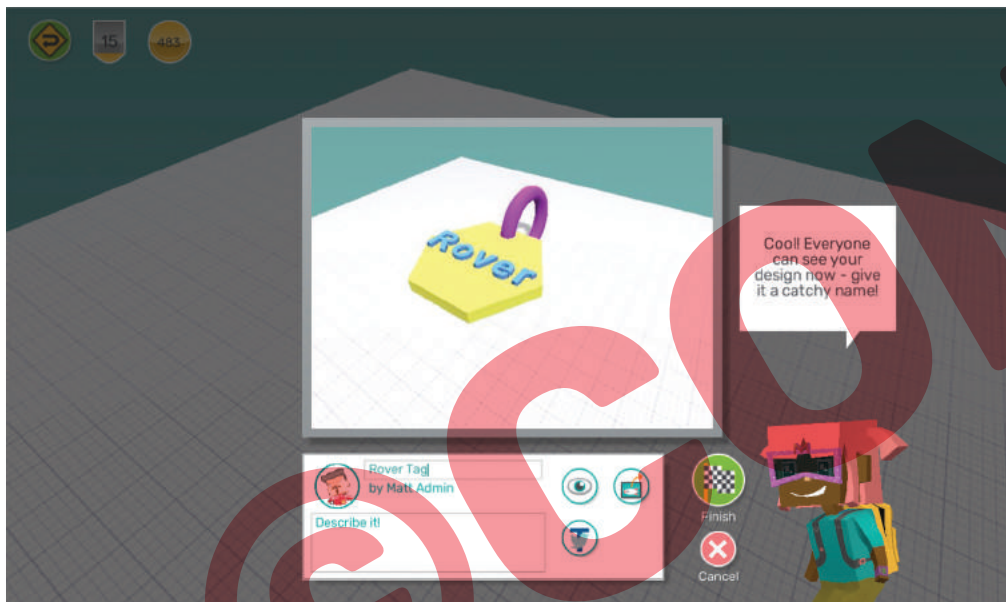


7. **Make sure your tag is not cut off by the work platform (the white rectangle)**

If your shapes are cut off by the platform they won't print! Use the **Move** tool to make your tag sit above the platform.



8. **When you have finished your pet tag, click "Finish" and give it a title**



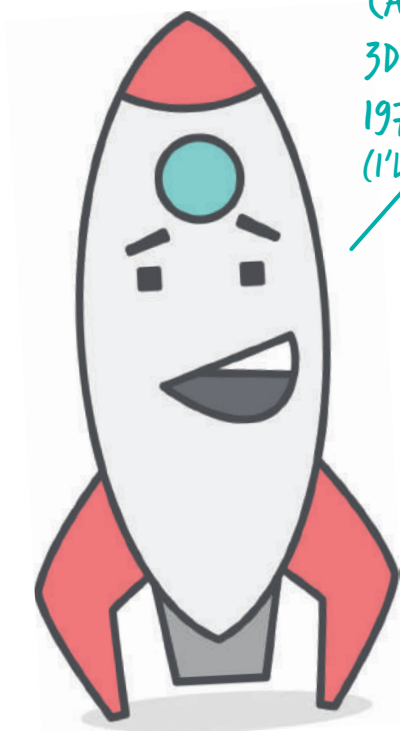
3. All about 3D printing

Description

In this lesson, you will learn all about 3D printers.

You will find out what a 3D printer is and how they work.

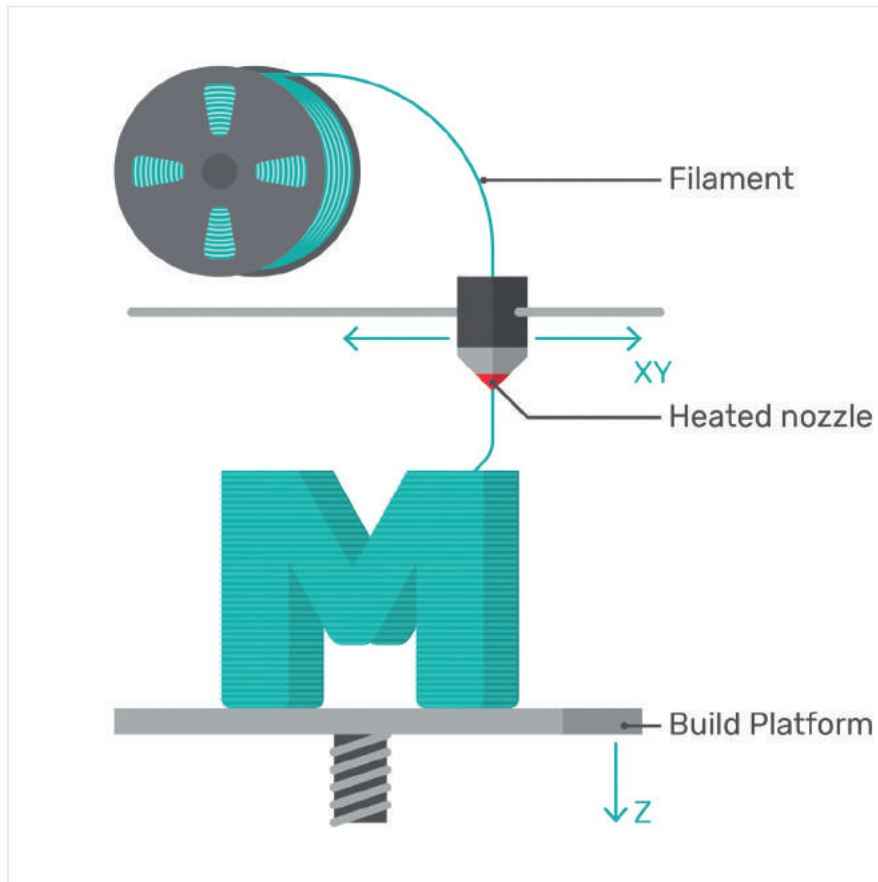
You will discover what 3D printers are being used for in different ways around the world.



CAN YOU GUESS WHEN THE FIRST
3D PRINTER WAS INVENTED:
1973, 1983, 1993 OR 2003?
(I'LL TELL YOU THE ANSWER LATER...)

Teachers' Notes

1. Begin with a demonstration of how the 3D printer works.
2. Print students' pet tags during this lesson
3. Diagram showing the parts students are asked to label on their drawings:



4. In **Step 2**, students should circle all of the pictures to show that 3D printers use many different materials and can be used for many different purposes. 3D printable materials include plastics, metals, sandstone, cement, ceramics, food and biomaterials.
5. An example of a sentence a student might write in **Step 3**, "The 3D printer has a very hot nozzle that melts the plastic filament and then extrudes the melted plastic to build the object one layer at a time."
6. In **Step 4** encourage students to make observations between their 3D printed pet tag and the design they created in the Makers Empire 3D app. They might notice differences in colour, texture or size. They might notice similarities in shape, design or size.

Learning Outcomes

- Identifies factors that impact on products and services to meet community needs and consider sustainability.
- Investigates the suitability of materials, systems, components, tools, and equipment for a range of purposes.

Assessment Rubric

★★★★★★	★☆☆☆☆	★★★☆☆	★☆☆☆☆	★☆☆☆☆
Draws a labeled diagram showing how a 3D printer works using accurate technical language and symbols such as arrows.	Draws a labeled diagram showing how a 3D printer works using accurate technical language.	Draws a labeled diagram showing how a 3D printer works.	Draws a picture of a 3D printer	Does not draw a picture of a 3D printer.
Identifies at least 3 uses for 3D printing from different fields, including an independently research example.	Identifies 3 uses for 3D printing from different fields.	Identifies 3 possible uses for 3D printing.	Identifies less than 3 uses for 3D printing.	Does not identify uses for 3D printing.
Suggests a problem that could be solved using 3D printing including reference to materials, tools and equipment Discusses the limitations of 3D printing to solve the problem.	Suggests a problem that could be solved using 3D printing including reference to materials, tools and equipment.	Suggests a way that 3D printing could solve a problem.	With support, suggests a way that 3D printing could solve a problem.	Does not suggest a way that 3D printing could be used to solve a problem.

Getting to know 3D printers

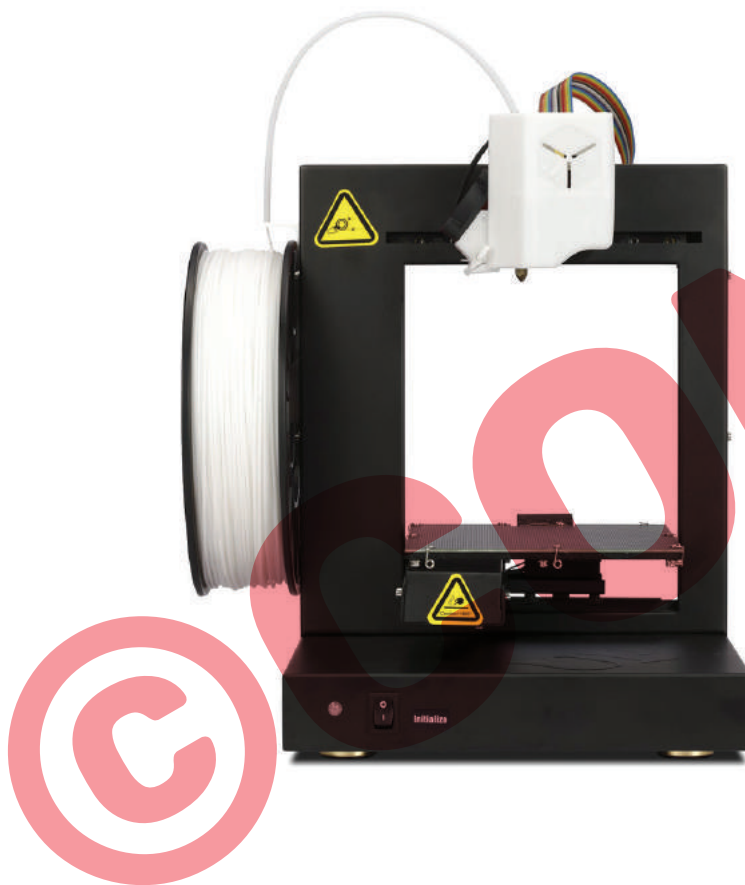
Step 1.

In this lesson, your teacher will show you a 3D printer in action.

Look at this picture of a 3D printer below and label these parts:

- The heated nozzle
- The filament
- The build platform

Can you label any other parts on this picture?



Step 2.

Look at the pictures below. Draw a circle around the things that could be made using a 3D printer:



Step 3.

Remembering the video your teacher showed you. Write a sentence to explain how the 3D printer makes objects.

.....

.....

.....

.....

Step 4.

When your pet tag has been 3D printed compare it to your design in the Makers Empire 3D app.

What has changed?

.....

.....

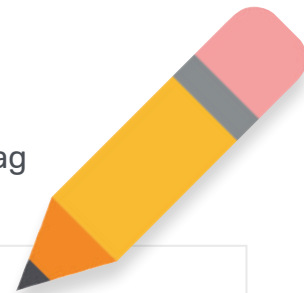
What looks the same?

.....

.....

Step 5.

Draw a picture of your pet, or the pet you know, wearing the name tag you made.



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4. Shaper project: Design a plant marker

Description

In this lesson you will learn how to put shapes together to make a plant marker in Shaper.

Your design can be 3D printed and used to start growing a class plant garden.

You will need to decide which herb you are going to plant.

Your plant marker needs to clearly show the name of the plant and will also need to have a spike to hold it up in the soil.

Once your plant marker is 3D printed you can plant your seeds and keep track of your plants as they grow.

Teachers' Notes

1. Provide a selection of herb seed packets for **Step 1**. Seed packets usually include information about how to grow the herb and how it is commonly used. You may also need to source additional information about herbs from gardening books or websites. You can refer to the Reference Material for this lesson for a few examples.
2. In **Step 3** students list the actual steps they used to design their herb marker such as selecting and resizing a shape to make the spike.
3. In **Step 4** students identify changes they made to their drawn design when creating their herb marker in Makers Empire. These might be aesthetic changes such as choosing a more interesting shape or functional changes such as needing to make the spike longer.
4. Now that you have a great set of herb markers why not set up a class herb garden and eventually cook up a storm with some tasty recipes?

Learning Outcomes

- Explains their design decisions related to the design criteria, including the use of symmetry, shapes, and angles.
- Uses 3D modelling tools to create structurally sound designs, prototypes, and models.
- Plans a sequence of production steps when making designed solutions.
- Describes characteristics of living things.
- Recognises some broad groups of living things. eg. flowering or nonflowering
- Observes a variety of living and nonliving things and infers differences between them.

Reference Material



Cilantro.jpg



Oregano.jpg



Herbs.jpg

Assessment Rubric

★★★★★	★☆☆☆☆	★★☆☆☆	★★★☆☆	★★★★★
Explains decisions and options considered in designing the herb maker including shapes used and other geometric language including angles and symmetry. Explains how the herb marker meets the design criteria.	Explains decisions made in designing the herb marker including shapes used and other geometric language including angles and symmetry. Explains how the herb marker meets the design criteria.	Explains decisions made in designing the herb marker including shapes used. Explains how the herb marker meets the design criteria.	Describes herb marker design.	Does not describe design.
Designs a functionally sound herb marker which meets the design criteria and includes added complexity such as cut-outs or hand drawn shapes.	Designs a functionally sound herb marker which meets design criteria and includes some original design features.	Designs a functionally sound herb marker with a spike and herb name.	With help designs a functional herb marker with a spike and herb name.	Does not design a functional herb marker.
Creates a detailed plan for the steps required to design the plant marker.	Draws and labels a sequence of steps required to design the plant marker.	Draws a sequence of steps required to design the plant marker.	Follows a sequence of design steps provided by the teacher.	Does not follow a sequence of steps.
Describes and compares the characteristics of more than 3 plants, including broad groups that they belong to. Makes connections between characteristics, uses and needs of the plant.	Describes and compares the characteristics of at least 3 plants, including broad groups that they belong to. Makes connections between characteristics and uses of the plant.	Describes and compares the characteristics of 2 plants and identifies a broad group that the plants belong to.	Describes the characteristics of 2 plants and identifies a broad group that the plants belong to.	Describes characteristics of 1 or 2 plants with limited detail

How to make a plant marker

Step 1.

Do some research about plants and decide which plant you are going to grow.

Complete the information about the plant you have chosen:

- Name of plant:

.....

- Growing conditions:

.....

.....

- Common uses:

.....

Is it flowering or non-flowering?

.....

Draw a picture of the plant.

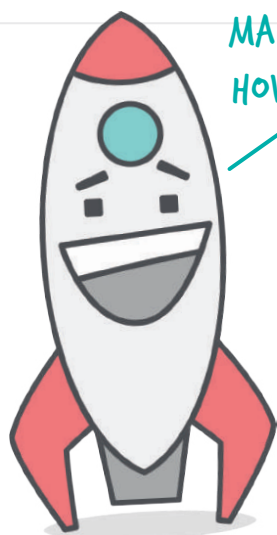


Step 2.

Draw your design idea for a plant marker here.



DRAFT



MANY PLANTS ARE GROWN FOR FOOD.
HOW MANY CAN YOU THINK OF?

Step 3.

Follow the steps to design your plant marker in Makers Empire 3D.

The design criteria for your plant marker are:

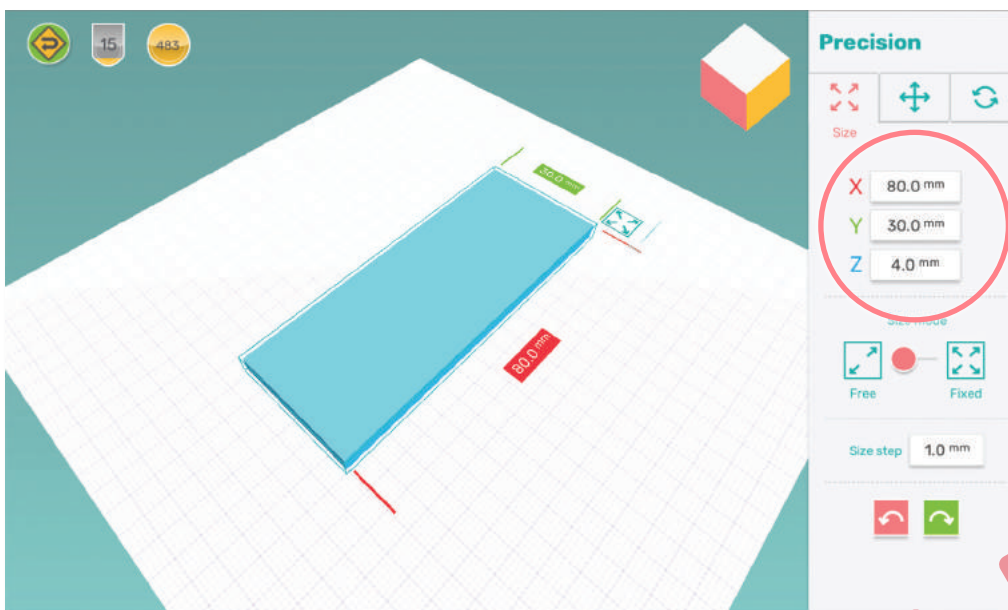
1. Must have a spike to hold the marker in soil.
2. Must clearly show the name of the plant.

Making a plant marker

1. **Log in to Makers Empire 3D and open Shaper**

2. **Select your base shape**

You can use any shape, but flat shapes work best. Resize your shape to match your drawn design.



3. **Add a spike**

A flat triangle is a good shape to use.



PRO TIP!

Use the **Group** tool to make sure your shapes stay together when you move and resize them. Click the Group button, choose the shapes you want to keep together, then click the **tick** button.



4. Add the name of your plant

Use the **Text** tool to write the name of your plant, then use the **Resize**, **Rotate** and **Move** tools to position the name.



5. Add extra decorations if you want to



Step 4.

List the steps you followed to create your plant marker.

1.
2.
3.
4.
5.

Step 5.

Compare your 3D plant marker with the drawing of your original idea. What changes did you make and why?

.....

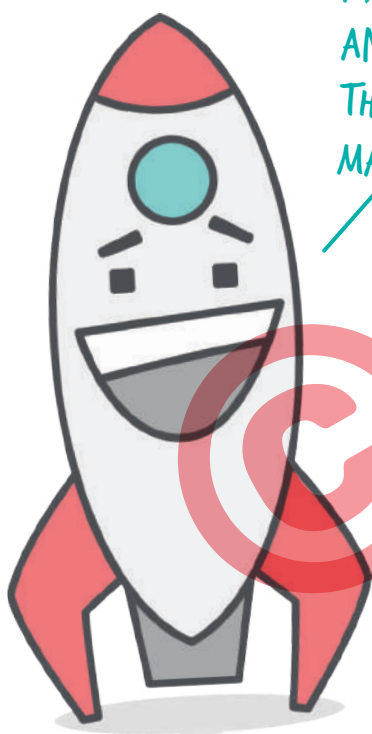
.....

.....

.....

.....

.....



OH, HI THERE!
ARE YOU LOOKING FOR THE
ANSWER FROM PAGE 18?
THE FIRST 3D PRINTER WAS
MADE BY CHUCK HALL IN 1983.

CONFIDENTIAL

Makers Empire Design Curriculum: Crestar Pilot Edition

The Makers Empire Design Curriculum describes the development of skills, knowledge, and understandings across K-6.

The aims of the Makers Empire Design Curriculum are that students:

- develop confidence as designers and problem solvers.
- use design thinking processes to generate and communicate design ideas
- produce designed solutions suitable for a range of technologies contexts by selecting and manipulating a range of materials, systems, components, tools and equipment creatively, competently and safely; and managing processes
- evaluate processes and designed solutions and transfer knowledge and skills to new situations
- become competent users of 3D design and 3D printing.
- Spatial awareness
- understand how technology is and can be used to develop designed solutions in real-world contexts and for a range of users.

The Makers Empire Design Curriculum is aligned to and based on design and technology, and engineering curricula from around the world including:

- The Australian Curriculum: Technologies, Design and Technologies
- The NSW Syllabus: Science K-10 (incorporating Science and Technology K-6)
- Victorian Curriculum: Technologies, Design and Technologies
- Next Generation Science Standards (NGSS): Engineering Design (US)
- ISTE Standards for Students: Innovative Designer
- UK National Curriculum

The Crestar pilot edition includes links to MOE Singapore Curriculum

The Makers Empire Design Curriculum has 6 content strands:

1. Technology Applications
2. Investigating
3. Generating Ideas
4. Prototyping and Modelling
5. Testing and Evaluating
6. Planning and Managing

The 6 content strands include skills, knowledge and understandings that develop across three bands:

K-2, 3-4 and 5-6

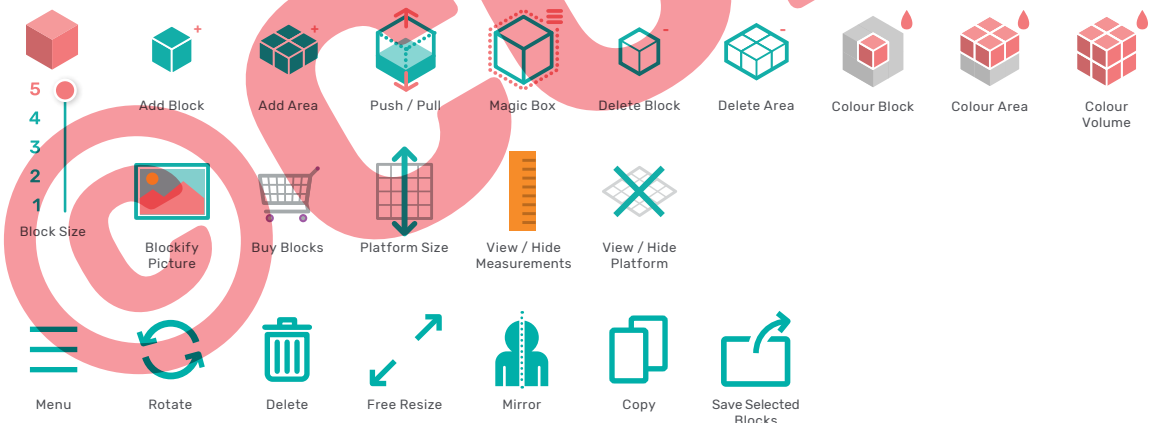
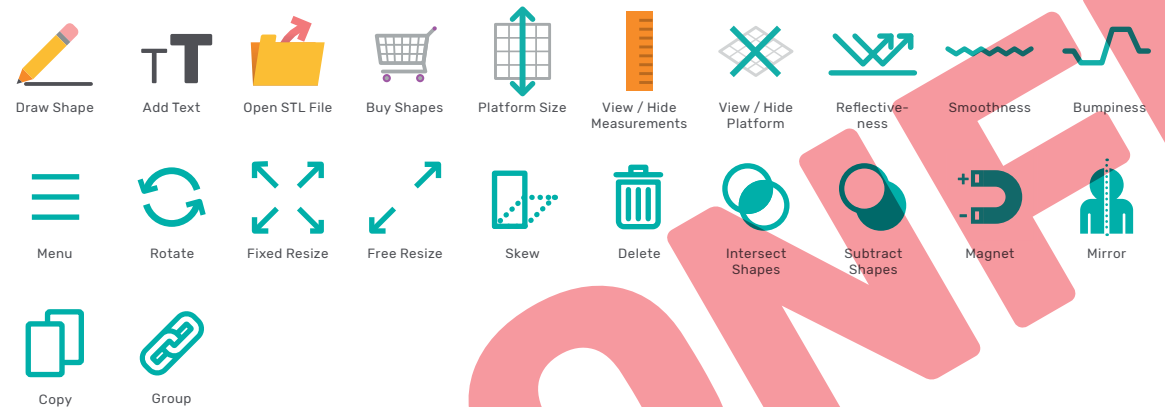
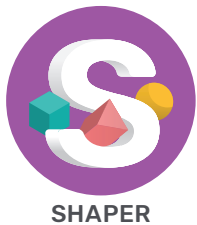
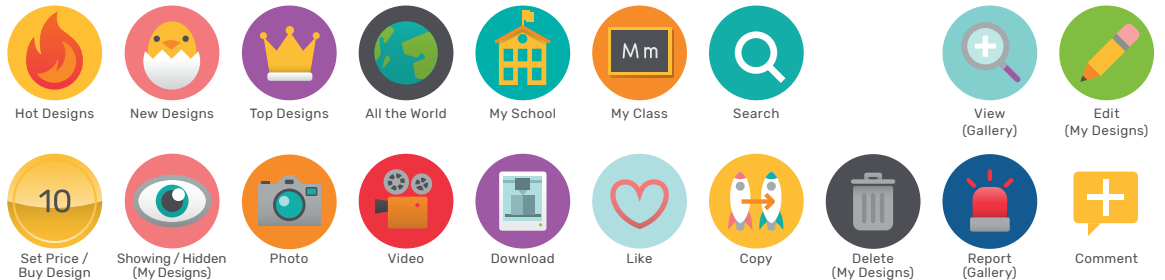
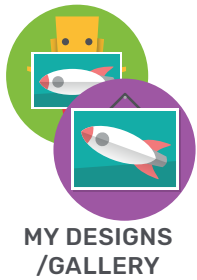
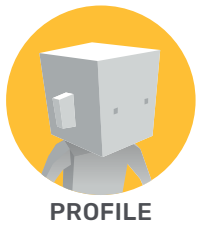
Mathematics sub strand: Geometry	
2D Shapes	<ul style="list-style-type: none"> identifying, naming and describing 2D shapes (semicircle, quarter circle) identifying the basic shapes that make up a given figure forming different 2D figures with rectangle, square, triangle, semicircle, quarter circle copying figures on dot grid or square grid
3D Shapes	<ul style="list-style-type: none"> identifying, naming, describing and classifying 3D shapes (cube, cuboid, cone, cylinder, sphere)
Mathematics sub strand: Area and Volume	
Area and Perimeter	<ul style="list-style-type: none"> concepts of area and perimeter of a plane figure measuring area in square units perimeter of rectilinear figure, rectangle, square area of rectangle/square
Mathematical Processes: Thinking Skills	
	<ul style="list-style-type: none"> classifying, comparing, sequencing, generalising, induction, deduction, analysing, synthesizing
Science: Diversity: Knowledge, Understanding and Application	
	<ul style="list-style-type: none"> Describe the characteristics of living things. <ul style="list-style-type: none"> need water, food and air to survive grow, respond and reproduce Recognise some broad groups of living things. – plants (flowering, non-flowering) Relate the use of various types of materials (ceramic, fabric, glass, metal, plastics, rubber, wood) to their physical properties.
Science: Diversity: Skills and Processes	
	<ul style="list-style-type: none"> Observe a variety of living and nonliving things and infer differences between them. Classify living things into broad groups (in plants and animals) based on similarities and differences of common observable characteristics. Compare physical properties of materials based on strength, flexibility, durability, and other qualities.
Science: Diversity: Ethics and Attitudes	
	<ul style="list-style-type: none"> Show curiosity in exploring the surrounding living and non-living things by asking questions. Value individual effort and teamwork by respecting different perspectives. Show objectivity by using data and information to validate observations and explanations about the properties and uses of materials

Makers Empire Design Curriculum 3-4

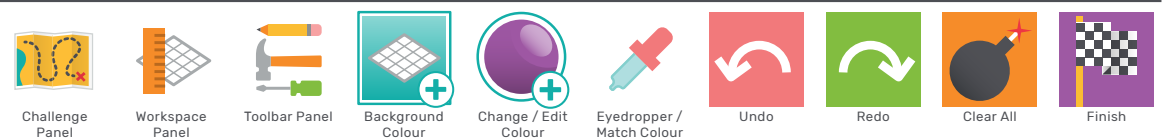
Learning Outcomes	
1	Technology Applications
	Identifies factors that impact on products and services to meet community needs and consider sustainability.
	Explains how forces and the property of materials affect the way a product behaves or performs
	Investigates the suitability of materials, systems, components, tools and equipment for a range of purposes
2	Investigating
	Defines a problem by identifying opportunities, critiquing needs, making predictions and analysing collected data
	Identifies criteria for success for a designed solution including sustainability considerations
3	Generating Ideas
	Generates and compares design ideas and makes decisions about design ideas most likely to meet the design criteria and constraints.
	Communicates and records design ideas using technical terms and graphical representation techniques.
4	Prototyping and Modelling
	Uses and chooses specific features in digital 3D modelling tools
	Interprets information and follows instructions using directional language.
	Explains their design decisions related to the design criteria, including the use of symmetry, shapes and angles.
	Uses 3D modelling tools to create structurally sound designs, prototypes and models
5	Testing and Evaluating
	Develops fair tests with guidance to evaluate designs against identified design criteria
	Makes further improvements and iterations of designs based on test results and feedback in order to address design criteria
6	Planning and Managing
	Plans a sequence of production steps when making designed solutions
	Works collaboratively with others to plan, make and evaluate designs that address identified criteria

QUICK GUIDE

Get started designing in Makers Empire 3D with this quick visual guide to the most used tools and navigation buttons.



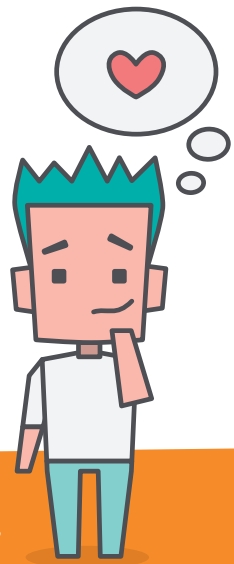
COMMON



D E N T I A L

Design Thinking for Schools

No problem is too big when you think like a designer!



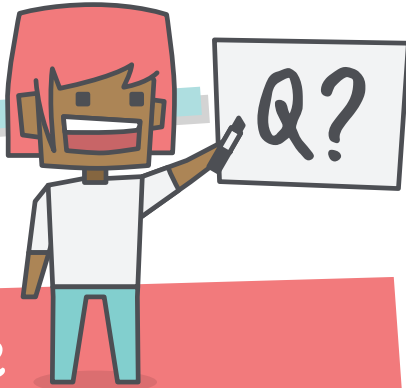
Empathise

Learn about your audience - that's the people you want to help.



Define

Decide how you can best help your audience. Where can you make the biggest difference?



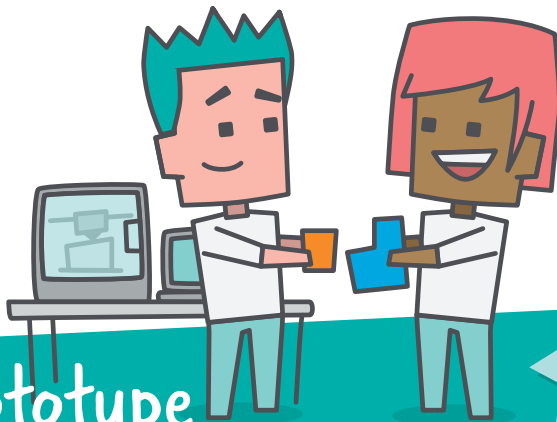
Ideate

Be creative and think of as many solutions as you can. 'Crazy' ideas are welcome!



Prototype

Make something that explains your best ideas to other people. Rough is okay!



Repeat?

Your first idea probably won't be perfect. That's okay - keep trying!

Test

Show your prototypes to your audience to see if they work, or if you can make them better!

