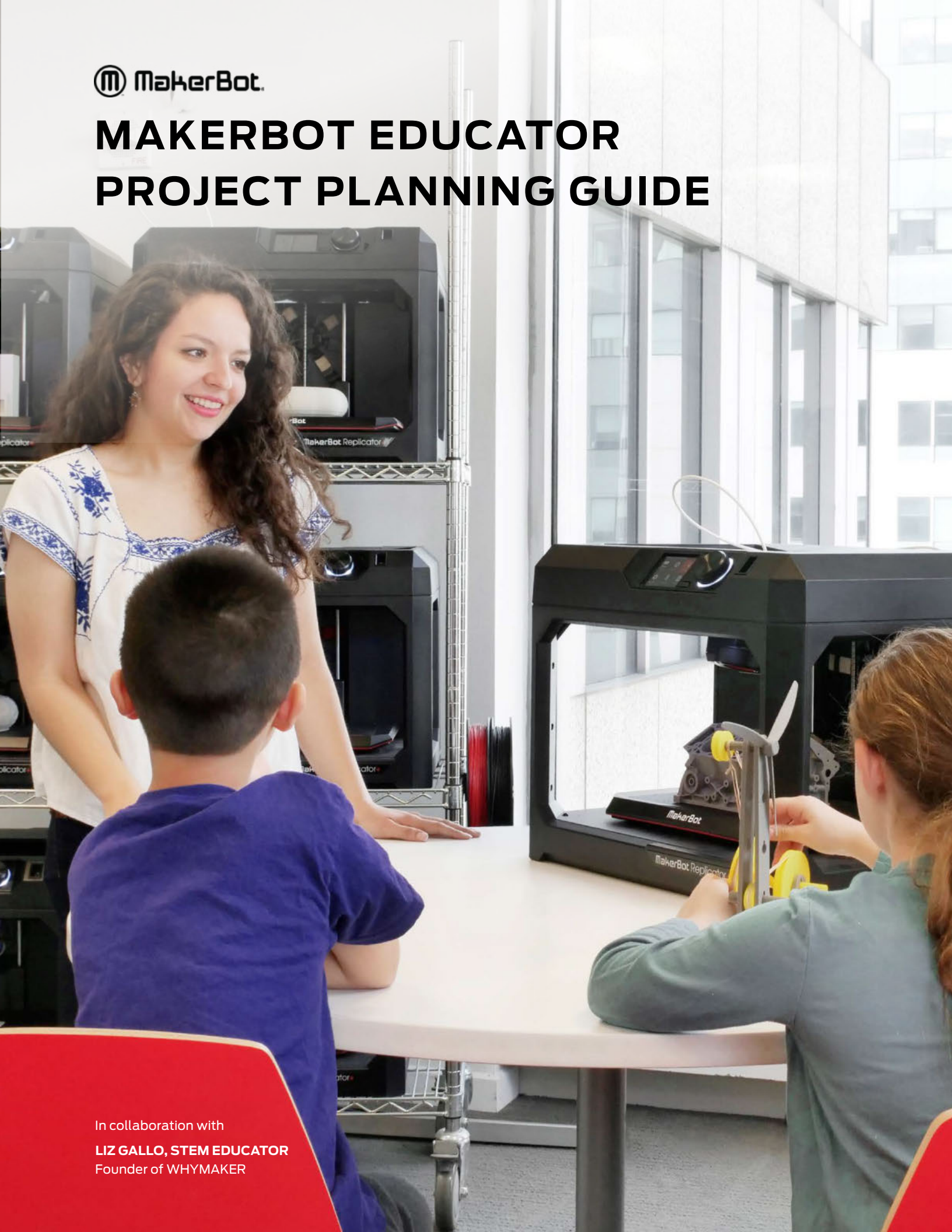
MakerBot

MAKERBOT EDUCATOR PROJECT PLANNING GUIDE



In collaboration with

LIZ GALLO, STEM EDUCATOR
Founder of WHYMAKER

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Replicator + Educators Edition

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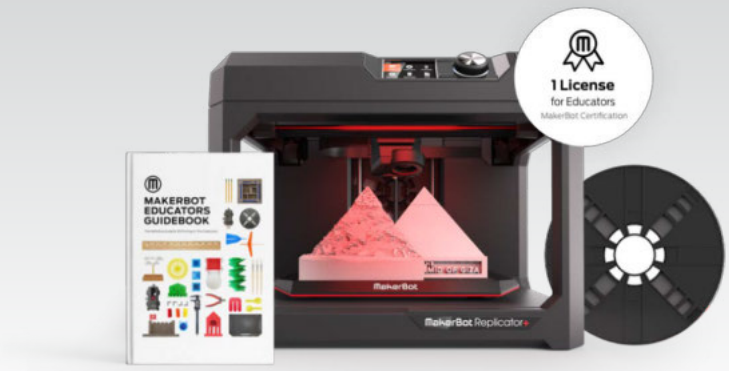

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MAKERBOT EDUCATOR PROJECT PLANNING GUIDE

You did it! You got a MakerBot 3D printer for your class! Phew, I bet that was a nerve wacking process and you made many strategic decisions.

Even better, your 3D printer is unboxed and printing! Your students are about to walk into your classroom for the first time and see it; you can't wait to see the look on their faces and the excitement in their voices.

The bell rings and students stagger into the classroom; no one seems to notice the printer until it makes its robotic noise sending the print head back across the x plane.

One student bounces over, "Hey Ms. Gallo, is this a MakerBot 3D printer?"

"Yes Jackson, it is!"

"Hmm..." Jackson inquires "But what are we going to do with it?"

Panic shoots through your heart, you think 'what ARE we going to do with this printer? I begged, I pleaded I finally got the 3D printer and then I think I offered up my lunch break all next year so that tech support would help me set it up. How am I going to teach all of the important content and units I usually have to teach while giving my students real opportunities to use the 3D printer?'

Seem familiar? Well, this guide will help you plan, measure, and assess performance on a meaningful 3D printing project. It follows a methodology that will usher you to apply 3D printing into current content areas while overcoming the technology barriers. Walking through this guide will help you overcome any fears you have about 3D printing, and give you ideas and suggestions for printing successfully with your class.

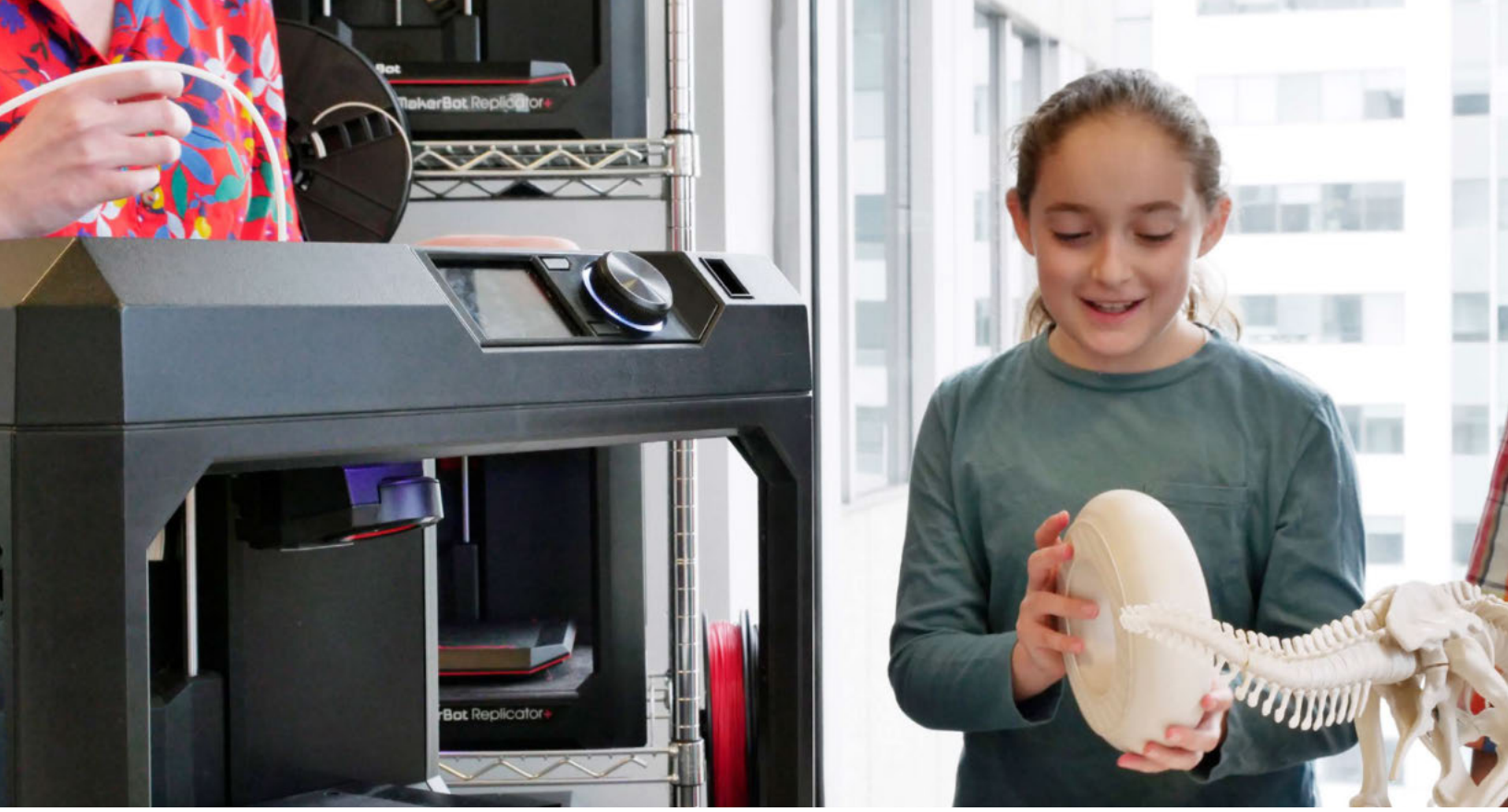
QUICK TIP:

1. Print and use this guide as often as necessary to develop multiple 3D printing projects.
2. Use the quick *Project Planning Blueprint* at the back of this guide to assist you with your project planning journey.

In collaboration with
Educator Liz Gallo
Founder of **WHYMAKER**

ABOUT LIZ GALLO

Liz Gallo is a Technology & Engineering Educator passionate about helping students becoming problem solvers and design thinkers. She is recognized as a leader in the New York State education scene, facilitating conversations about the future of education for all students. WhyMaker is a professional development organization providing curated STEM and Maker Education training to all teachers. WhyMaker's mission is to support all educators in feeling comfortable and confident engineering students' hands-on, technology-rich, project based learning experiences.



When creating a 3D printing project there are 3 major areas to focus on:

PURPOSE - Connecting to content + meaningful engagement
LEARNING - Ownership of content + technology
LOGISTICS - How to 3D print in the classroom

Using this guide will act as your template. Fill it out and answer each question thoroughly to hit all 3 of these areas in your teaching successfully.

Each section includes these icons to help focus on specific components of this methodology:

TEACHER WORK

Things for the teacher to plan and keep in mind while creating a project.

TIMING

Remember to think about timing and the timeline of your project.

STUDENT WORK

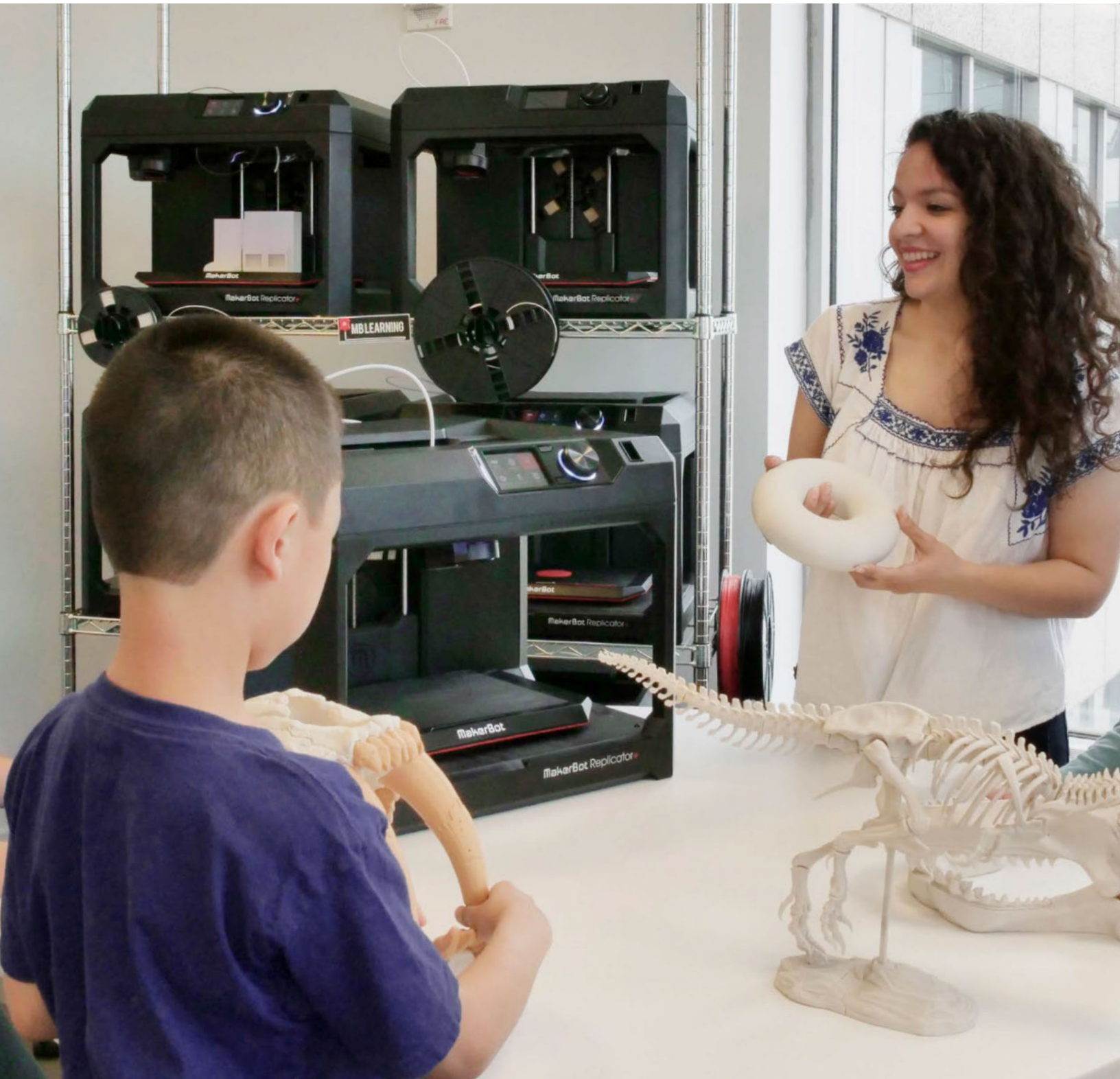
Information that students need to know, questions and work students have to complete.

LOGISTICS

Organizational and planning tips for teachers.

PURPOSE

Use this section to develop meaningful 3D printing projects for your students. 3D printing becomes powerful and useful in your classroom when students are connecting it to the content areas they are already learning and/or are creating a solution to a problem.



INTEGRATION WITH OTHER SUBJECT AREAS

TEACHER WORK

The best 3D printing projects are authentic and meaningful while connecting to an existing lesson that helps to solve a problem. When students create their own 3D design, they are empowered to exercise creativity and learn through using new technologies.

Coming up with a meaningful 3D printing project for students can be challenging. Start by looking at the requirements for what you are expected to teach your students.

Ask your curriculum: what can students create using a 3D model to demonstrate what they know? What can students create using a 3D model to solve a problem within the context of your curriculum? What are all your expectations for student learning in this project?

TRY VARIATIONS ON THESE PROJECT IDEAS:

1. MAPPING + LANDMARKS

Teaching about World War 2? Have students connect with a WW2 veteran or read a biography of a WW2 veteran and design and build a monument to tribute that veteran.

2. HABITATS

Teaching about adaptations? Create new animals and have students design and build habitats for that animal.

3. TOOLS

Create a tool to help you eat your favorite food perfectly.

4. STRUCTURES

Design a model of a park, a community, a school, using specific architecture features.

5. ASSISTIVE DEVICES

Have students go out into the world or school and find issues to solve using a 3D printer, maybe the secretary's desk is wobbly. Can your students fix it?

6. LEARNING MANIPULATIVE

Have students connect with teachers of other subjects and other grades to create different manipulative for others, OR have students design and 3D print models of content they are learning about.

7. NEW BUSINESS IDEAS

Allow students to dream up the best new product and 3D print prototypes of it. Then have them "pitch" their ideas.

8. DESIGNING A SOLUTION

Have students determine a problem in the real world and design a solution using the design thinking process.

QUESTIONS TO THINK ABOUT....

What is the big idea? Why are students engaging in this 3D printing project? What is the driving question?

LIZ'S NOTES:

What content is necessary for students to learn before they design their 3D model? How will your students learn the necessary content?

There is still content specific knowledge that students need in order to create 3D designs. They cannot design monuments of World War 2 veterans if they do not know anything about the World War 2 veteran. What knowledge do students need in order to build the best content rich 3D model they can design?

OBJECTIVES

BEFORE THE PROJECT STUDENTS WILL KNOW:	**AFTER THE PROJECT STUDENTS WILL BE ABLE TO DEMONSTRATE:**
Content (Cognitive)	Content (Cognitive)
Technology/MakerBot 3D Printer (Psychomotor)	Technology/MakerBot 3D Printer (Psychomotor)
Personal Growth (Affective)	Personal Growth (Affective)

On **PAGE 19** is the assessment rubric, which uses these objectives to determine if students exceed, meet or do not meet these learning objectives.

TIMELINE

What is your project timeline? In total, how much time can you allot for your students to work on this project during class time? We will come back to this question, but keep in mind the amount of in-class time students have to complete this project.

GROUPING

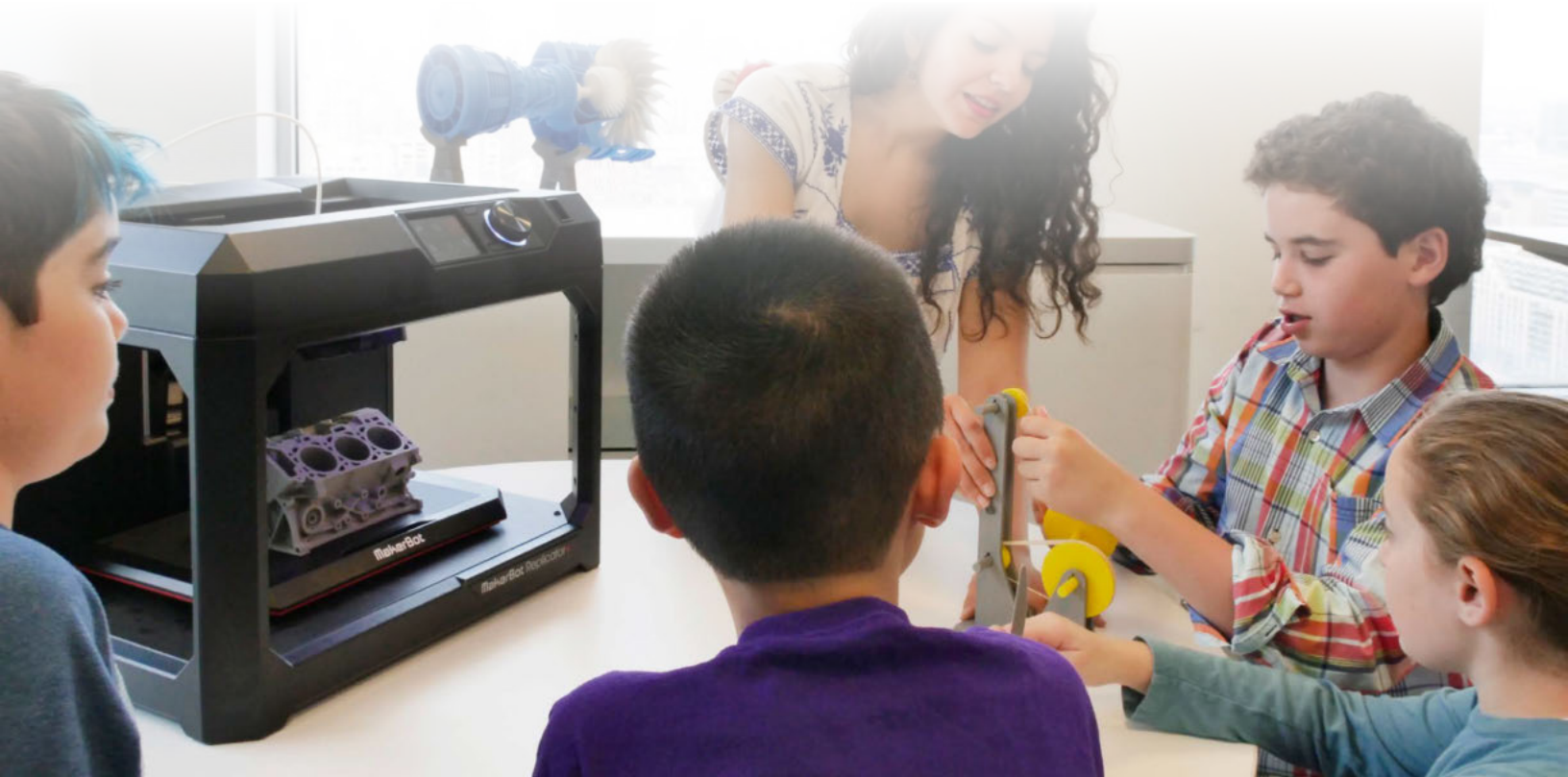
TEACHER WORK

Will students be grouped? How? How many projects will be printed?
How will you decide who prints or in what order from the group?

- Students can vote on the best design to print
- Teacher can select specific students prints
- Teacher can scatter projects over a long period of time
- Prints can be sent to a makerspace with multiple printers
- Allow all students to print their projects

LIZ'S NOTES:

The only way to learn how to 3D model is to give all students the opportunities to do it themselves. It is a very personal experience in which each person sees their 3D world in their own way. It is recommended that each student create their own 3D model. But it may be difficult for ALL students to use the 3D printer to print out their creation.



STUDENT CHALLENGE

STUDENT WORK

Fill out the questions below to help guide you in your project planning journey.

1. What will students be challenged to design and print?

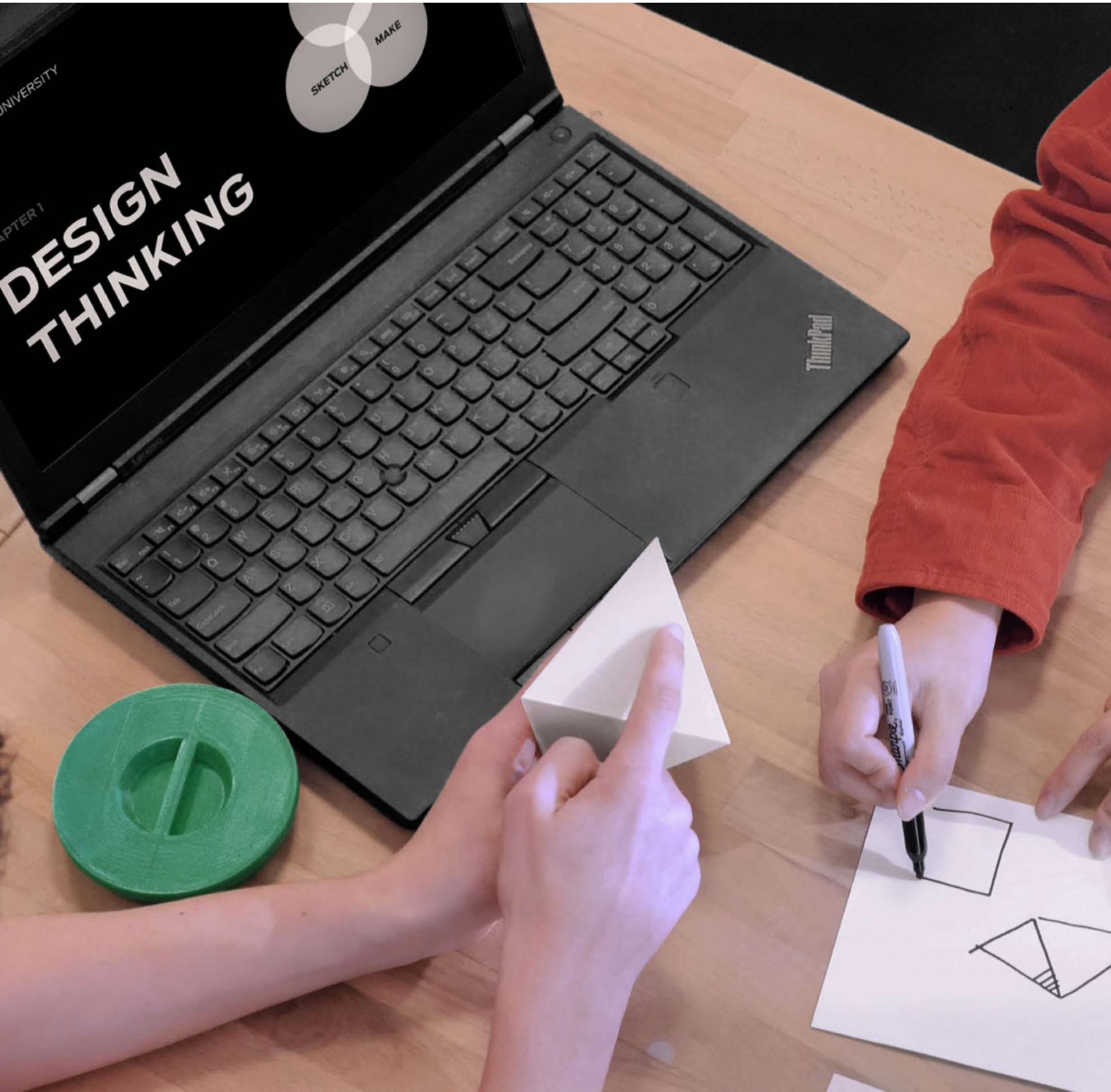
2. What are the specifications?
Specifications are things that the design must have

3. What are the constraints?
Constraints are things that limit a design (size, shape, time, materials)

4. How will you address these constraints?

LEARNING

Determine how your students will learn about the specific content they need to know. Also, how will they learn about the 3D modeling software and how to use the Makerbot 3D Printer?



STUDENT CONTENT LEARNING & RESEARCH

Fill out the questions below to help guide you in your project planning journey.

TEACHER WORK

What do students need to know about the content and subject matter before starting a 3D design?

STUDENT WORK

1. How will they learn the content and subject matter?

2. How will they prove they know the content and subject matter?
   What type of assessment will they participate in?

TIMELINE

Estimated Duration - How long will this project take?

Estimated Duration - How will time be split between subject matter and 3D design?

LEARNING 3D MODELING SOFTWARE

TEACHER WORK

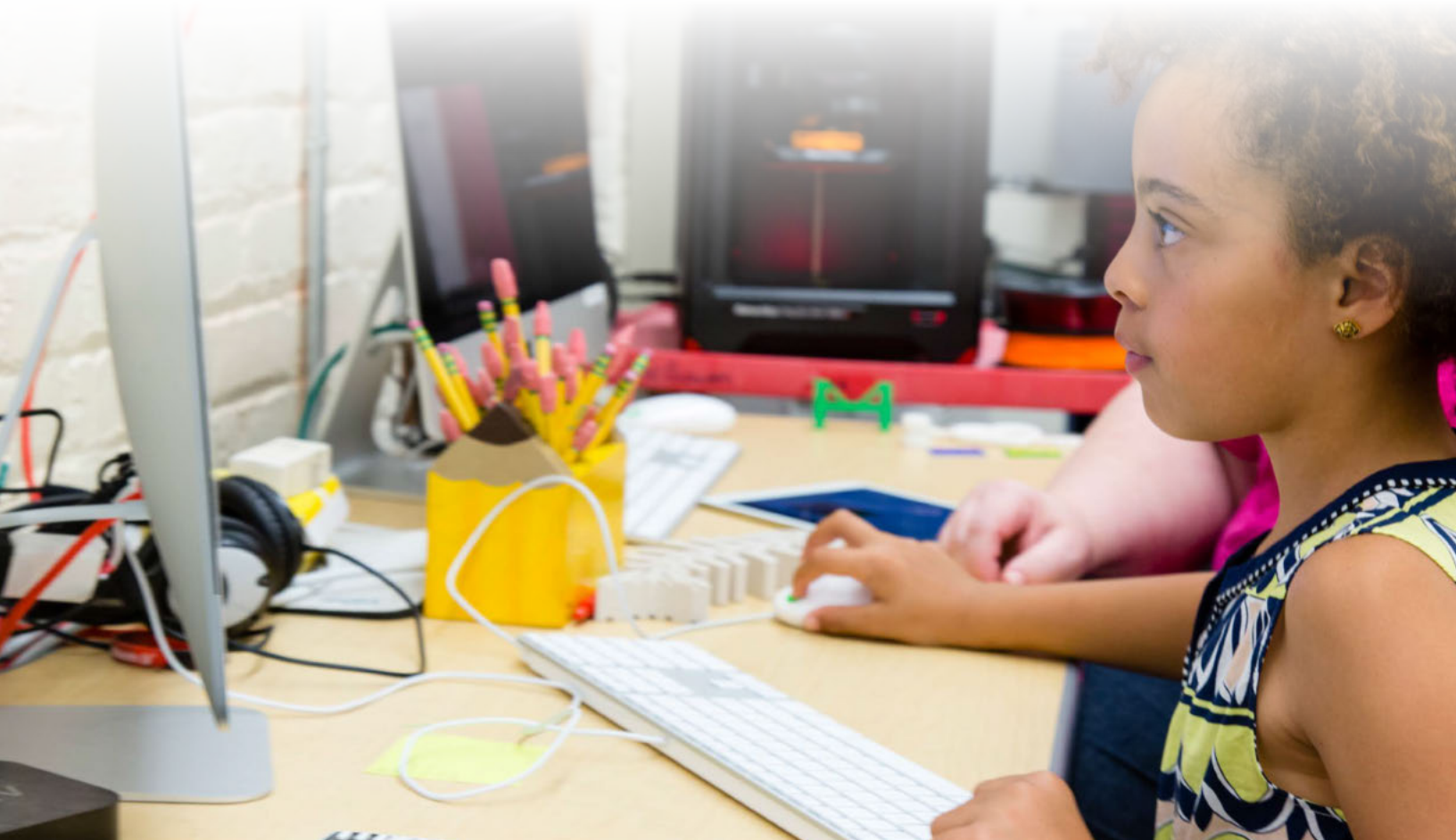
Fill out the questions below to help guide you in your project planning journey.

1. How will students learn 3D modeling software?

We recommend getting started with TinkerCad at www.tinkercad.com

2. What resources are available to your students to learn the 3D modeling software?

3. Are there tutorials, videos, local experts, teacher-led instructions, and practice projects?



STUDENT IDEATION = PUTTING TOGETHER THE IDEA

STUDENT WORK

BRAINSTORM

Give students creative freedom and allow them to think of anything they want with no wrong answers or judgements. Encourage them to write or draw every idea. How many brainstorms do you want students to come up with? This is an important step before going into 3D modeling because it helps generate ideas quickly.

PLANNING

Students will choose a final design from their brainstorms.
How will students plan their object to 3D print?

Will they plan with a...

- Detailed sketch
- Play dough model
- Paper model
- Cardboard model

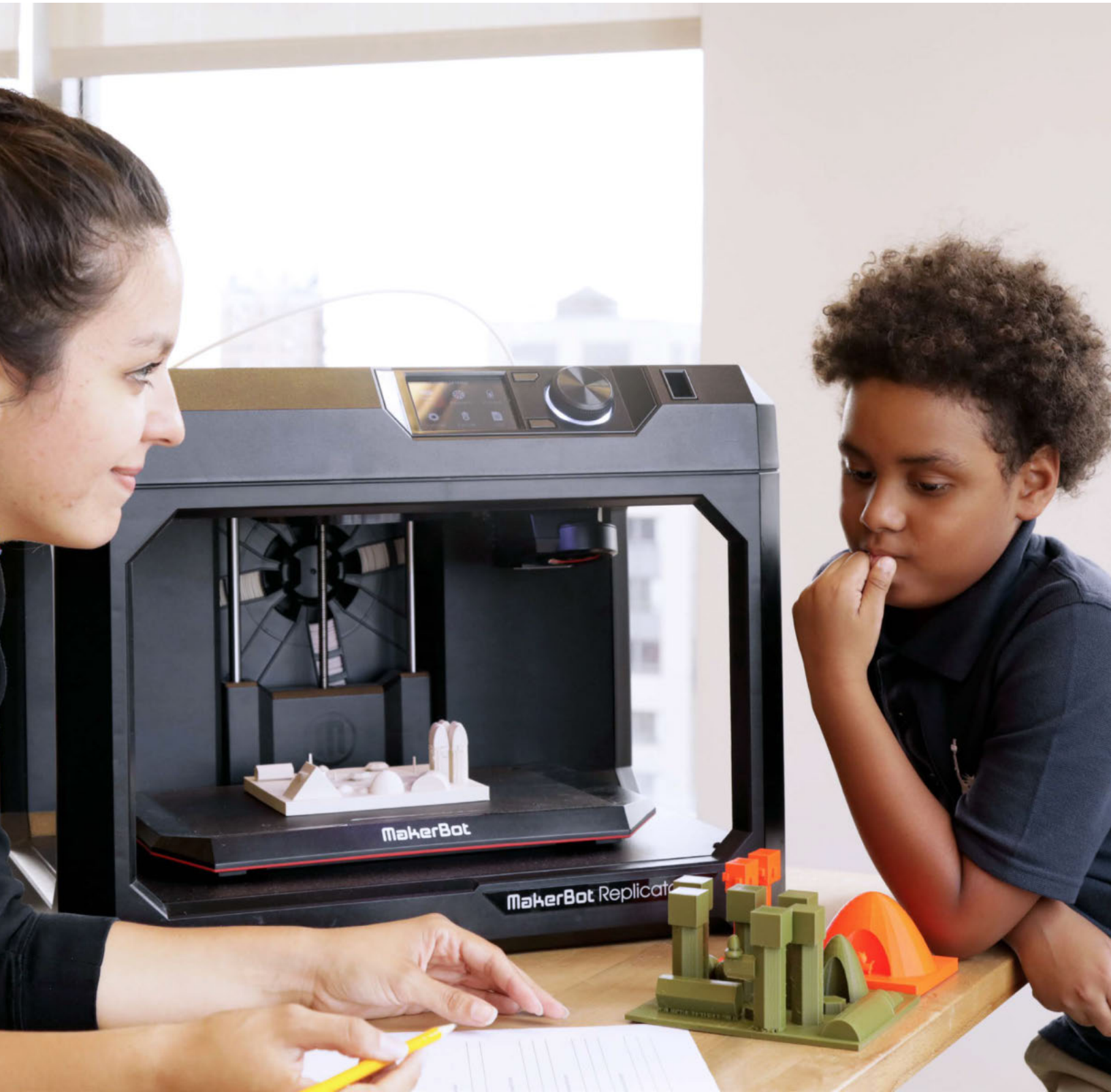
Sometimes it is tricky to figure out how to transition a 2D drawing to a 3D model. Encourage your students to use as many of these methods as needed.

LIZ'S NOTES:

If students are struggling with designing in 3D, give them play dough to create a model in 3D. Pay attention to students with spatial awareness difficulties; they may need multiple methods of modeling in the physical world before jumping into the digital.

LOGISTICS

Plan out how your classes will use the Makerbot 3D printer. How will students create 3D models, review their models, print, and assess their work.



STUDENT MODELING

TEACHER WORK

How will students practice using 3D modeling software?

- Tinkercad, Fusion 360, and OnShape are great places to start practicing. Frain your browser without downloading.
- Tutorials, teacher-instructed, online videos (flipped classroom), exploratory, practice project, birdhouse, where everyone creates the same? What will it be?

A good 3D design lesson, like a good computer science lesson, follow a pedagogical formula.

The formula is probably very similar to other ways you know how to teach:

COPY ▶ CHANGE ▶ CREATE

Allow students to start learning a new program by copying exactly what you do. Then give them some freedom to change the project.

LIZ'S NOTES:

When first introducing 3D design skills, we usually teach teachers how to build a keychain name tag. We begin by getting everyone to create the same base plate, 10cm long, 4cm wide, 2cm high and adding a hole for the ring. Then we allow them to change the design by adding their name and other shapes. Finally, they are allowed to create their own project, whatever they are interested in.

TIMELINE | MODELING

How long will students have to model their final design?

REVIEWING & EDITING 3D MODELS

LOGISTICS

If working within a group, what will each student be working on? Will they be working on entirely different models, or the same model, or the same design with individual twists?

How will students' name their files? It is SO IMPORTANT to explicitly teach students a naming structure. It may include things like student name, class, project title, or even the color they want to print in.

How will students 3D models be reviewed? How will groups or classes decide which model to print?

Peer review, teacher review, paper print out CAD file, email review, over the shoulder check, expert review, interviews?

LIZ'S NOTES:

Peer reviewing is a powerful way to help students engage with one another and learn from their counterparts. Doing projects like these are not meant to be competitive. In the real world, collaboration is valued way more than competition. Helping students see this will set them up for success. Students should be encouraged to review each other's work and give feedback that is kind, specific and helpful. Check out this Students Peer Review Worksheet for TinkerCad: https://www.teacherspayteachers.com/Product/Student-Peer-review-worksheet-for-Tinkercad-file-4275058

TIMING | REVIEWING & EDITING 3D MODELS

How much time will students have to edit their project?

TRANSFER .STL TO MAKERBOT PRINT SOFTWARE

LOGISTICS

1. How will students transfer a file from the 3D modeling software to a .STL file?
2. What other activities are going to be introduced while students are waiting to print?

WHAT IS AN .STL?

An .STL is the universal file type for a 3D printable model.

1. HOW WILL STUDENTS' .STL FILES BE TRANSFERRED TO THE MAKERBOT 3D PRINTER?

Students will...

- Upload .STL design to Makerbot Cloud
- Put a copy on the flash drive or SD card
- Upload a copy of the file to Google Drive or Classroom
- Email a copy to their teacher
- Share their file with teacher
- Download file on dedicated 3D printer
- Queue files in cloud print account

Teachers will...

- Pull them from each account
- Have all students logged into one CAD account

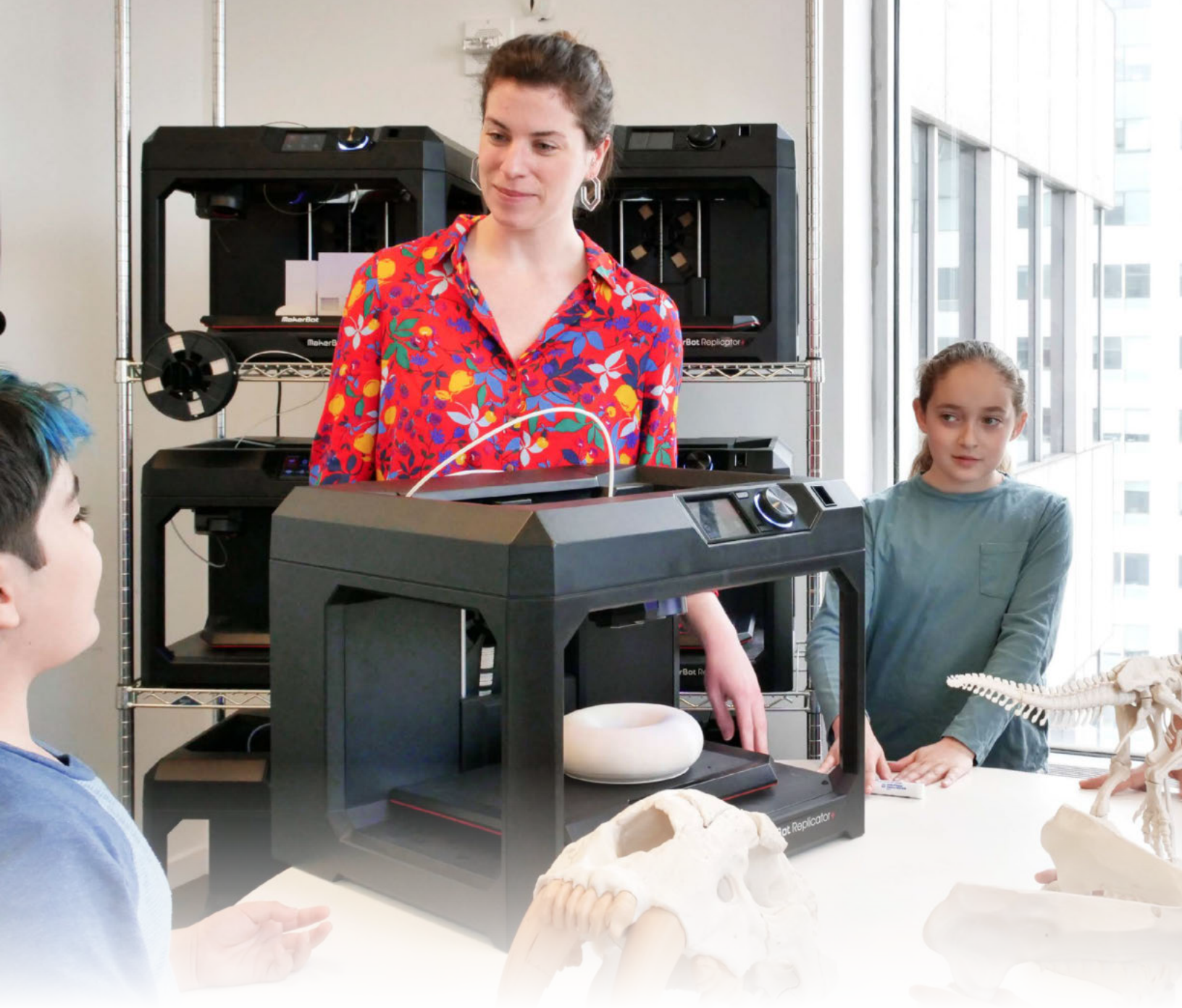
2. HOW WILL THE ORDER OF PRINTS BE DETERMINED?

- First come, first serve basis
- In alphabetical order
- By color (teachers can print multiple models on a single plate)
- By estimated print time

3. HOW WILL COLORS OF FILAMENT FOR PRINTING BE SORTED?

If students want to print different colors, how will you make this as easy as possible for everyone?

- Only one color per flash drive
- One color per printer
- Order of printing
- Class based color
- No option
- Print white and color with Sharpie markers after



LIZ'S NOTES:

Managing projects like this can be tricky. Make sure your students know and understand that this project will take time and patience; and to manage expectations. Sharing the progress, timeline, and logistics with students will help them feel more comfortable while learning any new technology.

TEACHER ASSESSMENT & STUDENT EVALUATION

TEACHER WORK

What is important to assess? Refer back to the purpose of the project and the objectives to determine assessment points.

CONCERNS/AREAS THAT NEED WORK TO MEET OBJECTIVE	ASSESSMENT STATEMENT MEETING THIS OBJECTIVE	ADVANCED EVIDENCE OF EXCEEDING OBJECTIVE
	Cognitive Assessment Statement: *Content* *Ex. Students will identify cloud types based on characteristics, appearance, and altitude.*	
	Affective Assessment Statement: *Technology / MakerBot 3D Printer* *Ex. Students will demonstrate their knowledge of cloud types by presenting the cloud type they designed and printed to the class.*	
	Psychomotor Assessment Statement: *Personal Growth* *Ex. Students will convert and manipulate their hand drawing of a cloud type through the TinkerCad software.*	
1-2 (Objective not met / Objective partially met)	3 (Objective met)	4 (Exceeds objective expectations)

LIZ'S NOTES:

For more help with identifying performance measures and providing feedback on essential skills, check out this great resource:

https://nyctecenter.org/life-career-competencies-framework

STUDENT WORK

Have students self-evaluate their final print.

- Did the solution build correctly?
- Does it look like what it was supposed to look like? Does it look like your original sketch?
- Are you happy with your print? What would you do differently next time? What did you learn?

ACADEMIC STANDARDS

What academic standards (e.g. NGSS, Common Core, etc.) does this project meet?

Refer to these resources for more information on academic standards:

- International Technology & Engineering Educators Association (ITEEA) - Technological Literacy Standards
- International Society for Technology in Education (ISTE) - Standards for Students
- Next Generation Science Standards (NGSS) - Education Standards

PROJECT TIMELINE

TIMELINE

Up to this point we have compiled a lot of information regarding how this project is going to help connect the content we teach to a 3D printing unit. Our final stage is to put it all together into a logical timeline. Use the blank template below to determine how and when your students are going to:

1. Learn content
2. Know the project design challenge
3. Learn modeling software
4. Ideate
5. Model
6. Review and edit their work
7. Transfer to print
8. Self evaluate & reflect and assess
9. Display their work

	Activities:	Teaching Strategies:
BEGINNING OF PROJECT	*Example:* *Have students research and discuss the different types of cloud formations.*	*Example:* *Have students make index cards for the different types of clouds.*
MIDDLE OF PROJECT	*Example:* *Have students hand-draw their clouds and convert them to 3D-printable files.*	*Example:* *Have students peer review each other's design to confirm they are printable.*
END OF PROJECT	*Example:* *Have students present their 3D printed clouds to the class and discribe why their cloud falls under a specific type.*	*Example:* *Print clouds in one color and print multiple student clouds on one build plate to save time.*

** The activities and teaching strategies examples above come from the Cloud Types lesson plan available in the MakerBot Educators Guidebook.*

TEACHER REFLECTION

TEACHER WORK

Fill out the questions below to help guide you in your project planning journey.

1. What went well?

2. What were the surprises?

3. What more do I need to learn about?

4. What would you do differently next time?

5. Did students meet or exceed your expectations?

6. Did project meet academic standards? What worked or don't work?

CONGRATULATIONS! You can now tell Jackson he is going to be 3D printing, and you feel comfortable knowing that you have a detailed plan of action.

"Hey Jackson!" Ms. Gallo says excitedly.

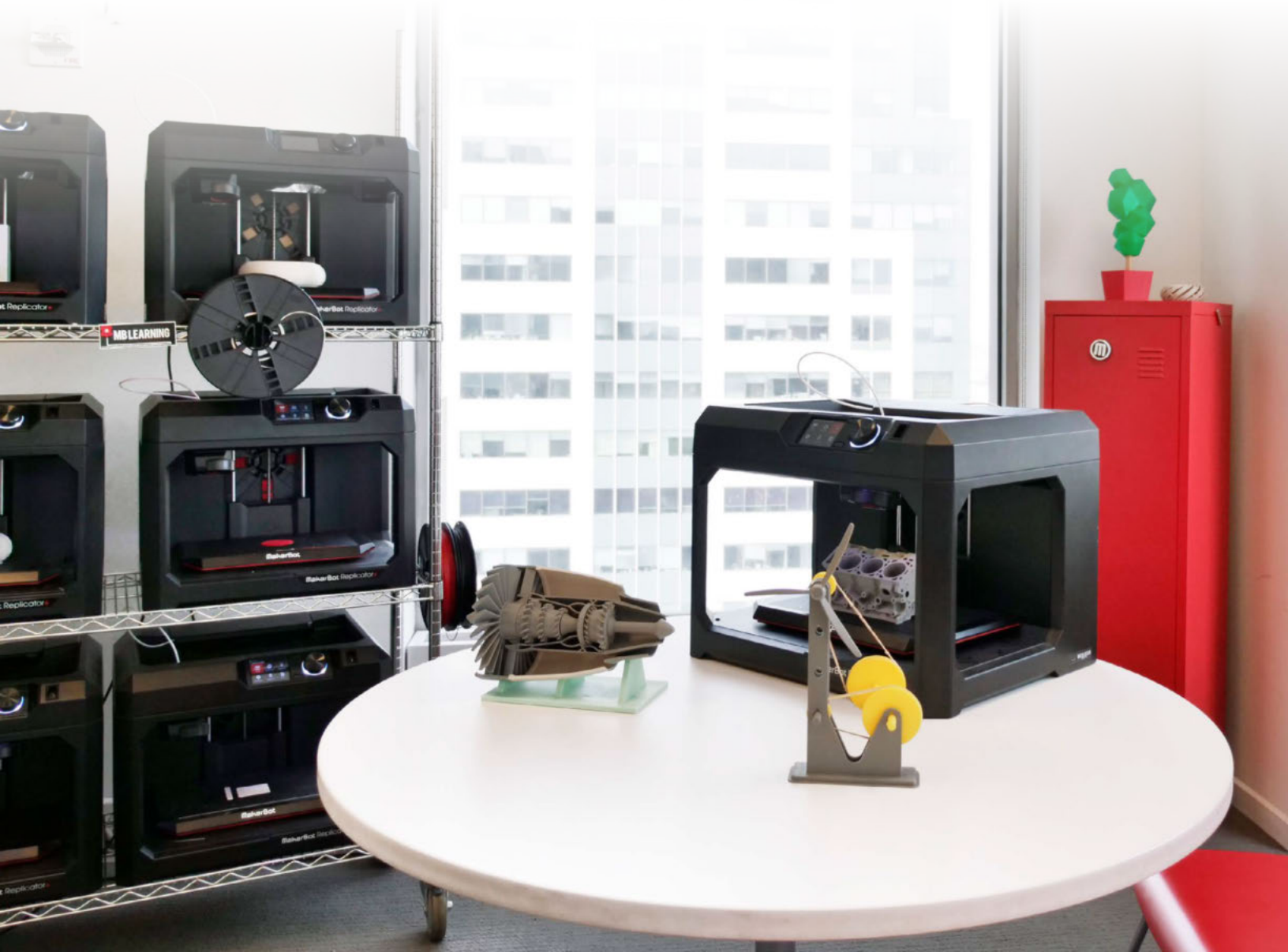
"Yah, Ms. Gallo." Jackson responds.

"We are going to be 3D printing locker organizers with our own designs. How amazing is that going to be?" Ms. Gallo squeals.

"Cool!" Jackson says, "I can't wait to design in 3D!"

We hope you find value going through this *Project Planning Guide*.

Please find the **PROJECT PLANNING BLUEPRINT** on the following page to further assist you with your project planning journey.



MAKERBOT PROJECT PLANNING BLUEPRINT FOR EDUCATORS

This MakerBot Project Planning Blueprint, created in collaboration with educator Liz Gallo, covers the three major areas to focus on when creating a 3D printing project in the classroom - regardless of subject or grade level:

PURPOSE - Connecting to content + meaningful engagement
LEARNING - Ownership of content and technology
LOGISTICS - 3D printing in the classroom

PURPOSE

The best 3D printing projects are authentic, meaningful and highly engaging. The driving questions to keep in mind are what the main idea for your project is, why students will be engaging in the project, and how students can be motivated to take ownership of both the technology and their project.

Fill out the following to help build out your project:

The "big idea" for my project is...

Students are engaging in this 3D printing project because...

Using 3D modeling and the MakerBot 3D printer, students are challenged to design and create

---

Need to be pointed in the right direction? Check out MakerBot Thingiverse Education to find over 600 lessons created by educators following these same guidelines.

LEARNING

It's important to keep in mind that while students need to learn about the content and subject matter the project is based on, they also need to learn about the technology that helps drive the project. Learning and mastering the technology helps give you and your students more freedom and opportunities to further improve the learning experience.

Answer the following to help guide your project:

How will students learn about content and subject matter for this project prior to designing in 3D?

How will students learn and practice with the 3D modeling software?

Do your students need help developing an idea and printing it? Learn more about the MakerBot Certification Program for Students where your students can design solutions for problems outside of their classroom.

LOGISTICS

Planning out the nuts and bolts of using the printer in the classroom is key to optimizing the use of your time, your students' time and the use of the printer.

Answer the following to help guarantee success in measuring the effectiveness of your project:

How will students' models be reviewed prior to being sent to the MakerBot 3D printer?

What is the timeline for the entire project?

Will students work in groups or will they work independently?

How will students assess their own learning?

How will the teacher assess students' growth?

READY FOR THE NEXT STEPS?

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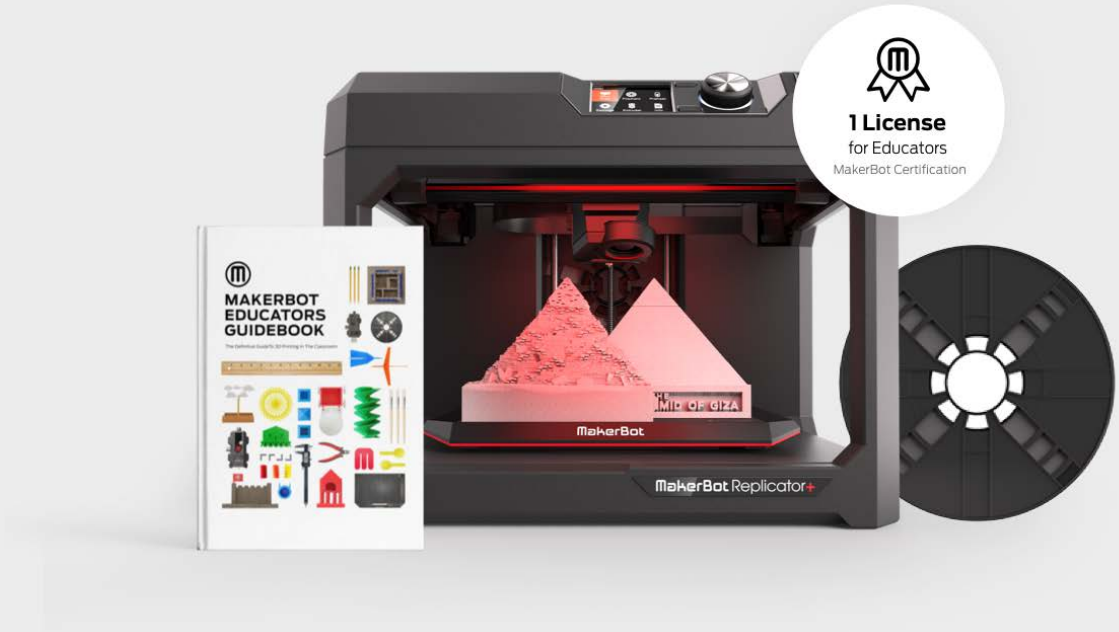

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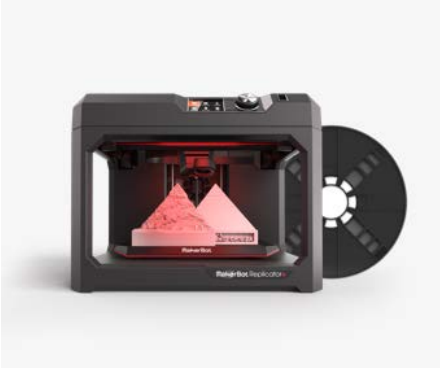

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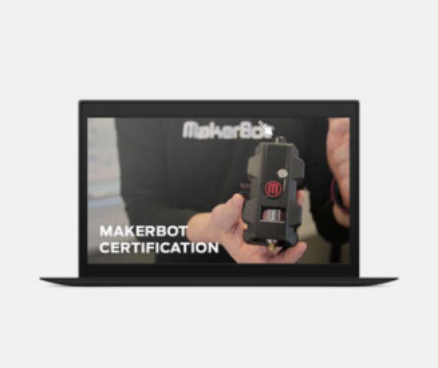

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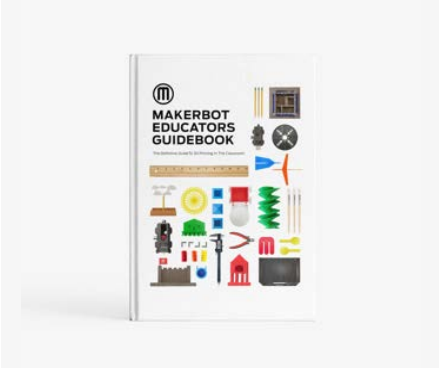
- Become a MakerBot 3D printing expert with the ISTE seal of approval
- Gain confidence as a STEM leader



THE MAKERBOT EDUCATORS GUIDEBOOK

- Provides a crash-course in 3D printing
- Introduction to 3D design tools
- 9 Classroom-ready 3D printing projects


MakerBot