FIRST® at Home

Core Values Media

ACTIVITY SUMMARY

After viewing the *FIRST*® Core Values, students will develop a meme or video to explore one or more of the Core Values using text and graphics.

Age Range & Grade Level: *Ages13+, Grade 7+*

Program Connection: *FIRST*® Tech Challenge & *FIRST*® Robotics Competition

Authored By: Lori Birch, Curriculum Developer, *FIRST*® Education

ACTIVITY OUTCOMES

Participants will:

1. Explore storyboarding, graphic design, messaging, video production.
2. Research career pathways and identify career readiness skills related to real world careers.
3. Learn about their audience and research the metrics of their uploaded content.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Marketing metrics	Scale and ratios	Research, Content Reading	Outreach, Social Listening, Career Connections	
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last core value should always be used when doing any *FIRST* activities.

ENGINEERING DESIGN PROCESS & *FIRST* CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

KEY VOCABULARY

Brainstorming	Teamwork	Discovery	Innovation
Fun	Impact	Inclusion	Metrics
Story Board	Meme	Resolution	Demographic

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

FIRST Core Values, Art supplies, photo editing software, video recording device, video editing app

GUIDANCE & SET-UP

Description – Action – Guidance	Notes
Provide students with the Core Values graphic	
Review the problem statement and criteria/constraints with the students. Remind students they will be using core values and their creativity to express one or more of the values.	
Students should be given some direction on how to create a meme or video and research the app options: imovie, TikTok, Flipgrid, and free software like Autodesk's Sketchbook	
Determine how students will complete the meme/video activity, what their length of time will be, how to collaborate and how to share their solutions. Have students work on their solutions.	Use a storyboard to develop and organize ideas. Remind them the video maximum is one minute.
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their core values self-assessment and review.	Core Values self-assessment is found in the Design Brief document.

STUDENT OR TEAM ACTIONS

1. Review the Core Values, problem statement and criteria/constraints.
2. Research the video and editing software options.
3. Storyboard their ideas.
4. Produce the meme or video.
5. Share your solution and reflect on your learning.
6. Explore the Go Further! opportunities.
7. Complete your *FIRST* core values self-assessment.

GO FURTHER!

Upload your design here:

Observe the metrics of your meme/video.

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution would help others.	Showed how the solution would help others.	Not clear how the solution would help others.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home
Core Values Media Design Brief

PROBLEM STATEMENT

Where do you get information from? What is the best method to share important information that can make a difference? We need your help to share *FIRST* Core Values! Can you create a media product that shares Core Values in a way that really makes an impact?

CRITERIA & CONSTRAINTS

- Your solution can be a meme (1080X1920 resolution) or video (maximum 1 minute).
- Your meme or video explores one or more Core Values using text and images/video.
- Your team number, team name is in the lower left-hand corner.

ENGINEERING DESIGN PROCESS & *FIRST* CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

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BUILDING THE BACKGROUND & BRAINSTORMING

- Using technology to get information out in a way that really impacts others can ignite a spark and really spread a message.
- Consider your favorite message that really made an impact and sticks in your mind. What aspects of that message made it memorable?
- Social media and the internet have transformed the way that messages and marketing are shared across the world. How does social media change the impact of a message?
- Read through the following blog on developing a marketing campaign:
- https://blog.waypostmarketing.com/5-campaign-must-haves

Reflect, research and answer the questions below

- Who is your demographic?
- What is the purpose of your meme/infographic or video? Are you trying to recruit new team members, reach the community, add to your portfolio for college?
- What other important elements are needed to ensure your campaign will be successful?

SKETCH YOUR DESIGN

Storyboard your ideas before you develop the meme or video.

- What is the theme?
- What tools will you use?
- What is the text/script message?
- How will you graphically represent one or more Core Values?

TEST YOUR IDEAS

Using your favorite social media sharing method, develop and test your ideas for campaign. Consider what you have learning while developing and testing your product.

SHARE AND COLLABORATE ON YOUR IDEAS

Using online collaboration or a parent, share your ideas with them. Get feedback on your message, how might it be improved?

REFLECTION QUESTIONS

1. How does your meme/video explore Core Values?

2. How do you think this will impact the audience?

3. What were the challenges of this activity?

4. What skills did you use or learn in this activity, that could be transferred to a career?

GO FURTHER!

Attached a picture of your design or a link to the design shared on social media.

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home
Algorithms

ACTIVITY SUMMARY

Students will use everyday activities such as cooking to understand how algorithms are used around them. They will use input, processing, and output to develop pseudocode for a recipe. They will then design a game using two different types of algorithms.

Age Range & Grade Level: *Ages 13+, Grade 7+*

Program Connection: *FIRST*® Tech Challenge & *FIRST*® Robotics Competition

Authored By: Lori Birch, Curriculum Developer, *FIRST*® Education

ACTIVITY OUTCOMES

Participants will:

1. Explore the way algorithms allow a process and feedback to be achieved.
2. Explore how an algorithm and feedback operates in a home appliance.
3. Design algorithms for a friend or family member to follow to compete in a newly designed game.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Temperature, Feedback	Algorithmic thinking	Writing and expository writing	Career Connections, Engineering for social solutions	Pseudocode Input, Processing and Output Algorithms Feedback
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last core value should always be used when doing any *FIRST*® activities.

KEY VOCABULARY

Psuedocode	Input	Feedback	Algorithm
Brainstorming	Output	Process	Thermostat

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

FIRST Coding Game Design Brief, assorted materials for building a solution (not required)

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the *FIRST* Coding Game Design Brief. Have students watch the demonstration video.	
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	Review the age appropriate engineering design process with your students.
Students should review the explanations of algorithms and then apply what they have learned by considering how an oven works to explain the input, process and outputs of the device.	Students do not have to make the recipe but could if they wanted to for more of a hands-on process.
They will learn how to develop pseudocode and develop algorithms for their favorite recipe, including the feedback code that allows the oven to stay at temperature.	The recipe could be one you are already making or one they would like to make. This is something that you can have fun discussing while you are doing the day to day things that need to get done.
Students will then use the knowledge they have gained to develop a game that includes algorithms.	The game could involve different objects from the home. It could be as simple as, a ball or a roll of tape in a specific location.
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their core values self-assessment and review.	Core Values self- assessment is found in the Galactic Builders Design Brief document.

STUDENT OR TEAM ACTIONS

1. Review the Coding Game design brief, problem statement, criteria/constraints and watch the demonstration video.
2. Discuss and learn about how an algorithm works on your oven.
3. Develop pseudocode for a recipe.
4. Create a solution for a coding game.
5. Share your solution and reflect on your learning.
6. Explore the Go Further! opportunities.
7. Complete your *FIRST* core values self-assessment.

GO FURTHER!

Students can develop multiple different algorithms for the game they are producing. You can also work with students to think through other algorithms/directions for things that operate in the home.

For example:

- What algorithm does an internet router run on to get provide internet to your home?
- How does a thermostat work to keep the temperature comfortable? How will the algorithm change as the seasons change?
- Students also can explore games and logic problems to develop more algorithmic thinking.

Students will put this all together to create a smart room in their home

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution would help others.	Showed how the solution would help others.	Not clear how the solution would help others.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home Algorithms Design Brief

PROBLEM STATEMENT

Game designers for video games, board games and sports games create various rules for how to play the game. In each of these types of games rules look different and are also incorporated in how the game is designed. Video game rules are written using computer programming and allow for many outcomes based on different inputs from a player. Outcomes based on inputs are called algorithms. In your challenge, how can you design a game that contains two different types of algorithms by creating an at-home game?

CRITERIA & CONSTRAINTS

- Design a game for a teammate or someone else at home to complete that contains two different types of algorithms.
- Design an algorithm that contains specific directions that are repeatable by another person.
- At least one algorithm should have a sequence of directions that does not require feedback.
- At least one algorithm should have decisions based upon feedback or input.
- The game should involve solving at least one problem or puzzle.
- There should be different outputs based upon an input.

ENGINEERING DESIGN PROCESS & *FIRST*® CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

BUILDING THE BACKGROUND & BRAINSTORMING

What is an algorithm?
A sequence of directions that are executable and create a specific outcome every time.

How can algorithms have different outcomes and make decisions?
Input, Processing, Output

You experience things every day that use algorithms to make things work around your home, and in life. Algorithms can be used to achieve different outputs or outcomes based on input, processing, and output. Inputs are sensors or data that can alter the path of the directions and create a different outcome. For instance, if your mom tells you to go to your friend's house, your room needs to be cleaned. The input is a clean room, if it is clean, then you get to go to your friends; if it is not clean, then you stay home.

Different outcomes or decisions are based upon a condition. Processing is the decision or condition that needs to be met to achieve the desired outcome. For example, complete steps 1-3 and then end, or if the temperature is 50, complete step 2. Robots and many electronics around your home use processing with specific conditions to achieve outcomes that make your home comfortable.

How are algorithms used in our everyday life?
Consider what occurs for you to bake something in your home. Most people will follow a recipe. Looking at the definition above, is a recipe an algorithm? If you follow the recipe for mixing your ingredients, you then put it into the oven to cook for a specific amount of time.

How does your oven know what to do?
How does it know the temperature to cook at?
How does it maintain that temperature?

How do algorithms create different outcomes?

When you set the dials or digital temperature you want the oven to cook at, that is an input. It has a thermostat that measures the temperature. The circuit (analog or digital) in the oven turns on the burner until the thermostat reaches a specific temperature, then it turns off; it kicks on again when the temperature drops below a certain point, and the process repeats until the time limit is reached. If the input you give the oven (temperature and time) is different, then you get a different outcome: your recipe is overdone (burned) or underdone (still raw)!!!

Algorithms and programs can be expressed in words (pseudocode or “false code”) versus a machine code or electronic circuit. It is called pseudocode because it cannot run on the machine, but these algorithms or programs can be written out on paper.

Example of pseudocode would be a recipe: if you can read, you can follow the recipe. Computers also must be able to read the code; they do this through different computer languages. The languages convert algorithms to binary code, the language the computers use to process information. Since learning a language and translating languages can be difficult, pseudocode allows you to think through an algorithm in the language that you know.

Develop a pseudocode

Develop a pseudocode or directions for making your favorite recipe. Include the algorithm that the oven needs to operate.

DESIGN YOUR OWN GAME WITH ALGORITHMS

Now it is time to use your knowledge to have some fun. Developing algorithmic thinking skills using games and strategy can be a fun way to improve directions and decision-making skills. Problem-solving using math or other logic problems can also be a fun way to increase algorithmic thinking skills.
Ex. A maze, word problem, puzzle or game.

You can be as creative with your game as you want. Look around your home or another environment for objects to have fun with them using them as inputs to make decisions. For example, getting a ball in a box or shooting a ball in a hoop.

Then design a game that incorporates the criteria and constraints from above.

SKETCH YOUR DESIGN

Using the criteria and constraints for the problem develop a pseudocode for your game. Sketch the flow of your game and decisions that could be made.

TEST YOUR IDEAS

As you improve and test your idea, be sure to record what works and what didn't. Test your algorithms with someone else at home or virtually with a teammate. Reflect as you watch them go through the process how might you improve the directions?

SHARE AND COLLABORATE ON YOUR IDEAS

Using online collaboration or a parent, share your ideas with them.

Discuss with them how you might improve your design to increase your algorithms and directions.

REFLECTION QUESTIONS

1. How did you use detailed directions for people to complete your game?
2. How do inputs and feedback allow decision making and different outcomes in algorithms?
3. When you combined algorithms with feedback, how did it increase innovation in the outcome of your program?
4. What other devices or processes around your home use algorithms?

GO FURTHER!

Make your home smart!

Research the idea of the Internet of Things and explore how smart technologies increase the complexity of an algorithm. Design a smart room in your house, write out the algorithms and explain how devices will communicate with each other. What inputs are from humans, what are from other machines?

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
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Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home Activity

XYZ Design

ACTIVITY SUMMARY

After viewing Understanding Cartesian Coordinates and the example grid students will create their own grid based on Cartesian coordinates. Using the grid, students will map out the coordinates necessary to get from point A to point B.

Age Range & Grade Level: *Ages 12+, Grade 7+*

Program Connection: *FIRST*® Tech Challenge and *FIRST*® Robotics Competition

Authored By: Elizabeth McClurg, Program Specialist, *FIRST*® Tech Challenge

ACTIVITY OUTCOMES

Participants will:

1. Draw a 2D object onto a coordinate plane and explore what makes a 3D shape.
2. Program a robot to complete a pattern using only coordinates to navigate.
3. Explore Cartesian coordinates within a CAD program, such as On Shape, AutoCAD, or similar.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Inquiry based problem solving	Measurement, 2D/3D modeling, Geometry, Spatial Reasoning	Research, Content Reading	Career Connections, Engineering for Social Solutions	Programming Variations
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last core value should always be used when doing any *FIRST* activities.

KEY VOCABULARY

Orientation	CAD	Cartesian Coordinates	Grid
Layout	Absolute Coordinates	Relative Coordinates	2D

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

Pen and paper, tape, markers chalk or other marking items. For example, if students choose to use the floor in a room tape can be used to lay out the x and y axes, and each grid box can be a piece of paper. On a sidewalk or driveway use chalk.

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the XYZ Design, Design Brief.	
Review the problem statement, criteria and constraints with the students. Remind them to use both the engineering design process and *FIRST* core values during the activity.	
Direct students to explore ways in which cartesian coordinates are used in 3D printing. Have students practice applying cartesian coordinates by choosing and object and drawing it in 2D on the plane provided.	Show other examples of a 2D drawing.
Students will now need to determine a path from point A to point B by only using coordinates to explain the pathway. Have one student design the pathway and provide the coordinates to another student to run the program. If doing this virtually have students' video or run the program using remote communication tools.	Solutions can be built and designed using materials around the house or it can be a drawing or computer aided design (CAD).
Reflect on what was learned in this activity with the students and how this may connect to future designs or programming.	
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their core values self-assessment and review.	Core Values self-assessment is found in the Galactic Builders Design Brief document.

STUDENT OR TEAM ACTIONS

1. Review the design brief, problem statement and criteria/constraints.
2. Watch the videos and read the content in the building background and brainstorming section.
3. Research the questions, discuss and complete the practice activity.
4. Create a solution to solve the challenge.
5. Share your solution and see if your coordinates completed the challenge.
6. Explore the Go Further! opportunities.
7. Complete your *FIRST* core values self-assessment.

GO FURTHER!

Choose a CAD program to practice layout using coordinates. Create a 2D shape using the Line tools and Cartesian coordinates. Send just the coordinates to a friend to create your design.

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution would help others.	Showed how the solution would help others.	Not clear how the solution would help others.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home
XYZ Design
Design Brief

PROBLEM STATEMENT

FIRST® needs you to design a path for a robot using only Cartesian coordinates to get from point A to point B. As a designer Cartesian coordinates are useful for planning paths for different planes of a design.

You will explore Cartesian coordinates and how they are used in everything from 3D printers to video games. Then you will design an object and make your robot draw out the path from A to B using only the Cartesian coordinates as instructions.

CRITERIA & CONSTRAINTS

- Choose a 3D object and turn it into a 2D drawing on a coordinate plane.
- Draw a sketch of your solution using the Cartesian Coordinate plane provided.
- Determine the some of the coordinate points that intersect with that image.
- Use materials to layout a grid using tape, chalk, paper, or other materials.
- Create a program for your robot to get from point A to point B using only coordinates.
- The robot must cross over the y axis to get from point A to point B.
- A diagonal line through (0,0) is not allowed.
- Provide the coordinates used to get from A to B

ENGINEERING DESIGN PROCESS & *FIRST* CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

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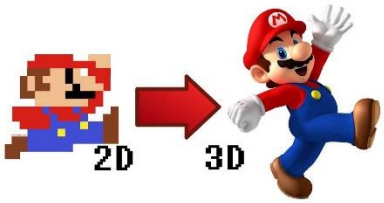
BUILDING THE BACKGROUND & BRAINSTORMING

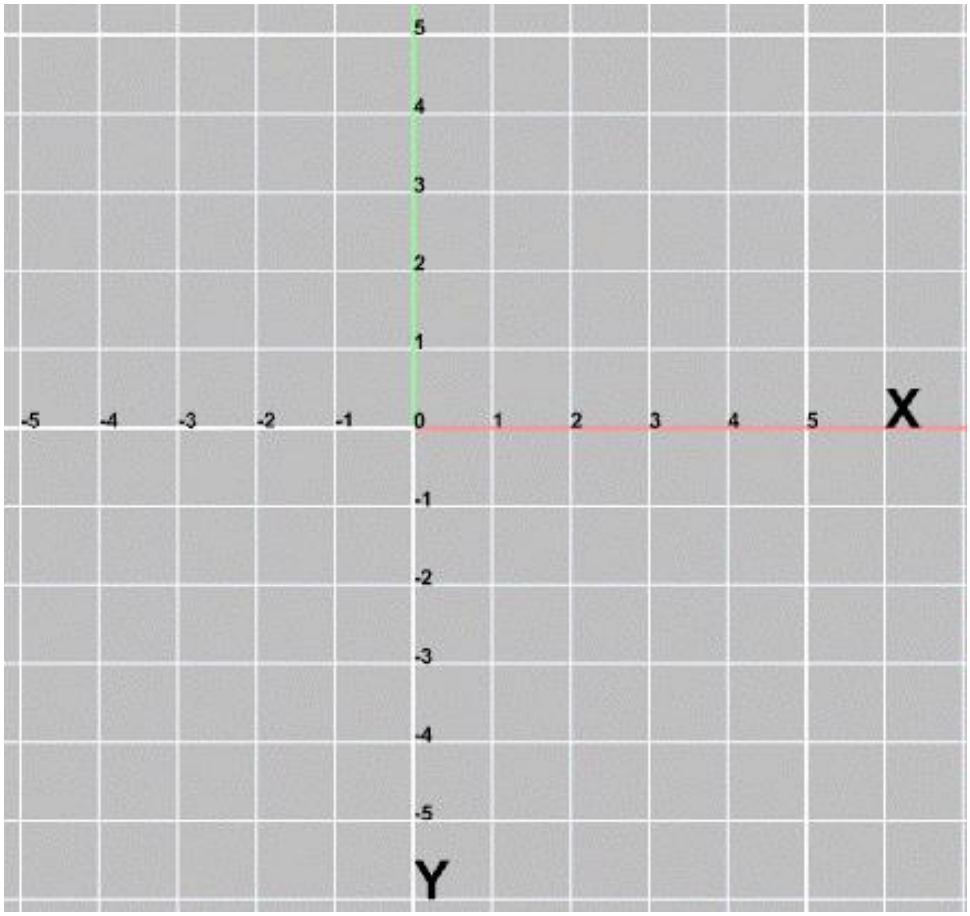
- Watch Understanding Cartesian Coordinates
- Consider Cartesian Coordinates and how they affect technology and many different things today.
- Read the article on how 3D printers rely on Cartesian Coordinates.

Designing directions that use Cartesian Coordinates can be important. 3D printers have code called G-Code that allows them to print on specific paths using Cartesian Coordinates. And video games use Cartesian Coordinates in 3 dimensions and 2 dimensions which is what allows game objects to move from one position to another. Using an objects dimension on specific coordinates is the basis for Computer Aided Design.

PRACTICE APPLYING CARTESIAN COORIDINATES



Find an object that you can find around your house. It can be a block, or any other household item. It will be your robot for you to use in your design challenge. Look at the object from a single angle and draw on the coordinate plane below. Draw it only from one angle to create a 2D drawing of the object. As you look at the object and draw the item from the top using cartesian coordinates this is your x, and y coordinates. Then look at the item from the side the x coordinate should be the same as your top drawing, but you will have a third coordinate which is the height this is the z coordinate.



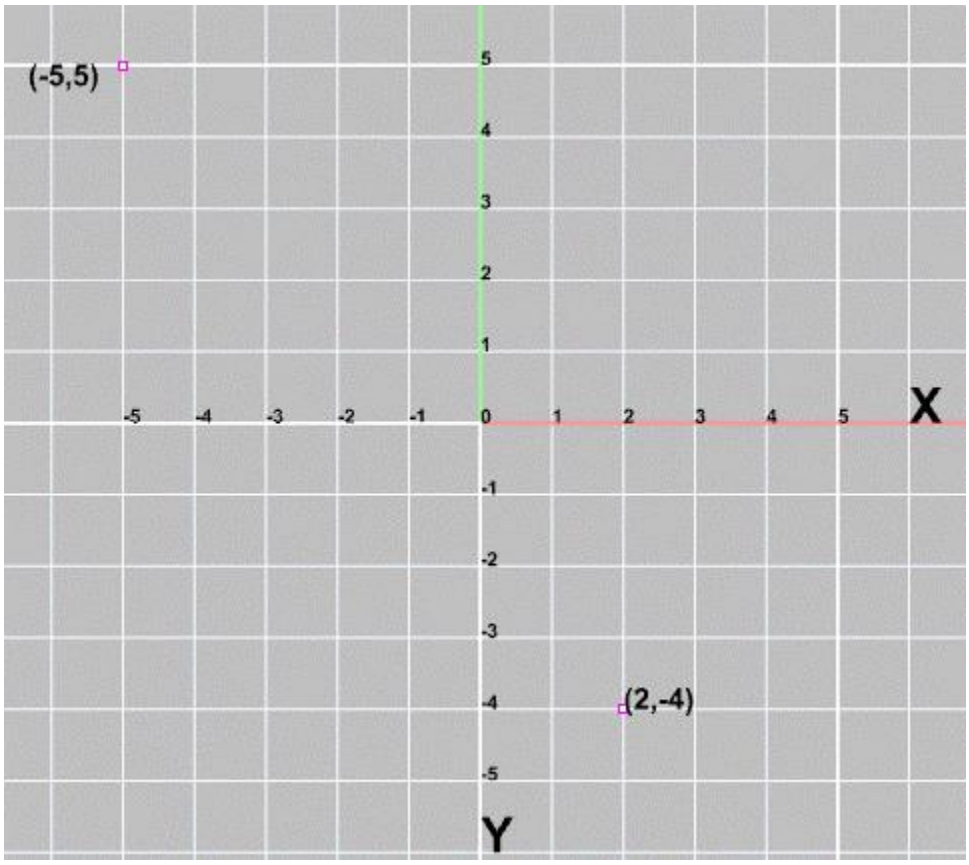
What type of drawing with the object be if you included the Z access in the drawing?

How does this relate to what you learned about how 3D printers work?

PROGRAMMING WITH CARTESIAN COORIDINATES

- Now you will have your robot move on a grid and get from point A to point B.
- Lay out an x y grid on your floor, driveway, or paper.
- Test out these coordinates before you get started using the grid below.
- Place markers at point A () and point B ()
- Decide how to get from point A () to point B () and write down the coordinates.
- How do different coordinates effect the path your robot travels?
- How could you use these coordinates to create your autonomous mode?

SKETCH YOUR DESIGN



WRITE OUT THE COORDINATES

Take a picture of your grid along with the path your robot will take to get from point A to point B.

REFLECTION QUESTIONS

1. Does the Cartesian coordinate system give you a better understanding of planning a path or design?
2. Did you learn a new way to see the playing field?
3. What ways will the Cartesian coordinate system effect your future designs?
4. What skills did you use or learn in this activity?

GO FURTHER!

Choose a CAD program to practice layout using coordinates. Create a 2D shape using the Line tools and Cartesian coordinates. Send just the coordinates to a friend to create your design.

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home
Electrical Circuits

ACTIVITY SUMMARY

Students will explore electronics, circuits power and energy in this at home circuit building challenge.

Age Range & Grade Level: *Ages 12+, Grade 6th grade +*

Program Connection: *FIRST*® Tech Challenge, *FIRST*® Robotics Competition

Authored By: Faith Bongiorno, Program Implementation Specialist, *FIRST*® Education

ACTIVITY OUTCOMES

Participants will:

1. Explore the electricity and circuit in their homes
2. Demonstrate electrical safety and what to not to do
3. Design a circuit with household items, testing various items to see discover which materials are conductors, power sources, or insulators.
4. Research career paths associated with electricity.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Electricity, Forces, Physics, Mechanics	Measurement, 2D/3D modeling, Geometry, Spatial Reasoning	Research, Content Reading	Career Connections, Engineering for social solutions	Intro to Hardware, Engineering Design Thinking
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last Core Value should always be used when doing any *FIRST*® activities.

ENGINEERING DESIGN PROCESS & *FIRST*® CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

KEY VOCABULARY

Electricity	DC Power	AC Power	Ohm's Law	Circuits	Insulators
Schematic	Current	Switch	Battery	Conductors	

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

FIRST Electric Circuit Design Brief, assorted materials for building a solution (not required) from around the home, and access to the internet

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the Electric Circuits Design Brief.	
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	Review the age appropriate engineering design process with your students.
Review electrical safety measure with your students, demonstrate safe practices.	View this link
Review brainstorming questions with you student(s). Inquire if they have any additional questions about electricity and circuits to research	Students can view the video links or look for additional resources to the provided questions
Determine how student(s) will complete the engineering activity, what their length of time will be, how to collaborate and how to share their solutions. Have student(s) work on their solutions.	Solutions can be built and designed using materials around the house after research is completed, review the engineering design process and identify where the student(s) is in the process and the what are the next steps will be in testing the materials gathered to create a circuit.
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their core values self-assessment and review.	Core Values self-assessment is found in the Galactic Builders Design Brief document.

STUDENT OR TEAM ACTIONS

1. Review the Electric Circuits Design Brief, problem statement and criteria/constraints.
2. Watch the videos.
3. Research the questions and discuss.
4. Create a solution to solve the challenge.
5. Share your solution and reflect on your learning.
6. Explore the Go Further! opportunities.
7. Complete your *FIRST* Core Values self-assessment.

GO FURTHER!

Explore the various areas of study and career pathway

Career	Education/ On job Training	Certifications	Future Forecast

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution would help others.	Showed how the solution would help others.	Not clear how the solution would help others.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home Electrical Circuits Design Brief

PROBLEM STATEMENT

Ever had something electrical go wrong and need to fix it? For example, have you ever had the wrong type of charger, a flashlight quit working or you want to put a new stereo in your car? From the beat of our heart to flicker of the TV, circuits can be found all around us. How we understand circuits to troubleshoot them or build a circuit of our own safely and operating correctly.
In your challenge, how can you create a simple circuit with household items.

CRITERIA & CONSTRAINTS

1. Design or fix an electrical circuit with supplies from you home.
2. The circuit should be illustrated using flow that properly powers the circuit using Ohm's law.
3. Use two power sources and two conductors.
4. The circuit should be able to be open and closed.
5. The circuit should use DC power only and be powered by no more than a 9-volt battery.
6. The circuit should follow proper safety procedures and guidelines.

ENGINEERING DESIGN PROCESS & *FIRST*® CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

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BUILDING THE BACKGROUND & BRAINSTORMING

Check out these video resources find out more about electricity and circuits.
Video Links:

1. Electrical Safety
2. Introduction to Simple Circuits
3. Ohm's Law
4. Electricity and Circuits
5. Schematics and Symbols

In your home what types of power do you have and what is the source of that power?
What items in your house use electricity that meets the criteria and constraints above?
Are there any items in your house that may be a non-traditional power source, like a lemon or potato?
What items in your house indicate that electricity is flowing?
Do you have items that prevent electricity from flowing or allow the current to flow?
What are the properties of those different types of items?

DESIGN A CIRCUIT WITH HOUSEHOLD ITEMS

Now it is time to use your knowledge to have some fun. Design a simple circuit using the household items you have discovered. Use your problem-solving skills and engineering design process to test which of the items works to complete the circuit. For example, can you use a banana to power a LED diode or a series of LED diodes?

Look around your environment and examines various items, what materials are those items created with, ask yourself are if those items conduct or generate power, will this material resist the flow of power or act as a switch.

Safety Tip 1

- Never Touch Plugs with wet hands
- Don't use appliances on a wet surface
- Don't use frayed cords.

Safety Tip 2

- Do not use AC power
- Ensure an adult has viewed your project prior to building

Safety Tip 3

- Do not leave your circuit on while unattended
- When deconstructing or building your circuit wear safety classes

Electricity can give you the shock of your life. Always check with an adult when working with electricity.

Identify components you discover around your home

Conductors	Insulators	Power Sources

Draw a simple circuit diagram

Using the items, you have found in your home and the knowledge you have gained about circuits Draw a circuit flow diagram labeling the power source, conductors, electrical components and switch using the correct symbols

Test Your Ideas

Test your circuit design and various materials, record which items work and which items did not work when creating a circuit. Why do you think those items didn't work? Reflect as you watch them go through the process how might you improve the directions?

SHARE AND COLLABORATE ON YOUR IDEAS

Using online collaboration or a parent, share your ideas with them.

Discuss with them how you might improve your design to create a series or parallel circuit.

REFLECTION QUESTIONS

1. What material work as conductors and why?
2. What materials work as power sources and why?
3. What happens when the circuit is open? What is happening to the electrons?
4. What is the difference between AC and DC power?

GO FURTHER!

Electrical engineers are not the only people fascinated with circuits!

The theory of power is fascinating to more than electrical engineers. Research the various areas of study that include circuits as part of the career pathway, what professional pathways are available to students, what credentials are needed, and what is the future forecast of need for these professionals.

Fill in the career pathway matrix below. One hint is to check out the website O'net used by professionals and career analyst or career trend to find out more about a variety of careers that use electricity.

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
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Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home
Engineering with Rube Goldberg

ACTIVITY SUMMARY

After viewing the Qualcomm video of a Rube Goldberg Machine students will learn about simple machines and how they can combine them to make their own Rube Goldberg machine.

Age Range & Grade Level: *Ages 12+, Grade 7-12+*

Program Connection: *FIRST*® Tech Challenge, *FIRST*® Robotics Competition

Authored By: Lori Birch, Curriculum Developer, *FIRST*® Education

ACTIVITY OUTCOMES

Participants will:

1. Explore Simple Machines and a Rube Goldberg
2. Research and identify simple machines around their home.
3. Design, build and test a Rube Goldberg from supplies around their home.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Motion, Forces, Physics, Mechanics	Measurement, 2D/3D modeling, Geometry, Mechanical Advantage	Research, Content Reading	Career Connections, Engineering for social solutions	Logical Thinking
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last core value should always be used when doing any *FIRST* activities.

KEY VOCABULARY

Machine	Pulley	Wedge	Lever
Mechanics	Inclined Plane	Wheel and Axel	Mechanical Advantage
Energy Transfer	Gear	Robot	

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

Student may use any supplies they can find around their home examples include rulers, tape dispensers, screws, cardboard, books and toys or parts of toys.

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the *FIRST* Rube Goldberg design Brief.	
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	Review the age appropriate engineering design process with your students.
Have students watch the Qualcomm video. Discuss with them how energy was transferred in the video and different mechanisms that they saw in the video.	https://www.youtube.com/watch?v=FQqi_7k1gyE
Determine how students will complete the engineering activity, what their length of time will be, how to collaborate and how to share their solutions. Have students work on their solutions.	Solutions can be built and designed using materials around the house or it can be a drawing or computer aided design (CAD).
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their core values self-assessment and review.	Core Values self assessment is found in the Rube Goldberg Design Brief.

STUDENT OR TEAM ACTIONS

1. Review the Engineering a Rube Goldberg, problem statement and criteria/constraints.
2. Watch the Qualcomm sponsor video.
3. Research the questions and discuss.
4. Create a solution to solve the challenge.
5. Share your solution and reflect on your learning.
6. Explore the Go Further! opportunities.
7. Complete your *FIRST* core values self-assessment.

GO FURTHER!

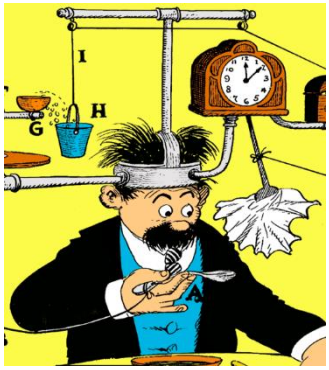
Students draw how they could incorporate simple machines into a robot design. Assemble and test different mechanisms for a robot if supplies are available.

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution would help others.	Showed how the solution would help others.	Not clear how the solution would help others.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home
Engineering with Rube Goldberg – Design Brief

PROBLEM STATEMENT



Solving problems to make new things possible requires innovation and creativity while using the engineering design process. We want you to take the idea of solving problems to a whole new level! Rube Goldberg was a cartoonist and inventor who solved simple tasks in the most overcomplicated, inefficient and hilarious way possible. In this challenge you will take on the FUN task of creating your own Rube Goldberg Machine.

CRITERIA & CONSTRAINTS -

- The Rube Goldberg should involve at least three simple machines.
- Use objects that you find around your home.
- Involve transfer of motion from one simple machine, to another.
- Complete the tasks or incorporate a fun outcome.

ENGINEERING DESIGN PROCESS & *FIRST* CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

BUILDING THE BACKGROUND & BRAINSTORMING

Watch the video on Rube Goldberg Machines from *FIRST* sponsor Qualcomm:

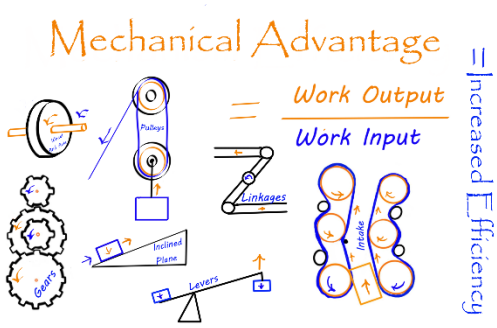
Mechanical engineers use multiple simple machine to make more complex machines. The Rube Goldberg machine that was developed by the students in the video used lots of simple machines to solve a single task using a very complex process.

Use the following information to learn more about simple machines.

We use simple machines in our life every day. Simple machines include a lever, pulley, wedge, inclined plane, a screw, and a wheel and axle. These simple machines have been used in construction and products in our homes and automobiles for many centuries.

Can you find examples of each of these simple machines in the video?

What other simple looking devices did you see in the video that could be used in a Rube Goldberg Machine?



Combining simple machines allows engineers to increase mechanical advantage, which increases the efficiency of work output from work input.

You also can combine simple machines, such as levers and a fulcrum, to move or launch objects.

What examples of Mechanical Advantage can you find in the video?

SKETCH YOUR DESIGN

Look for simple machines around your home. Record a brief sketch of the simple machine and how it increases the mechanical advantage of the work it is designed to accomplish. Consider simple machines you have around your home, and how could you use them in your Rube Goldberg. Be sure to include dimensions, different drawings from different angels to demonstrate movement, and how the energy will be transferred.

What is the planned output task of this machine?

REFLECTION QUESTIONS

1. How did you use simple machines to accomplish the task?

2. In testing, how did you increase the mechanical advantage of the simple machine to make the task easier?

3. Did you try to combine multiple simple machines? If so, did it increase the mechanical advantage?

4. How did you use the engineering design process in designing your Rube Goldberg and how is this process like what they might have done in the video?

GO FURTHER!

How are simple machines used on a robot to accomplish a task? How could you apply the same principles of energy transfer to a robot design?

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home
Escape Room

ACTIVITY SUMMARY

Students will work on designing an escape room in their home. It will involve solving a series of problems using elements of robotics such as simple machines and programming. They can complete the activity in the classroom, in the home, or around the home.

Age Range & Grade Level: *Ages 12+, Grade 7-12+*

Program Connection: *FIRST*® Tech Challenge, *FIRST*® Robotics Competition

Authored By: Lori Birch, Curriculum Developer, *FIRST*® Education

ACTIVITY OUTCOMES

Participants will:

1. Incorporate problem-solving into creating an escape room scenario.
2. Develop and incorporate a themed scenario for an escape room.
3. Design and test ideas for an escape room.
4. Identify areas where there are opportunities to improve the design.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Motion, Forces, Physics, Mechanics	Measurement, 2D/3D modeling, Geometry, Spatial Reasoning	Research, Content Reading	Career Connections, Engineering for social solutions	Pseudocode
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last Core Value should always be used when doing any *FIRST* activities.

KEY VOCABULARY

Pseudocode	Robots	Loops and Conditionals	Engineering Design Process
Mechanics	Sensors	Brainstorming	

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

Escape Room Design Brief, assorted materials for building a solution (not required)

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the Escape Room Design Brief.	
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	Review the age appropriate engineering design process with your students.
Have students read the blog about escape rooms to build background on the subject allow students time to explore ideas and possibilities around their home that could be used to create an escape room.	Students can really explore as ideas as possible encourage them to explore all possibilities and be creative.
Determine how students will complete the escape room activity, what their length of time will be, how to collaborate and how to share their solutions. Have students work on their solutions.	This is an open-ended project so students can collaborate virtually or complete this via social distancing or with a virtual learning environment using resources they have at home or just completing the design portion of the activity not the building of the room.
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their core values self-assessment and review.	Core Values self-assessment is found in the Galactic Builders Design Brief document.

STUDENT OR TEAM ACTIONS

1. Review the Escape Room design brief, problem statement and criteria/constraints.
2. Research the questions and discuss.
3. Create a solution to solve the challenge.
4. Share your solution and reflect on your learning.
5. Explore the Go Further! opportunities.
6. Complete your *FIRST* Core Values self-assessment.

GO FURTHER!

This is a perfect opportunity for student to use this as a possible future team activity for fundraising, hosting a STEM night or making an impact in their community.

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution would help others.	Showed how the solution would help others.	Not clear how the solution would help others.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home
Escape Room
Design Brief

PROBLEM STATEMENT

Your problem during this challenge is to design an escape room in your classroom, or in or around your home that incorporates the skills outlined below.

- How to develop marketing materials using *FIRST*® Core Values
- How to write algorithms and develop programming skills.
- How to design using CAD and cartesian coordinates.
- How to design electricity works and design an electrical circuit.
- How to use simple machines to make a Rube Goldberg Machine.

Your design challenge is to create an escape room that incorporates the knowledge and skills like what you explored previously. For this lesson, you will focus on how you could design the physical space and the storyline needed for the escape room as well as how you could incorporate your knowledge and skills into the escape room.

CRITERIA & CONSTRAINTS -

1. Incorporate at least two *FIRST* Core Values with a marketing campaign that promotes your event.
2. Programming skills including algorithms, state machines, loops and conditionals.
3. Have a design plan with a design for each problem to be solved in the space.
4. Involve mechanical components such as simple machines and electronic circuits in the problems.
5. Have an exciting narrative that will engage your participants to want to solve the problem.
6. The escape room should be designed to fit in a space around your home or classroom.

ENGINEERING DESIGN PROCESS & *FIRST* CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

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BUILDING THE BACKGROUND & BRAINSTORMING

- Escape rooms involve solving a sequence of problems to reach the outcome of escaping the scenario. *FIRST* is centered around giving you real world problems to solve in a fun way, that incorporates game strategy and how you solve the problem.
- Consider your surroundings and a possible theme you could develop an escape room around. How can you make it creative and engaging?
- If you have been to an escape room how did, they design the narrative and problem to be engaging and increase your “want” to solve the problem?
- Read this article or research escape rooms to build some ideas for your solution.
- How could incorporating elements of robotics into the escape room make it more engaging and help others develop robotics skills?

DESIGN YOUR ESCAPE ROOM

Using the design criteria design your escape room. Create an outline that has your theme or scenario as well as how you might incorporate the activities you have developed into the escape room. You may not have all the skills to include every element of the design criteria right now (e.g.. your marketing plan and state machines). These will be your next activities to develop. Focus right now on including the elements that you have learned already.

SKETCH YOUR DESIGN

Sketch the physical space of your escape room where each problem will be for them to solve. Be sure to consider the physical space and how you could incorporate these principles

TEST YOUR IDEAS

Use someone in your home or collaborate virtual to share ideas, have them read through your scenario and try to solve the problem. Testing is important especially in this type of environment to make sure that others are interpreting the problem correctly.

REFLECTION QUESTIONS

1. How can solving problems in the perspective of a game make it more fun and engaging to learn?
2. Looking at the lessons you have learned from your testing. Evaluate which design criteria you still need to improve on.
3. How can you continue to improve your escape room by focusing on the testing of the ideas you have already?
4. How can this testing give you information on how your escape room can be better designed and marketed?

GO FURTHER!

- If you are a *FIRST* team or want to start a *FIRST* team how could you use this activity to make an impact for others in your community?
- How could they learn more about *FIRST*?
- How could it be used promote STEM in your community and demonstrate *FIRST* Core Values?

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home
Business Plan

ACTIVITY SUMMARY

Researching business plans to develop a plan for the escape room business that students will design the remaining weekly activities.

Age Range & Grade Level: *Ages 12+, Grade 7+*

Program Connection: *FIRST*® Tech Challenge and *FIRST*® Robotics Competition

Authored By: Elizabeth McClurg, Program Specialist, *FIRST*® Tech Challenge

ACTIVITY OUTCOMES

Participants will:

1. Develop an overall plan for the escape room business.
2. Explain how the business operates on a day-to-day basis.
3. Revise and edit through the process to home in on the best solutions for potential risks.
4. Consider how to add value and created a successful business through value propositions.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Inquiry based problem solving	Cost/Profit sheets, Excel equations and totals	Research, Content Reading	Career Connections, Engineering for Social Solutions	
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last core value should always be used when doing any *FIRST* activities.

KEY VOCABULARY

Business Plan	Mission Statement	Risk Assessment	Value Propositions
Solution	Operations	Procedure	

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

The business template, a spreadsheet either handwritten or a spreadsheet program

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the business plan template and example.	
Review the problem statement, criteria and constraints with the students. Remind them to use both the engineering design process and *FIRST* core values during the activity.	
Direct students to brainstorm and outline their escape room business.	Research examples of escape room businesses. Show examples of small business planning.
Students will now need to write out their business plan for the escape room.	Show students how to write costs and profits and tally in a spreadsheet.
Reflect on what was learned in this activity with the students and how this may connect to future career or business plans.	
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their core values self-assessment and review.	Core Values self-assessment is found in the Galactic Builders Design Brief document.

STUDENT OR TEAM ACTIONS

1. Review the design brief, problem statement and criteria/constraints.
2. Access the template and review the example business plan.
3. Outline the basic concept for the escape room.
4. Create a solution to the potential risks involved with this type of business.
5. Share your business plan with outline and spreadsheet(s).
6. Explore the Go Further! opportunities.
7. Complete your *FIRST* core values self-assessment.

GO FURTHER!

Research value propositions and develop some for the escape room business. Prompt with “What do potential customers want from an escape room experience?”

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution would help others.	Showed how the solution would help others.	Not clear how the solution would help others.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home
Business Plan
Design Brief

PROBLEM STATEMENT

FIRST® needs you to create a business plan for your capstone project, the escape room. A business plan will outline key areas of the business, a mission statement, organizational structure (your team), operational procedure (how will the business operate) financials (operating costs and profit) and a bit of foresight into the potential risks of this type of business and a plan to solve for those risks.

CRITERIA & CONSTRAINTS

The business plan must explain the following about your escape room:

- A mission statement for your escape room.
- Organizational structure of your business.
- Operational procedure (Open hours, schedules etc.).
- Financials (how will your business make a profit).
- Risks and solutions.

ENGINEERING DESIGN PROCESS & *FIRST* CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

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BUILDING THE BACKGROUND & BRAINSTORMING

- Review *FIRST*® Robotics Competition Business Plan Template
- Consider how this template applies to your business, the escape room, and outline your own business needs to fulfill the criteria.
- Read the business plan as an example.

PRACTICE APPLYING

- What kind of roles do the members of the team need to play to operate an escape room?
- What are the operating hours and overall plan (scheduled appointments, first come first serve, etc.)
- Explain the overall concept of the customer experience.
- How can we test our business plan concepts before launching the business?
- Will this help predict risks and solutions?

WRITE YOUR BUSINESS PLAN

Follow the examples provided in the Building Background section using the criteria and constraints plus what you have learned in the practice applying.

REFLECTION QUESTIONS

1. Did writing the business plan help shape the vision for your escape room?
2. What changes to your vision did you make through this process?
3. How did you incorporate Core Values into the plan?
4. What skills did you use or learn in this activity?
5. How will these skills help you in a future career?
6. How to you think an entrepreneur would use a business plan like this when creating a new business?

GO FURTHER!

Consider ways to make your business, the escape room profitable.

Brainstorm ideas to attract customers.

Write down some value propositions, a promise of value to be delivered, communicated, and acknowledged by potential customers.

What kinds of special events or themed escape rooms will attract different demographics of people?

Reflect on the location of your business and how does that impact potential customers?

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home
The State of Things

ACTIVITY SUMMARY

Students will investigate how state machines can improve flow and use of algorithms. They will create a workflow for a state machine.

Age Range & Grade Level: *Ages 13 +, Grade 7+*

Program Connection: *FIRST*® Tech Challenge, *FIRST*® Robotics Competition

Authored By: Lori Birch, Curriculum Developer, *FIRST* Education

ACTIVITY OUTCOMES

Participants will:

1. Explore state machine theory.
2. Identify the relationship between a state and transitions between states.
3. Apply state machines and transitions and how they are used in industry.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Motion, Forces, Physics, Mechanics	Measurement, 2D/3D modeling, Geometry, Spatial Reasoning	Research, Content Reading	Career Connections, Engineering for social solutions	Inputs, outputs, state machines, transitions between states
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last core value should always be used when doing any *FIRST* activities.

KEY VOCABULARY

Pseudo Code	State Machine	Output	Transition	Loops
Input	Sensors	Algorithm	Conditionals	Flow Control

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

The State of Things Design Brief, assorted materials for building a solution (not required)

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the *FIRST* Design Brief.	
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	FIRST Engineering Design Process
Have students conduct research to understand what a state machine is and how they can be used to control flow.	Student can find videos online and research images of different state machines.
Determine how students will complete the engineering activity, what their length of time will be, how to collaborate and how to share their solutions. Have students work on their solutions.	Students will complete a flow chart of controlling the flow of their escape room with states.
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their core values self-assessment and review.	Core Values self-assessment is found in the Galactic Builders Design Brief document.

STUDENT OR TEAM ACTIONS

1. Review the state of things design brief, problem statement and criteria/constraints.
2. Research the questions and discuss.
3. Create a solution to solve the challenge.
4. Share your solution and reflect on your learning.
5. Explore the Go Further! opportunities.
6. Complete your *FIRST* core values self-assessment.

GO FURTHER!

How could you incorporate state machines on a robot? How could it help you move objects from one place to another?

How are state machines used in industry and business? Consider a factory how might state machines be used in manufacturing? Create a drawing of a factory and a state machine that could be used to produce something such as a car?

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution would help others.	Showed how the solution would help others.	Not clear how the solution would help others.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home
The State of Things
Design Brief

PROBLEM STATEMENT

In an escape room, participants must complete tasks to move forward, find new puzzles or clues and ultimately escape the room. Sometimes tasks can be completed out of order but do not reveal the next step until all parts are completed and those conditions are met. In this activity you need to explore how the escape room is optimized using algorithms with state machines to improve the playing experience. Use your escape room design or existing escape room design to explore how state machines can prove the concept of the room, determine difficulty level, and ensure a good player experience.

CRITERIA & CONSTRAINTS

- Participants must only be in one state at a time.
- You should have transitions that trigger a participant to go from one state to another.
- You should include algorithms that have a sequence as well as a decision based upon input.
- Your state machines should involve solving problems that include coding, electrical circuits, cartesian coordinates, and simple machines.

ENGINEERING DESIGN PROCESS & *FIRST* CORE VALUES

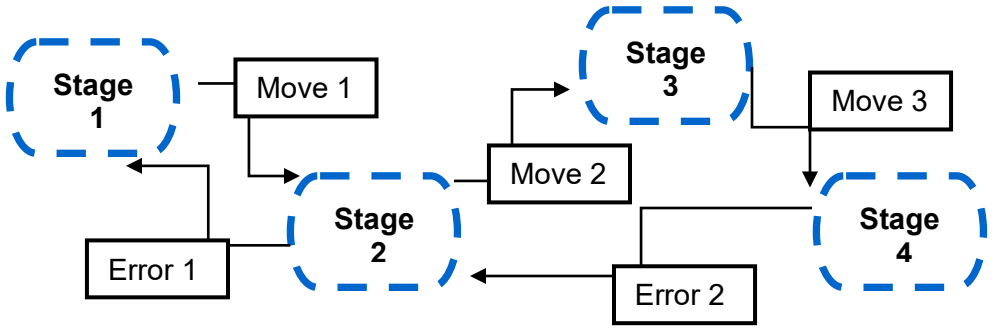
FIRST Engineering Design Process | Explore *FIRST* Core Values

BUILDING THE BACKGROUND & BRAINSTORMING

Reflect, research and answer the questions below.

- What is a state machine?
- What triggers the ability to move from one state to another?
- What is a transition in a state machine?
- How can inputs and conditions be used to trigger a transition between states?
- How can loops be used in a state?

State diagram Example



SKETCH YOUR DESIGN

Create a state diagram or pseudo code that creates states of a person moving through your escape room.

REFLECTION QUESTIONS

1. What are the states of a person in your escape room?
2. How can the algorithm in the state affect the output of the participant?
3. What is the input that triggers a transition from one state to another?
4. What is the output from each transition?
5. How does a state machine improve the flow of your escape room participants?
6. What skills did you use or learn in this activity?
7. How do state machines relate to artificial intelligence?

GO FURTHER!

How could you incorporate state machines on a robot? How could it help you move objects from one place to another?

How are state machines used in industry and business? Consider a factory how might state machines be used in manufacturing? Create a drawing of a factory and a state machine that could be used to produce something such as a car?

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® atHome
Detailed Drawings

ACTIVITY SUMMARY

Student will explore CAD and technical drawings and apply them to the design of an escape room.

Age Range & Grade Level: *Ages 13 +, Grade 7+*

Program Connection: *FIRST*® Tech Challenge, *FIRST*® Robotics Competition

Authored By: Lori Birch, Curriculum Developer, *FIRST* Education

ACTIVITY OUTCOMES

Participants will:

1. Explore the resources available for using CAD to make 3D designs.
2. Students will research principles used in CAD and technical drawings.
3. Students will apply the skills through creating a CAD model of their escape room and engineering drawings of 3 escape room components.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
	Measurement, 2D/3D modeling, Geometry, Spatial Reasoning	Research, Content Reading	Career Connections, Engineering for social solutions	3D coordinates and planes
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last core value should always be used when doing any *FIRST* activities.

KEY VOCABULARY

Extrude	Hole	Orthographic View	Dimensions	
Tolerance	Chamber	Planes	Assembly	Sketch

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

FIRST Detailed Drawings design brief, computer with possibility of installing CAD software, paper, ruler, escape room materials.

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the *FIRST* Detailed Drawings Design Brief.	
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	Review the age appropriate engineering design process with your students.
Have students explore the resources for designing with CAD. Create a team account if you are participating as part of a team.	OnShape can run completely web-based, students at a younger level can also use Tinkercad. Fusion 360 and Solidworks will require the ability to install on the computer.
Determine how students will complete the design activity, what their length of time will be, how to collaborate and how to share their solutions. Have students work on their solutions.	Solutions can be built and designed using materials around the house or it can be a drawing or computer aided design (CAD).
Review Evidence of Achievement rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the Go Further! opportunities	See below
Wrap up – Have students complete their core values self-assessment and review.	Core Values self-assessment is found in the Design Brief document.

STUDENT OR TEAM ACTIONS

1. Review the design brief, problem statement and criteria/constraints.
2. Review the list of possible CAD programs and choose one.
3. Research the questions and discuss.
4. Create a solution to solve the challenge.
5. Share your solution and reflect on your learning.
6. Explore the Go Further! opportunities.
7. Complete your *FIRST* core values self-assessment.

GO FURTHER!

Explore other CAD tools or complete tutorials on the CAD tool you chose. How can you use your skill in CAD for a future career? Are there any jobs that require types of CAD to be considered qualified for the job?

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution would help others.	Showed how the solution would help others.	Not clear how the solution would help others.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® atHome

Detailed Drawings Design Brief

PROBLEM STATEMENT

You need to obtain funding for your escape room business and investors want to see both how the room works and what it looks like to ensure this will be an exciting experience. The theme of the room is just the surface but below that are complex layers that require specific design details. Your challenge is to demonstrate to the investors both what your room looks like and how it works.

Enigma, and Cryptography

CRITERIA & CONSTRAINTS

- You should create a 3D model of the escape room using an online CAD tool.
- The CAD model should be created by using extrusions and assemblies.
- You should have engineering drawings of at least 3 objects that will be in your escape room.
- The engineering drawings be in orthographic projection, with proper scale.

ENGINEERING DESIGN PROCESS & *FIRST* CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

BUILDING THE BACKGROUND & BRAINSTORMING

- What is cryptography and how does that relate to code breaking?
- How can you use gear ratios and rotation to create a cryptographic device?
- Explore gear trains and gear logic using logic puzzles
- https://www.youtube.com/watch?v=GkkinJRKr7E
- How do you determine gear ratio?
- How do gear ratios help you determine speed, power and direction?

SKETCH YOUR DESIGN

In the area below sketch the components that you would like to make an engineering drawing of. Then use a separate piece of paper to create a detail engineering drawing of at least three of the components you will have in your escape room.

SCREENSHOT YOUR 3D MODEL

Using one of the tools above take 3 screenshots of your escape room model which include the elements of your criteria and constraints.

REFLECTION QUESTIONS

1. How does the plane and view of an object correlate on a technical drawing and a 3D model?

2. How are sketches useful in addition to a 3D model?

3. How can CAD and demonstrating assemblies create a more efficient design process?

4. How has 3D design become more important as 3D printing is more available?

5. How can the use of drawings and 3D models help you communicate with others details of your design?

GO FURTHER!

- How can you utilize 3D design tools help you and your team?
- How do you think it could improve your robot design process?
- How can CAD help you in in situations where your team cannot meet?

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
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Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home
Get In Gear

ACTIVITY SUMMARY

Students will design a gearbox using materials from their home. They repurpose gears from existing objects such as toys or make their own using cardboard and pencils.

Age Range & Grade Level: *Ages 13 +, Grade 7+*

Program Connection: *FIRST*® Tech Challenge, *FIRST*® Robotics Competition

Authored By: Lori Birch, Curriculum Developer, *FIRST* Education

ACTIVITY OUTCOMES

Participants will:

1. Learn about gears, gear ratios and how to assemble gear trains.
2. Design, and test ideas for their gearbox.
3. Identify areas where they still need to improve their design to meet the full criteria.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Motion, Forces, Physics, Mechanics	Measurement, 2D/3D modeling, Geometry, Spatial Reasoning	Research, Content Reading	Career Connections, Engineering for social solutions	
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last Core Value should always be used when doing any *FIRST*® activities.

KEY VOCABULARY

Diameter	Robots	Brainstorming	Mechanics	Pitch
Gear Ratios	Compound Gears	Engineering Design Process		
Torque	Speed			

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

FIRST Get in Gear Design Brief, assorted materials for building a solution

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the *FIRST* Get in Gear Design Brief.	
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	Review the age appropriate engineering design process with your students.
Have students watch allow students time to explore ideas and possibilities around their home that could be used gearbox.	Students can really explore as ideas as possible encourage them to explore all possibilities and be creative.
Determine how students will complete the gearbox activity, what their length of time will be, how to collaborate and how to share their solutions. Have students work on their solutions.	This is open ended if student requirements for social distancing are not necessary encourage them to work together to find a common space and can use as many resources as possible.
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their core values self-assessment and review.	Core Values self-assessment is found in the Galactic Builders Design Brief document.

STUDENT OR TEAM ACTIONS

1. Review the resources on creating gears and understand gear ratios
2. Research the questions and discuss.
3. Create a solution to solve the challenge.
4. Share your solution and reflect on your learning.
5. Explore the Go Further! opportunities.
6. Complete your *FIRST* Core Values self-assessment.

GO FURTHER!

This is a perfect opportunity for student to use this as a possible future team activity for fundraising and making an impact in their community.

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution would help others.	Showed how the solution would help others.	Not clear how the solution would help others.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home
Get In Gear
Design Brief

PROBLEM STATEMENT

Machines everywhere use gears to gain a mechanical advantage for speed or more torque. Consider a time where you were in a machine such as a car or bicycle, what is occurring when you hear the machine shift? What happens after the shift? Your design challenge for this activity is to design your own gear box.

CRITERIA & CONSTRAINTS

- Your gear box should have gear ratios that can increase the speed of the output.
- It should contain at least one compound gear ratio
- It can be made from materials you find around your home such as cardboard, pencils, toys, LEGO® elements, bike sprockets.
- You should add to your design a way to incorporate pulleys or chains and sprockets with the gear train.

ENGINEERING DESIGN PROCESS & *FIRST*® CORE VALUES

FIRST Engineering Design Process | Explore *FIRST*® Core Values

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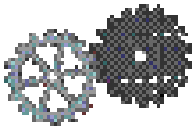
BUILDING THE BACKGROUND & BRAINSTORMING

What are the components of a gear train and how can we increase mechanical advantage with it?

A wheel and axle is a wheel with a rod through the center. A wheel and axle can make it easier to lift or move something. There are wheels and axles in cars, wagons, and doorknobs.

What objects do you have around your home that could be used as an axle?

Gears are toothed wheels that fit together so that one wheel turns another. There are gears in clocks, drills, and bicycles.



What supplies do you have around your home that you could make gears with? Do you have something that already has gears that you could repurpose?

What is the pitch of a gear? What is the difference between outside diameter, inside diameter and circular pitch?

Explore the resources below to create your own printable gears on paper. These could be glued to

cardboard and the cardboard cut to fit the gear.
https://www.youtube.com/watch?v=uz436Ixbl-I
https://www.youtube.com/watch?v=oNuhr3htNWs
https://woodgears.ca/gear_cutting/template.html
https://docs.revrobotics.com/15mm/transmitting-and-transforming-motion/gears

A pulley is a wheel with a groove around the rim. A rope or belt can fit into the groove. Pulling on one end of the rope around a pulley can raise, lower, or move something attached to the other end of the rope. There are pulleys in flag poles, window blinds, and cranes.

How might you combine pulleys or chains and sprockets with gears to create a more advanced machine?

How do gear ratios apply when using pulleys, chains and sprockets?

SKETCH YOUR DESIGN

Draw out the design for your gearbox. Include any calculations that you might need to make sure you meet the design constraints. Be sure to include dimensions, different orthographic angles, and how the energy will be transferred.

BUILD YOUR DESIGN

TEST AND RECORD

Record any testing observations you made while building.

REFLECTION QUESTIONS

1. What do you notice about gear and rotation?
2. What might be important things to consider when you are incorporating a gearbox in a machine?
3. How do gears allow you to manipulate and transfer energy?
4. How can outside diameter, insider diameter and circular pitch affect your gear box design?
5. What could occur if you incorrectly assemble a compound gear ratio?

GO FURTHER!

How could you apply the same principles of gear boxes to a robot design? Explore other types of gears such as worm gears, bevel gears and rack and pinion. How can they help you gain more mechanical advantage in you robot design?

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® atHome
Encryption Enigma

ACTIVITY SUMMARY

Students will explore how encryption devices are created and how they work. They will use their experience developed making gear trains and gear ratios to develop their own encryption device.

Age Range & Grade Level: *Ages 13 +, Grade 7+*

Program Connection: *FIRST*® Tech Challenge, *FIRST*® Robotics Competition

Authored By: Lori Birch, Curriculum Developer, *FIRST*® Education

ACTIVITY OUTCOMES

Participants will:

1. Gain knowledge about encryption devices and how they work.
2. Develop and incorporate algorithms and gear ratios into an encryption device.
3. Design, test and iterate ideas for their encryption device.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Motion, Forces, Physics, Mechanics	Measurement, 2D/3D modeling, Geometry, Spatial Reasoning	Research, Content Reading	Career Connections, Engineering for social solutions	Pseudocode Encryption
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last Core Value should always be used when doing any *FIRST* activities.

KEY VOCABULARY

Encryption Enigma Pseudocode Algorithm Gear Ratios

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

FIRST Encryption Enigma Design Brief, assorted materials for building a solution (not required)

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the *FIRST* Encryption Enigma Design Brief.	
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	Review the age appropriate engineering design process with your students.
Have students watch videos and allow students time to explore ideas and possibilities around their home that could be used as an escape room.	Students can really explore as ideas as possible encourage them to explore all possibilities and be creative.
Determine how students will complete the activity, what their length of time will be, how to collaborate and how to share their solutions. Have students work on their solutions.	This is open ended if student requirements for social distancing are not necessary encourage them to work together to find a common space and can use as many resources as possible.
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their core values self-assessment and review.	Core Values self-assessment is found in the Galactic Builders Design Brief document.

STUDENT OR TEAM ACTIONS

1. Review the Encryption Room design brief, problem statement and criteria/constraints.
2. Research the questions and discuss.
3. Create a solution to solve the challenge.
4. Share your solution and reflect on your learning.
5. Explore the Go Further! opportunities.
6. Complete your *FIRST* Core Values self-assessment.

GO FURTHER!

1. How is writing code for encryption like writing code for a robot?
2. How is encryption used in the wireless technology used in a *FIRST*® Tech Challenge or *FIRST*® Robotics Competition robot?

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution would help others.	Showed how the solution would help others.	Not clear how the solution would help others.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home
Encryption Enigma Design Brief

PROBLEM STATEMENT

Mechanical machines are not just used to perform work, they also can be used to make devices that can encrypt messages. Encryption machines such as an Enigma machine were some of the first ways that messages were encrypted during war time. How can you use your knowledge of coding and simple machines build an encryption machine for your escape room?

CRITERIA & CONSTRAINTS

- The encryption machine should use gears and gear ratios
- Use objects that you find around your home.
- The gears should be able to store a system of letters and numbers that when the method of encryption is known it can easily be decoded.
- You should develop a pseudocode to design your encryption device.
- End with a fun outcome.

ENGINEERING DESIGN PROCESS & *FIRST*® CORE VALUES

FIRST® Engineering Design Process | Explore *FIRST* Core Values

BUILDING THE BACKGROUND & BRAINSTORMING

Experiment with different types of encryption and how rotary devices such as gears can be used to accomplish encryption:

The Enigma Machine Explained
https://www.youtube.com/watch?v=ASfAPOiq_eQ

Enigma 37 machine using gears
https://www.youtube.com/watch?v=_Jsk1jfHyjc

Hour of Code – Simple Ecryption
https://studio.code.org/s/hoc-encryption

Enigma Machine white paper with wiring diagram
https://web.stanford.edu/class/cs106j/handouts/36-TheEnigmaMachine.pdf

Gear Template Generators
https://geargenerator.com/ & https://woodgears.ca/gear_cutting/template.html

SKETCH YOUR MACHINE DESIGN

Using the resources above sketch the gear designs you would like to use to make you encryption machine. Consider how might the encryption be affected by the orientation of the gears.

SKETCH YOUR ENCRYPTION ALGORITHM

Design the pseudocode for the algorithm that will run your encryption machine.

TEST YOUR ALGORITHM WITH THE GEARS

Test and modify your algorithm as needed.

REFLECTION QUESTIONS

1. How can encryption increase security of an algorithm or message?
2. How did you use gear ratios in your encryption device?
3. How could a person choose a different gear ratio and it affect the encrypted message?
4. How will understanding how encryption works help you solve problems more easily in your future?

GO FURTHER!

1. How is writing code for encryption similar to writing code for a robot?
2. How is encryption used in the wireless technology used in a *FIRST*® Tech Challenge or *FIRST*® Robotics Competition robot?

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
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Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
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Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® atHome
Final Escape

ACTIVITY SUMMARY

Using skills developed in the previous activities in this series, students will now finalize their escape room concepts and present their plans to potential investors for funding to open this exciting new business.

Age Range & Grade Level: *Ages 13 +, Grade 7+*

Program Connection: *FIRST*® Tech Challenge, *FIRST*® Robotics Competition

Authored By: Lori Birch, Curriculum Developer, *FIRST*® Education

ACTIVITY OUTCOMES

Participants will:

1. Incorporate problems they have been solving into an escape room scenario.
2. Develop and incorporate a scenario for their escape room.
3. Develop a sales pitch for the evidence of success for their escape room.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Motion, Forces, Physics, Mechanics	Measurement, 2D/3D modeling, Geometry, Spatial Reasoning	Research, Content Reading	Career Connections, Engineering for social solutions	Pseudocode
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last Core Value should always be used when doing any *FIRST* activities.

KEY VOCABULARY

Pseudocode	Robots	Engineering Design Process	Brainstorming
Mechanics	Sensors	Sales Pitch	

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

FIRST Final Escape Design Brief, assorted materials for building a solution (not required)

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the *FIRST* Final *Escape* Room Design Brief.	
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	Review the age appropriate engineering design process with your students.
Allow students time to explore ideas and possibilities around their home that could be used as a escape room.	Students can really explore as ideas as possible encourage them to explore all possibilities and be creative.
Determine how students will complete the escape room activity, what their length of time will be, how to collaborate and how to share their solutions. Have students work on their solutions.	This is open ended if student requirements for social distancing are not necessary encourage them to work together to find a common space and can use as many resources as possible.
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* Opportunities	See below
Wrap up – Have students complete their Core Values self-assessment and review.	Core Values self-assessment is found in the Galactic Builders Design Brief document.

STUDENT OR TEAM ACTIONS

1. Review the Final Escape design brief, problem statement and criteria/constraints.
2. Research the questions and discuss.
3. Create a solution to solve the challenge.
4. Share your solution and reflect on your learning.
5. Explore the Go Further! opportunities.
6. Complete your *FIRST* Core Values self-assessment.

GO FURTHER!

1. How is writing code for encryption like writing code for a robot?
2. How is encryption used in the wireless technology used in a *FIRST*® Tech Challenge or *FIRST*® Robotics Competition robot?

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution would help others.	Showed how the solution would help others.	Not clear how the solution would help others.
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Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® atHome
Final Escape
Design Brief

PROBLEM STATEMENT

Are you ready for your final escape? Throughout this series of *FIRST*® @ Home lessons you have been applying lessons to the design of your escape room. Those lessons have included:

- How to develop marketing materials around *FIRST* Core Values
- How to write algorithms using states.
- How to apply CAD and use it to design your room.
- How to develop gear ratios and gear trains to alter torque and speed.
- How to develop an encryption machine combining coding and gears.

It is now time to finalize your escape room concepts and present it to potential investors for it to be adopted in your community.

Your design challenge is to create make a final escape room that incorporates prior activities. For this lesson, you will focus on how to apply all the skills your practiced to an escape room that challenges you to apply STEM skills.

CRITERIA & CONSTRAINTS

- Have an exciting narrative promoting the FUN that you can have through solving problems that involve skills you use in building robots.
- The escape room should be designed in a space around your home, or another public space (depending on social distancing requirements)
- The escape room should include mechanical concepts such as simple machines, transfer of energy (Rube Goldberg), gear ratios, and gear trains.
- The escape room should involve following a design created using CAD.
- The series of problems that the participants solve should follow an algorithm that only allows them to be in one state at a time.
- The final escape problems should involve the use of solving a code using an encryption device.
- Include a “Shark Tank” sales pitch to present the final concept and evidence of design success to at least one other person.

ENGINEERING DESIGN PROCESS & *FIRST*® CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

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BUILDING THE BACKGROUND & BRAINSTORMING

- Escape rooms involve coordination of solving different problems to reach an outcome to allow someone to escape the scenario. *FIRST* is centered around giving you real world problems to solve with fun, that comes from the game strategy, and how you solve the problem. The scenario and theme of the game is what makes it fun.
- How have you continued to develop skills and improve your escape room through learning and applying new skills?
- How have you designed the algorithm of problems to solve that ensure that the participants are following a path and only in one state? How might you have multiple groups in at a time and have the algorithm so that they do not interact?
- How could incorporating elements of robotics into the escape room make it more engaging and help others develop robotics skills?
- See the other activities for more information on simple machines, CAD, Rube Goldberg, Gear ratios, and encryption.
- How can you present a design idea to others and illustrate evidence of how it will be successful? What are the elements of a good marketing and sales pitch? What will others need to know to buy-in to your design plan and design idea?

DESIGN YOUR ESCAPE ROOM

Using the design criteria above design your escape room. Create an outline for your "Shark Tank" pitch, what are the essential elements that need to be expressed? How will you prove the effectiveness and data that your design is proved and will work?

EVIDENCE OF SUCCESS

You have continued to develop skills to improve your escape room, record how your escape room has improved over the series of the last 5 lessons. How can you show that improvement and growth of learning and applying your skills? How has the percentage of your design criteria changed as you learned and applied new skills?

REFLECTION QUESTIONS

1. How can solving problems in the perspective of a game make it more fun and engaging to learn?
2. How have you used iteration and the design process to improve your escape room?
3. How did learning additional concepts such as state machines and encryption improve the design of your escape room?
4. How can researching and learning additional concepts about a topic improve the product and the engineering design process?
5. How does gathering data throughout the engineering design process allow you to better market and prove evidence of success for your product?

GO FURTHER!

- If you are a *FIRST* team, or want to start a *FIRST* team how could you use this activity to make an impact for others in your community?
- How could you apply your knowledge of the design process to other parts of your learning to develop and improve products through iteration?

CORE VALUES SELF-REFLECTION

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