

**STEM2D Design Process Challenge Syllabus**

**Challenge Overview**

The STEM2D Design Process Challenge is a team-based learning project that will focus on incorporating simple machines into a mini-golf course. Youth will design, build, and test the construction of their simple machines within the setting of their mini-golf course hole.

**“Simple Machines Mini-Golf Course” Project**

Each team will be responsible for the following:

1. Students will be separated into five teams.
	1. Teams will collaborate to determine a theme for their mini-golf course.
	2. Teams will select historic buildings, landmarks, statues, etc. from **any country** to serve as the theme for their mini-golf course.
	3. Each team member is responsible for creating one hole on the mini-golf course.
2. Each mini-golf hole must incorporate **a minimum of two simple machines.**
	1. Students will research and identify the 6 simple machines, work, force, and mechanical advantage.
	2. Each team member will select **at least two** simple machines to incorporate into their design.
	3. Each team member must select at least one unique **simple machine** to avoid overlap among members.
3. Teams must demonstrate their simple machines **functioning properly** during the presentation.

The challenge will be completed in 5 parts: 1) The Design Process, 2) Content and Concepts, 3) 3D Modeling, 4) Prototyping, and 5) Final Presentation.

1. **The Engineering Design Proc**ess: Designing and building is essential to engineering. Engineers follow the steps of the design process to help them create the best possible solutions to real-world problems. These challenges may be simple or complex and the wide variety of solutions can also cover a range of effort for the user.
2. **Content and Concepts:** In order to understand how simple machines function, teams must work together to investigate mechanical advantage and how it relates to potential, kinetic, and mechanical energy. Teams will research and identify the six simple machines and how they operate to make work easier.
3. **3D Modeling:** Engineers need to present their ideas visually through 3D modeling. 3D models assist engineers at every stage, from designing to conception to presenting in front of others. Teams will utilize industry-based modeling software to create a three-dimensional visual representation of their solution.
4. **Prototyping:** Each team will bring their brainstorming solution to life through a prototype. The most important advantage of a prototype is that it simulates the real and future product. You can test the design’s correctness before it comes into production, and you can discover design errors. Teams will create a working prototype of their mini-golf hole that incorporates the use of a simple machine using primarily cardboard, duct tape, and any other household items.
5. **Final Presentation:** Each team will present their process and recommendations during a final Showcase. Oral Presentations should be accompanied by all PowerPoint slides outlined above.
	* Be creative. Make these presentations visually appealing by incorporating elements, such as graphics, video, or another form of creative oral communication. Students will have a pre-recorded 30-second video demonstrating their prototypes functioning correctly, which will be included in the final presentation. Each team will have 10-12 minutes to present. Included will be a 5-10 minutes question and answer session at the end of each presentation.

**NOTE:** This STEM2D Design Process Challenge is designed to mimic a real-life work experience; therefore, all information about your project must remain confidential among you and your team members. You should not share details of your project with anyone on a different team.

**Materials**

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| * Golf club\*
* 3 Golf balls *(ping pong balls)*
* Colored pencils
* Marbles
* Cardboard
* Duct tape (1 roll)
* White printer paper (25 sheets)
* 1 12-inch ruler
* 1 pair of scissors
* Computer for research
* Colored paper or paint (optional)
* Household items (be creative!)
* Spaghetti (20 sticks)
* String (12 inches)
* 1 large marshmallow
 |  |

*\*Students do not need an actual golf club. A piece of wood, baseball bat, hockey stick, etc. will be sufficient.*

**Learning Objectives**

By the end of the project, each student will:

* Understand the importance of creative an effective and thorough design brief.
* Identify and explain the function of six simple machines.
* Analyze and explain the relationships between the simple machines, work, force, and mechanical advantage.
* Experiment with 3D modeling utilizing industry-based software.
* Create a model displaying how simple machines make work seem easier.
* Learn to work as a team.
* Develop their time management, research, communication, and presentation skills.

**Simple Machines**

*“Work Smarter, Not Harder”*

Simple machines have few or no moving parts, they make work easier by changing the direction of a force or by changing the amount of force needed.

1. **Lever (lifting):** A plank that rests on something underneath and moves up and down. When you push down on one side of a lever, the other side goes up. Levers can also be used to lift heavy objects such as a rock or furniture. A seesaw is an example of a lever.
2. **Pulley:** A pully has a wheel that allows you to change the direction of a force. As you pull down on the rope, the wheel turns and whatever is attached to the other end goes up. A flagpole uses a pulley to raise the flag.
3. **Inclined Plane:** A simple machine that has a gently sloped surface so it can be used to move objects upwards with less force. Ramps are examples of inclined planes.
4. **Wedge:** An object that tapers to a thin edge. By placing a thin end of a wedge onto a log, you can hit it with a hammer. The wedge changes the direction of the force, and it pushes the log apart. A knife is also an example of a wedge.
5. **Wheel and Axle:** A circular frame (the wheel) that revolves on a shaft or rod (the axle). Here, the effort or the force is applied to the axle that causes the wheel to rotate at a rapid rate. This means that the motion initiated by the axle gets transferred to the wheel. Some of the real-life applications that use this type of wheel and axle simple machines include bicycle and Ferris wheel. Force can also be applied to the wheel, causing it to rotate. The motion of the simple machine is initiated by the wheel that builds a significant amount of pressure on the axle. Some of the examples of such machines include pizza cutter and windmill.
6. **Screws:** An inclined plane wrapped around a center rod. An example of a screw is a spiral staircase. Can also be used as a fastener or as a force and motion modifier.



**Team Assignments:**

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| --- | --- | --- | --- | --- |
| **Team 1** |  |  |  |  |
| **Team 2** |  |  |  |  |
| **Team 3** |  |  |  |  |
| **Team 4** |  |  |  |  |
| **Team 5** |  |  |  |  |

**Agenda:**

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| Part 1 | * Day 1.1 STEM2D Challenge Introduction
* Day 1.2 STEM2D Online Game & Tower Instant Challenge
* Mini-Golf background
* Students play online game
* Tallest Tower Instant Challenge (group)
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| Part 2 | * Day 2.1 STEM2D Design Process
* Adam Grant Ted Talk
* Day 2.2 STEM2D Engineering Design Brief
* Design Brief WS on Kami
* Day 2.3 STEM2D Maze Runner Design Challenge (individual)
* Submit video on FlipGrid
* Day 2.4 STEM2D Simple Machines
* Canva Instagram post over Compound Machines
* Day 2.5 STEM2D Work, Force, and Mechanical Advantage
* Kahoot Review
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| Part 3 | * Brainstorming Mini-Golf Course Themes
* Day 3.1 STEM2D Introduction to 3D modeling
* Tinkercad Keyboard Shortcut
* Live Q&A sessions with individual groups
* Day 3.2 STEM2D Introduction to Prototyping
* Hide-and-Seek activity
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| Part 4 | * 3D modeling workday
* Prototype workday
* Live Q&A sessions with individual groups
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| Part 5 | * Day 5.1 STEM2D Presentations
* “The Tyre Collective” video
* Live Q&A sessions with individual groups
* Presentation Dress Rehearsal
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| Showcase | * Presentations
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