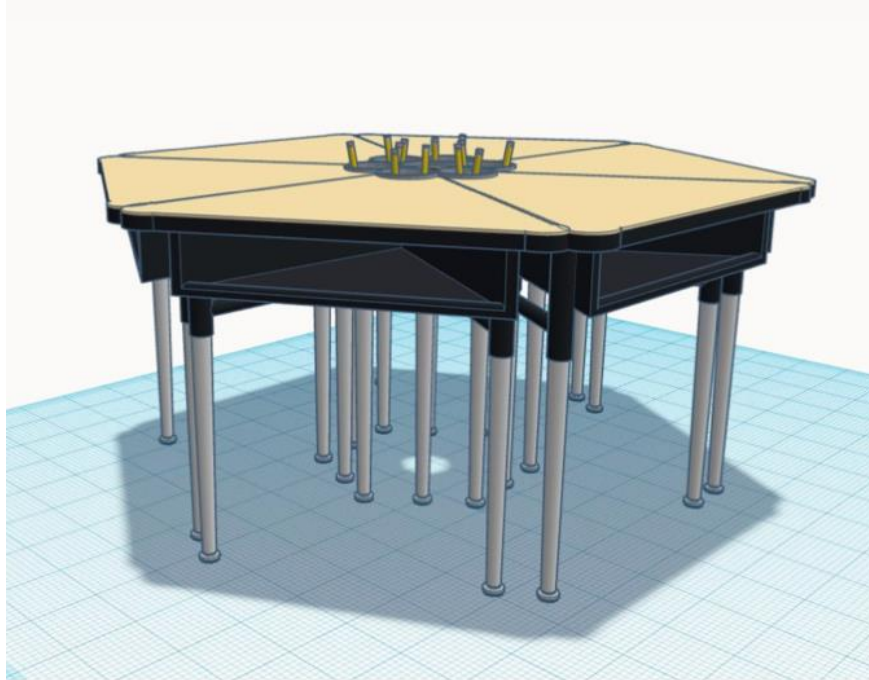




Lesson Plan: Redesign Classroom Furniture



Grades: 4 – 8 (US)

Duration: 5 hours

Skills:

- Design Thinking
- Problem Solving
- 2D design
- 3D design
- Visual communication

Subjects:

- Design
- Engineering
- Technology

Lesson Plan Overview

Students will investigate ways to improve common classroom furniture (desks, chairs, cubbies) to better fit our modern education needs. Using the engineering design process, students will design their own furniture by creating 2D sketches and 3D models that can fit into any classroom space whether at school or at home.

The estimated duration is provided for each unit in the lesson, giving you the flexibility to adjust as needed. This lesson requires no previous experience in 3D design or Tinkercad.



Learning Objectives

- Effectively determine design constraints.
- Develop thumbnail sketches that are used to create a detailed final 2D sketch.
- Use Tinkercad to create a 3D representation of a furniture prototype based on the final 2D sketch.
- Develop a presentation that meets all specifications and constraints, and effectively evaluates the prototype with peers.
- Effectively evaluate design solutions and develop a clear and labeled 2D sketch of the redesigned solution.

Standards

- **ISTE Standard 4 | Innovative Designer:** Students use a variety of technologies within a design process to identify and solve problems by creating new, useful, or imaginative solutions.
- **ISTE Standard 5 | Computational Thinker:** Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.
- **ISTE Standard 6 | Creative Communicator:** Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats, and digital media appropriate to their goals.
- **CCSS, Grade 5, Geometric Measurements:** Understand concepts of volume.
- **CCSS, Grade 6, Geometry:** Solve real-world and mathematical problems involving area, surface area, and volume.
- **NGSS MS-ETS1-2:** Evaluate competing design solutions using a systematic process to determine how well they meet criteria and constraints of the problem.

For more information about standards used in this lesson plan, visit these websites:

- ISTE: <https://www.iste.org/standards/for-students>
- Common Core (Math): <http://www.corestandards.org/Math/Content/5/introduction/>
- Next Generation Science Standards: <https://www.nextgenscience.org/>



Materials

This is a list of materials each student will need to complete this lesson.

- Computer or tablet with access to the Internet and Tinkercad, plus slideshow software like Google Slides, PowerPoint, or Keynote
- Included lesson planning documents and handouts
- Paper, markers, crayons, or colored pencils/pens

You'll find links below where you can directly download and print files from the [Tinkercad Lesson Plan page](https://www.tinkercad.com/lessonplans/redesign-classroom-furniture) (<https://www.tinkercad.com/lessonplans/redesign-classroom-furniture>) that your students will need for this lesson.

- [Evaluation Rubric](#) [PDF with fillable text fields]
- [Engineering Design Process](#) [PDF]
- [Identify the Problem worksheet](#) [PDF with fillable text fields]
- [Define the Problem worksheet](#) [PDF with fillable text fields]
- [Identify Constraints worksheet](#) [PDF with fillable text fields]
- [Thumbnail Sketches Planning Document](#) [PDF]
- [Graph Paper](#) [PDF]

Setting Up Your Class

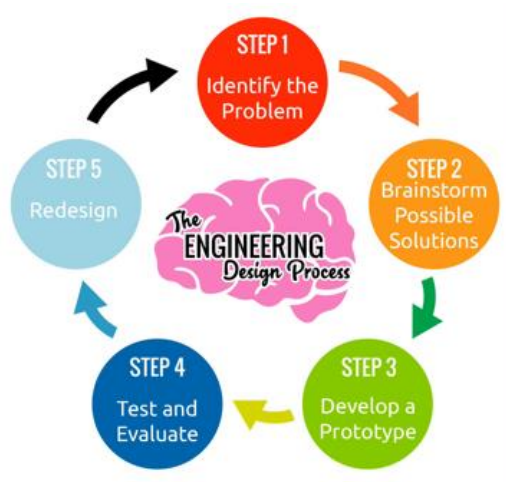
If students are working remotely, ask them to use an online tool approved by your school, such as Zoom, to collaborate with each other. If students are working in a classroom, they can complete this lesson individually. Review the list of materials, and ask students to make sure they have them on hand when they need them.

Explore the Problem [45m]

1. Introduction Video [1m]

Watch this brief video for an overview of the Redesign Classroom Furniture project. (Click the link to watch the video.)

2. Use an Engineering Design Process [10m]



Teacher Instructions

Share the Engineering Design Process.pdf (see link below) with your students. Modify steps or vocabulary to better suit students' needs if applicable. Discuss how a design loop can be used as a tool to methodically solve problems. Discuss the significance of the steps and how they rely on one another to best solve a problem. Finally, discuss the concept of "redesign" and how no solution is ever really finished. As new information, skills, and technology become available, there are always ways to make improvements.

Student Instructions

Engineers, designers, and professional innovators use a problem-solving process to help them create solutions to everyday problems we face. Through this challenge, you will be using a problem-solving process too!

Problem-solving processes come in many different shapes and sizes, but they almost always resemble a loop. Why do you think that is?

What significance do you think each step of the design process has? How do you think professionals use loops like this to solve problems?

Why do we think the "last" step is redesign? Is that really the last step? Is any design ever perfect?



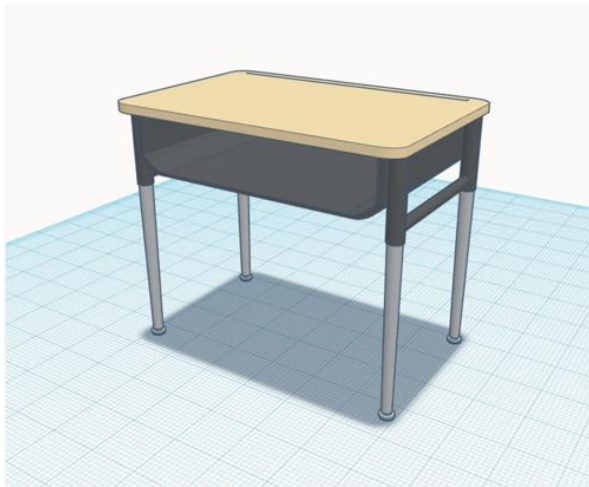
Materials:

- [Engineering Design Process](#) [PDF] *(Please click the link to download the worksheet.)*

Outcome:

- Determine how an engineering design process can be used as a tool to solve everyday problems and to improve existing solutions.

3. Identify the Problem [20m]



Teacher Instructions

Have students look at their instructional environments at home or at school. Point out that even though these are the desks, chairs, and furniture they use, they might not be ideal. If students are struggling to visualize typical furniture, share the example Tinkercad models with them.

Guide them through using the Identify the Problem worksheet, and provide them with instructions for sharing their work with you. *(Please see the worksheet link below.)*

Student Instructions

Today's instruction looks and feels different from before, but do our instructional spaces? It may not be possible for every class to get an entirely new classroom or building, but the furniture within may be improved to better suit your needs. First, identify where your instructional environment is. Is it in a school or at home? Then look at desks, tables, chairs, cubbies, whiteboards, or other common furniture items in your environment. Do they encourage creativity and learning? Do they allow for diverse accessibility?

Materials:

- [Identify the Problem worksheet](#) [PDF] *(Please click the link to download the worksheet.)*
- Tinkercad models of typical classroom furniture: [desk](#), [chair](#), [cubby](#)

Outcome:

- Use a problem-solving process to identify a real-world problem.

4. Define the Problem [15m]



Teacher Instructions

Encourage students to really think of how the furniture in their instructional spaces are used. What do they like and what don't they like about it? Make real-world connections by challenging your students to think of other students. Would their instructional spaces work for students in other grades, subjects, countries, or with special needs?

Guide students through using the Define the Problem worksheet.pdf to document their thoughts, and provide them with instructions for sharing their work. If possible, have students collaborate and share ideas to develop a list of things that could be improved upon. *(Please see the worksheet link below.)*

Student Instructions

Now that you've identified the problem, you'll work on developing a better understanding of it. Look at your instructional environments and the furniture within. List at least three things they do well and three things they don't do so well. To help, think of how you use the furniture while you are learning and consider the following questions. Use the worksheet to document your answers.

1. Is it comfortable?
2. Does it reduce distractions?
3. Does it have room for all of your stuff?
4. Does it fit the needs of any student that might need to use it?

Share your thoughts and ideas with your peers to see if you have similar or different ideas!

Materials:

- Pens/pencils
- Paper
- Tinkercad models of typical classroom furniture: [desk](#), [chair](#), [cubby](#)



- [Define the Problem worksheet](#) [PDF] *(Please click the link to download the worksheet.)*

Outcome:

- Determine strengths and weaknesses with existing solutions.

Brainstorm Possible Solutions [1h]

5. Identify Constraints [10m]

Surfaces



Seating



Storage



Teacher Instructions

Guide students through choosing an item to redesign based on their ideas from the previous step. Discuss the importance of constraints; why shouldn't designers just make anything they want? (Be prepared to discuss time, money, needs, etc.)

Guide students through using the Identify Constraints worksheet.pdf (*please see worksheet link below*) to document their thoughts, and provide them with instructions for sharing their work.

Student Instructions

Now that you've identified the problem you'd like to solve and flaws with existing solutions, you'll need to identify constraints to design new possible solutions to solve the problem! Constraints are criteria, rules, or specifications that define what a solution can accomplish. Use the worksheet to document your answers to the following prompts. First, choose which furniture you plan to redesign from one of the following categories: surfaces, seating, or storage. Next, list at least five things your solution must do in order for it to be an improvement over existing solutions. These are your design constraints!

Materials:

- [Identify Constraints worksheet](#) [PDF] (*Please click the link to download the worksheet.*)
- Pens/pencils, paper

Outcome:

- Use a problem-solving process to identify a real-world problem.



6. Create Thumbnail Sketches [20m]

[Watch this brief video to learn about thumbnail sketches.](#) *(Click the link to watch the video.)*

Teacher Instructions

Students may struggle to think of multiple ways to solve their problem. Suggest to students that it's best to avoid "falling in love" with the first idea they think of.

The video provides an overview about how to use the worksheet (*please click the link above to watch the video*). You may decide to either print and hand out the Thumbnail Sketches Planning Document.pdf (*please see link below*), or ask students to download and print it.

After one sketch is made, encourage students to tweak, improve, or vary one thing about it to make their next one, and the next, and so on.

Student Instructions

There is not just one way to solve any problem! In this step, you'll create 12 "thumbnail sketches" of possible solutions to the problem based on your specifications and constraints. Thumbnail sketches are often rough and do not need to be drawn in great detail.

Using the worksheet (you may need to print it if your teacher doesn't provide you with a printed copy), create mini sketches of different designs that all meet your constraints. They may be similar to one another, but try to think of as many different possible designs as you can. Try not to pick favorites! It's in our nature to want to go with our first idea, but that's not always the best one.

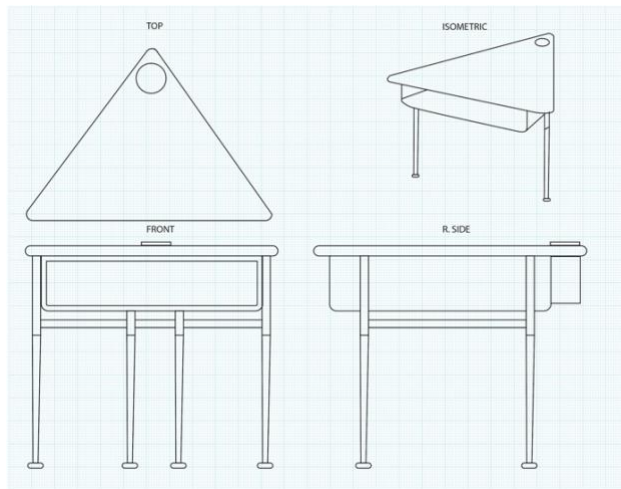
Materials:

- Computer and speakers or headphones, with online access
- Pens/pencils, paper
- [Thumbnail Sketches Planning Document](#) [PDF] *(Please click the link to download file.)*

Outcome:

- Use sketching techniques to communicate ideas.

7. Draw the Final Design [30m]



Teacher Instructions

2D sketching is both a communication and design tool as it helps students share visual ideas they have in their heads. This skill takes time and practice to master; encourage students to take this time to put great detail and care into their sketches. Planning in great detail may assist in creating 3D models in a later step.

Ask students to use a piece of graph paper to document their 2D sketches. A link to graph paper is provided here that can be downloaded and printed, if needed. *(Please see link below.)*

Student Instructions

After completing your thumbnail sketches, look at the similarities and differences among them. Does one stand out more than the others? Or are their features from each that could be combined into the best design?

On a large sheet of graph paper, create a 2D sketch of your final design. (A link to a piece of graph paper is provided here that you can print, if needed.) Unlike the thumbnail sketches, this drawing should be neat and clear as it will serve as the blueprint for your 3D model.

To understand something complex, it's best to look at it in pieces. You can use "orthographic projection" to break down a design and study it. This means drawing an object straight on from each of its sides. The top, front, back, left side, right side, and bottom are separate sketches. Drawing first in 2D before moving on to 3D design is helpful, because it allows you to see how each side relates to the other before building out your design.

[Review this blog post and video](#) to learn more about the basics of 2D drawing. For instructions on how to easily switch from "perspective" view to "orthogonal" view in Tinkercad, [visit this blog post](#).



Materials:

- Pens/pencils
- [Graph Paper](#) [PDF] *(Please click the link to download file.)*

Outcome:

- Create a 2D representation of a piece of furniture.



Develop a Prototype [2h]

8. Work with Shapes in Tinkercad [30m]

Teacher Instructions

Having basic knowledge of Tinkercad will help students with this lesson. If your students aren't yet familiar with Tinkercad, guide them through or have them independently complete the brief tutorials. Encourage students to use the software to explore how to place, view, move, rotate, resize, group, and align different shapes.

Student Instructions

If you're new to Tinkercad and 3D design or just need to refresh your knowledge, review these short tutorials. They'll guide you through working with shapes in a 3D space, including how to place, view, move, rotate, resize, group, and align different shapes. These tutorials will help you later in this lesson when you create a prototype!

Follow this link to view the tutorials:

<https://www.tinkercad.com/learn/project-gallery;collectionId=OPC41AJKIKDWDV>

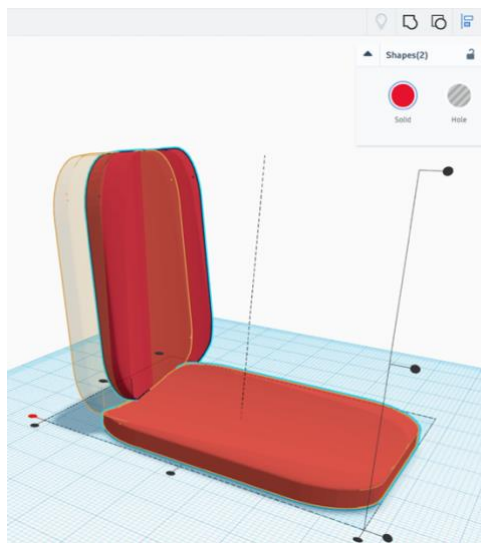
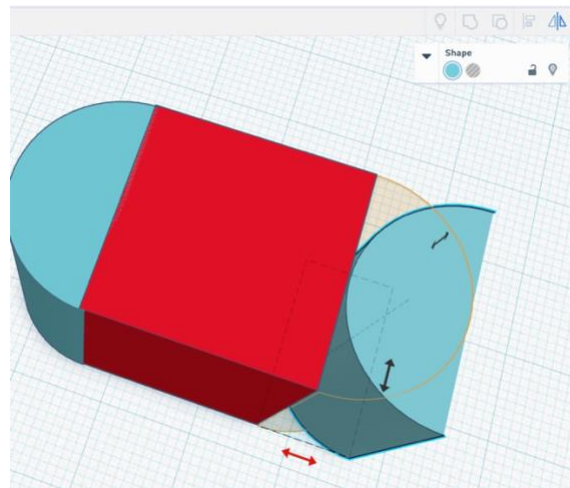
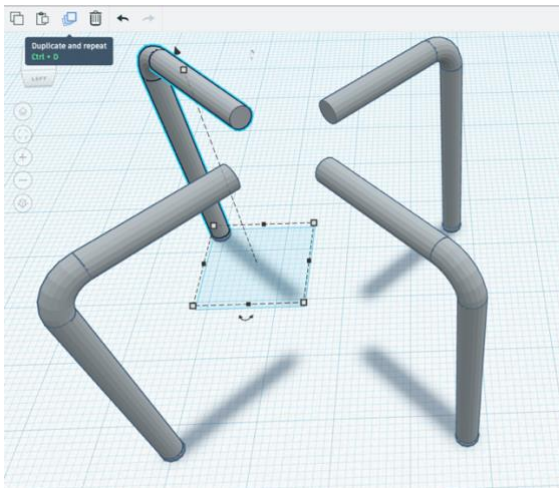
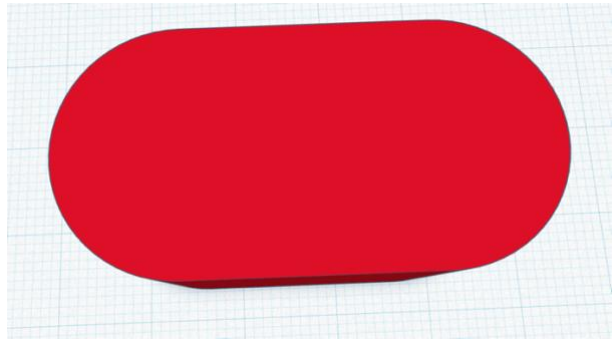
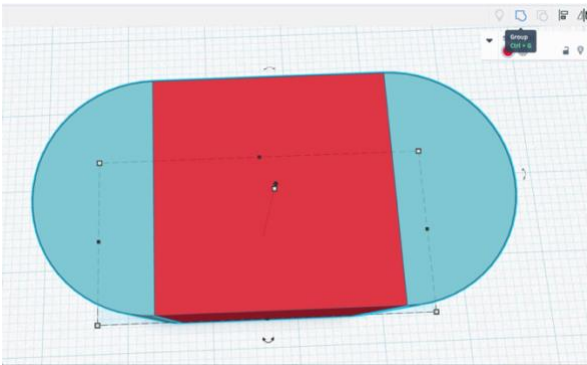
Materials:

- Computer with online access to Tinkercad
- 2D furniture sketch

Outcome:

- Create a 3D representation of a character using Tinkercad.

9. Use Tools to Manipulate Shapes [30m]





Teacher Instructions

Ask students to review these tools and techniques for manipulating shapes in Tinkercad, and then play around with shapes in Tinkercad on their own.

Student Instructions

You can create just about any object by combining and manipulating basic shapes in Tinkercad. To do this efficiently, it's important to become familiar with a few key tools. The **Group** tool (Ctrl + G) allows you to combine shapes together to make more complex solid shapes, or cut holes into shapes. By selecting two or more shapes, you can combine their properties together. Don't like what you see? You can always ungroup to adjust or make changes! Note, you can still choose to keep shapes multicolor after they are grouped in the shapes fill window.

The **Duplicate and repeat** tool (Ctrl + D) allows you to make copies of a shape or group of shapes you've created. This tool may be really handy in this challenge as many pieces of furniture shares common parts (legs, feet, etc.) The duplicate and repeat tool also helps you create patterns. Make a duplicate of an object, then move or scale it. This tool will not only copy the next object, but it will also move and scale it in the same way!

The **Mirror** tool allows you to flip objects so they face different directions. This tool may be useful in this challenge, as many pieces of furniture are symmetrical.

The **Align** tool lets you align two or more objects with one another. This is a handy tool to center two shapes perfectly.

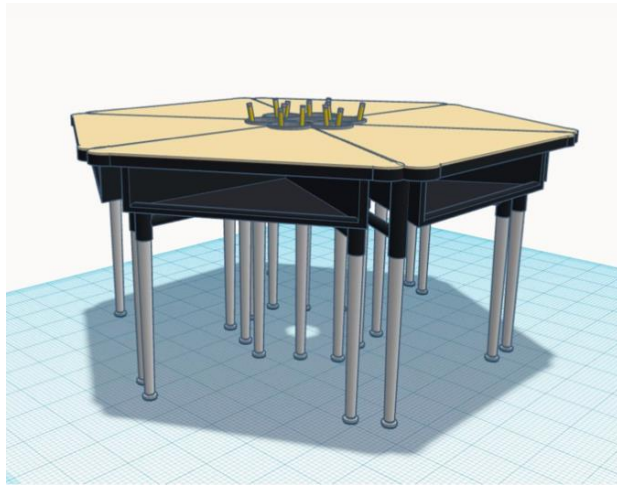
Materials:

- Computer with online access to Tinkercad

Outcome:

- Create a 3D representation of furniture using Tinkercad.

10. Create Your Furniture Prototype in 3D [60m]



Teacher Instructions

If students have questions about using shapes in Tinkercad, review the tutorials included earlier in this lesson. Give students instructions for sharing their creations with you.

Student Instructions

Refer to your final 2D drawing of your furniture prototype from section 7 to create a 3D model of it using the Tinkercad application. (Check with your teacher if you need help making an account.) Once completed, save, and share your file according to your teacher's instructions.

Bonus challenge: Create your furniture using dimensions that are proportional to a real piece of furniture in your instruction space.

Materials:

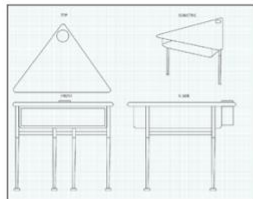
- Computer with online access to Tinkercad
- 2D plan of furniture design

Outcome:

- Create a 3D representation of a piece of furniture using Tinkercad.

Test and Evaluate a Prototype [30m]

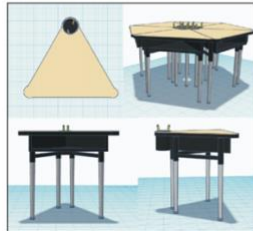
11. Develop a Presentation [20m]



The Pi Desk

By: @MrErdreich

This desk prototype is part of the surfaces category and is design to improve upon the typical in-school classroom desk



Design Constraints:

- 1 - Large Storage Cubby Space
- 2 - Ergonomic Pencil / Supply Holder
- 3 - Height Adjustable
- 4 - Easily Movable
- 5 - Modular / Flexible Seating Capability

Teacher Instructions

Students should be prepared to introduce their furniture and explain the constraints that were determined in the brainstorming stages of the design process. Students should evaluate how they believe their prototype would perform if it were manufactured and used in their actual instructional space. A paper or poster presentation may be a suitable alternative visual to the slide presentation. Provide students with instructions for preparing to share their work with you.

Student Instructions

Now that you've created your furniture prototype in 3D, it's time to share it with your peers! Using a presentation program like Google Slides, PowerPoint, or Keynote, create a single slide that overviews your design. Your slide should include:

- The name of your design
- Your name
- Your final 2D drawing
- At least one screenshot or image of your 3D prototype
- Your five design constraints you documented earlier

Materials:

- Computer with online access
- Presentation software
- 2D drawing and 3D model of prototype

Outcome:

- Introduce 3D furniture prototype to the teacher or the class.



12. Share Your Model [10m]

Teacher Instructions

Depending on the structure of your class, ask students to present their furniture creations to you or to the entire class. This can be done in person or in a remote learning environment.

Bonus challenge: Group students and allow them to compile their prototypes into a single Tinkercad design to create a prototype classroom with their models.

Student Instructions

Following your teacher's instructions, share your furniture design with the class. Compile constructive feedback from your peers as to how they believe your prototype would perform if it was actually manufactured and installed in an instructional space. Provide feedback to your classmates' presentations.

Materials:

- Computer with online access
- Presentation software
- 2D drawing and 3D model of prototype

Outcome:

- Introduce 3D furniture prototype to the teacher or the class.



Improve Your Design [30m]

13. Redesign Your Prototype [30m]

Watch this brief video for an overview of redesigning your prototype. ([Click the link to watch the video.](#))

Teacher Instructions

The concepts of failure, improvement, and redesign can be challenging for students to truly understand, but they are a vital step in the engineering design process. Encourage students to think critically of their designs as they envision how they would perform in a classroom setting.

As time allows, encourage students to expand upon their ideas and designs to add more depth to their inventions. In alignment with privacy guidelines for your school or district, consider sharing the story of your project work from this activity on social media with Tinkercad using the hashtag #TinkercadLearning:

- Tinkercad on [Twitter](#)
- Tinkercad on [Instagram](#)
- Tinkercad on [Facebook](#)

Student Instructions

As discussed in the first step, no design is truly ever finished. Now that we've learned so much about 3D modeling, prototyping, and problem solving, it is time we look back at our prototypes to determine how we can improve them.

Consider the feedback you received from your teachers and peers. If you were to create this prototype again, what would you change? What works well about your design and what could be made better?

Create a 2D sketch of your redesigned prototype with your improvements and changes labeled.

Materials:

- 3D model of prototype
- Pens/pencils
- [Graph Paper](#) [PDF] (*Please click the link to download file.*)

Outcome:

- Use an engineering design process to develop a solution to a real-world problem.