Unit Title: Simple Machines	**Grade Level:** 3
Date Developed/Last Revised: 7.2.13	**Time Frame:** 1 quarter
Unit Author(s): JoAnn Ishida, Lynn Lum	**Primary Content Area:** Science and Engineering

UNIT DESCRIPTION:

Simple machines are created to make work easier. In this unit, students apply their scientific knowledge of simple machines to engineer a machine of their own using the Engineering Design Process.

Big Ideas (Student Insights that Will Be Developed Over the Course of the Unit):

The Engineering Design Process (EDP) enables us to solve problems, create, and redesign products and systems. Through engagement in this process, students will engage in creating prototypes of ideas while applying their knowledge in science, math, and technology. They will also practice the STEM Competencies as they apply the cooperative skills needed to work in engineering design teams and optimize their product. In this unit, students will work in teams and apply their scientific knowledge of simple machines that would help make life and work easier.

Essential Questions (Questions that Will Prompt Students to Connect to the Big Ideas):

- Why are simple machines important in our lives?
- What is the Engineering Design Process?
- How does the Engineering Design Process help us?

	BENCHMARKS/STANDARDS/LEARNING GOALS
Science	**SC.3.7.1** Compare how simple machines do work for us to make life easier **Supporting Science Standards:** **SC.3.1.1** Pose a question and develop a hypothesis based on observations **SC.3.1.2** Safely collect and analyze data to answer a question
Technology	**Standard 1:** TECHNOLOGICAL DESIGN: Design, modify, and apply technology to effectively and efficiently solve problems
Engineering	**Standard 1:** TECHNOLOGICAL DESIGN: Design, modify, and apply technology to effectively and efficiently solve problems
Mathematics	**Supporting CC Math Standards:** **CCSS.Math.Content.3.MD.B.3** Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs. *For example, draw a bar graph in which each square in the bar graph might represent 5 pets*.
English Language Arts and Literacy	**Supporting CC ELA Standards:** **CCSS.ELA-Literacy.W.3.7** Conduct short research projects that build knowledge about a topic.
STEM Competencies	**Indicator 2.2:** Collaborates with, helps and encourages others in group situations **Indicator 4.1:** Recognizes and understands what quality performances and products are

LESSON SEQUENCE

	Lesson Title/Description	Learning Goals (What Students Will Know and Be Able to Do)	Assessments	Time Frame
1	What is a Simple Machine?	Students will know … • The six types of simple machines: lever, pulley, inclined plane, wedge, screw, wheel & axle Students will be able to … • Identify the six different simple machines: lever, pulley, inclined plane, wedge, screw, wheel & axle • Give examples of each of the six simple machines • Describe the function of each of the six machines	Formative: • Teacher Observations/Discussions Summative: • Simple Machines Summative Assessment	1 hour
2	Engineering Design Process (EDP)	Students will know … • The Engineering Design Process is a systematic process used to design and redesign tools/products Students will be able to … • Design a simple machine that will effectively and efficiently solve a problem	Formative: • Teacher Observations/Discussions Summative: • Simple Machines EDP Journal • EDP Summative Assessment (Use EDP Rubric)	Approximately 5 45-minute blocks

Unit Title: Simple Machines Lesson Title: What is a Simple Machine? Date Developed/Last Revised: 7.2.13 Unit Author(s): JoAnn Ishida, Lynn Lum	Lesson #: 1 Grade Level: 3 Primary Content Area: Science Time Frame: 1 hour

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- **SC.3.7.1** Compare how simple machines do work for us to make life easier

2A. Criteria- What Students Should Know and Be Able to Do:

Students will know …

- The six types of simple machines and their functions (lever, pulley, inclined plane, wedge, screw, wheel & axle)
- How machines make life easier for people

Students will be able to …

- Identify the six different simple machines: lever, pulley, inclined plane, wedge, screw, wheel & axle
- Give examples of each of the six simple machines
- Describe the function of each of the six machines

2B. Assessment Tools/Evidence:

Formative:

- Teacher Observations/Discussions

Summative:

- Simple Machines Summative Assessment

3. Learning Experiences (Lesson Plan)

Materials:

Possible examples of the 6 types of simple machines:

- Lever: ruler, pencil, window opener, doorknob
- Pulley: flag pole, purchased pulleys
- Inclined plane: wood plank, cardboard ramps
- Wedge: door stop, stapler, scissors
- Screw: different-sized screws
- Wheel and axle: wheel/axles on toy cars, tinker toys

Handouts:

- Simple Machines Summative Assessment
- Simple Machines Note-taking Form

Other Resources:

- Simple Machines Teacher Background Information Sheet
- (2005). *ScienceSaurus: A Student Handbook* (red cover), Great Source Education Group, http://www.greatsource.com/store

Procedure:

1. HOOK: Point out a few simple machines from your classroom, such as a pencil, scissors, stapler, doorknob, or window opener. Ask: What do these objects have in common?

2. Define + Discuss: Simple Machines.
   - Definition: A simple machine is a tool that makes work easier. Force is used to make a simple machine work.
   - What simple machines do you see in this room?

Information taken from: *ScienceSaurus: A Student Handbook*, Great Source Education Group.

3. Define + Discuss: Technology.
   - Definition: Technology is any tool that people find useful
   - What's the function for each of these simple machines? How do simple machines enhance our lives and make it easier?

Information taken from: *ScienceSaurus: A Student Handbook*, Great Source Education Group.

4. Set out the different examples of simple machines for students to explore. Students play with the different types of simple machines. Students explain the type of force being used and think about the function of the simple machine.

5. Students visit the library or the internet to research the six simple machines (lever, pulley, inclined plane, wedge, screw, wheel & axle). Students fill in the Simple Machines Note-taking Form.

*See attached Simple Machines Teacher Background Information Sheet.

Suggested online resources:

- http://www.tooter4kids.com/Simple_Machines/
  - Simple animations with descriptions for each type of simple machine
- http://www.mikids.com/Smachines.htm
  - Photos for each type of simple machine with links to more information

6. Distribute Simple Machines Summative Assessment to students.
   - List and/or draw examples of each of the six simple machines
   - Describe the function for each

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7) **Completed by teacher after instruction has taken place**
4. Teaching and Collecting of Evidence of Student Learning: Teacher Notes:
5. Analysis of Student Products/Performances - Formative: Teacher Notes:
6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson): Teacher Notes:
7. Teacher Reflection: Replanning, Reteaching, Next Steps: Teacher Notes:

Name of Scientist: _____ Date: _____

Simple Machines Summative Assessment

1. Each image in the box above represents a simple machine. Is it a lever, wheel and axle, pulley, inclined plane, screw, or wedge?
2. DRAW and LABEL the correct image for each type of simple machine. Then draw an example of that type of simple machine and describe its function.

Type of Simple Machine	Example	Function

Type of Machine	Example	Function

Choose one of your simple machines: _____

Think about the work that it was designed to do. Describe what that simple machine does and how it helps you.

_____

_____

_____

_____

_____

_____

_____

Simple Machines Teacher Background Information Sheet

Information taken from: http://www.edheads.org/activities/simple-machines/glossary.shtml

How does a lever work? How can I make a lever?

- A straight rod or board that pivots on a point known as a fulcrum.
- The fulcrum can be moved depending on the weight of the object to be lifted or the force you wish to exert.
- Pushing down on one end of a lever results in the upward motion of the opposite end of the fulcrum.

Examples: Door on Hinges, Seesaw, Hammer, Bottle Opener

How does a pulley work?

- A wheel that usually has a groove around the outside edge.
- This groove is for a rope or belt to move around the pulley.
- Pulling down on the rope can lift an object attached to the rope.
- Work is made easier because pulling down on the rope is made easier due to gravity.

Examples: Flag Pole, Crane, Mini-Blinds

How does a wedge work?

- Two inclined planes joined back to back. Wedges are used to split things.

Examples: Axe, Zipper, Knife, Door Stopper

How does a screw work?

- An inclined plane wrapped around a shaft or cylinder.
- This inclined plane allows the screw to move itself or to move an object or material surrounding it when rotated.

Examples: Bolt, Spiral Staircase

How does a wheel and axle work?

- A wheel and axle has a larger wheel (or wheels) connected by a smaller cylinder (axle) and is fastened to the wheel so that they turn together.
- When the axle is turned, the wheel moves a greater distance than the axle, but less force is needed to move it.
- The axle moves a shorter distance, but it takes greater force to move it.

Examples: Door Knob, Wagon, Toy Car

How does an inclined plane work?

- A sloping surface, such as a ramp.
- An inclined plane can be used to alter the effort and distance involved in doing work, such as lifting loads.
- The trade-off is that an object must be moved a longer distance than if it was lifted straight up, but less force is needed.

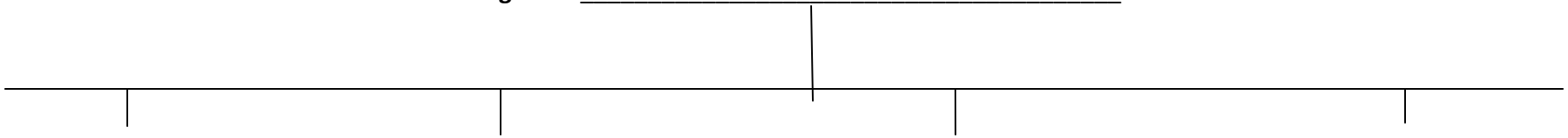
Examples: Staircase, Ramp, Bottom of a Bath Tub

Name: _____ Student #: ___

Simple Machines Note-Taking Form

Topic: Simple Machine – Why are simple machines important in our lives?

Big Idea: _____



What does it look like?

How does it work?

How does it move objects?

How does it help us?

Unit Title: Simple Machines Lesson Title: Engineering Design Process (EDP) Date Developed/Last Revised: 7.2.13 Unit Author(s): JoAnn Ishida, Lynn Lum	Lesson #: 2 Grade Level: 3 Primary Content Area: Science Time Frame: 2 hours

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- **SC.3.7.1** Compare how simple machines do work for us to make life easier

2A. Criteria- What Students Should Know and Be Able to Do:

Students will know:

- The Engineering Design Process is a systematic process used to design and redesign tools/products

Students will be able to:

- Design a simple machine that will effectively and efficiently solve a problem

2B. Assessment Tools/Evidence:

Formative:

- Teacher Observations/Discussions

Summative:

- Simple Machines Engineering Design Process Journal
- Engineering Design Process Summative Assessment

3. Learning Experiences (Lesson Plan)

Materials:

Possible materials to have for students to construct their mini golf hole:

- Cardboard boxes
- Rulers
- Masking tape
- String
- Golf ball
- Putter (or make your own)
- Scissors (and/or box cutter for teacher use only)
- Other recycled items (e.g. bottles, cans, newspaper, etc.)

Handouts/Other Resources:

- Simple Machines Engineering Design Process Journal
- Engineering Design Process Rubric
- Engineering Design Process Summative Assessment

Procedure:

1. Pre-assessment of Engineering Design Process

- Ask students - What is an engineer? What do they do? How do they design/improve models that help solve the problems in our world? (ANSWER: An engineer is a person who solves problems by creating technological tools/products by applying their scientific knowledge.)
- What is the Engineering Design Process? (Record responses on a class KWL chart)

We have just learned about simple machines. In this lesson, students will be engineering a simple machine that would help guide a ball into a golf hole.

2. Engineering Design Process

- Pass out Simple Machines Engineering Design Process Journals to each student.

Note: The class will go through each step of the process together. Stop after each step to discuss what the students did and the criteria needed. Teacher may refer to the Engineering Design Process Rubric to help guide discussions. Do the amount of steps you feel your students can handle in the time allotted. It may take one day or many days to go through and understand these steps. Don't worry… it's the process that's important.

- Assign students to work with a partner, just as they would in the real world.

Note: Although students are part of a team, each student is responsible for completing each part of their own engineering design process journal. The team is there to help brainstorm, share ideas, and create one product, but each student must participate and contribute their individual ideas to help the group.

- Read performance task to students.

Performance Task:
Our school is having a fundraiser to raise funds for our new STEM Center. Each grade level is responsible for creating a fundraising project. Your grade level will be designing a miniature golf course. Your engineering team's task is to design a simple machine to help players get a ball into a designated hole, e.g. ramps, lever, wheel and axle, pulleys, gears, wedges. Players must be able to get the ball into the hole within three tries with the aid of your team's simple machine. Your team's simple machine will be tested through trials that demonstrate your ability to get the ball into the hole within three tries.

Ask (Step 1):

- Students identify the problem of the performance task.
- Students identify what they are creating.
- Students identify the criteria and constraints for making the simple machine.
- Students write further questions they may have about constructing the simple machine.

- Go over the criteria for the "Ask" section of the process.
    - What did you do at this step of the process?
    - Do you have any questions on this step of the process?
    - Teacher may check with rubric to see if students met the criteria for this step of the process.

Imagine (Step 2):

- Individually brainstorm ideas of building a simple machine and draw or write your idea in your journal.
- Share out individual ideas to your engineering team.
- The engineering team will decide which design to use (or you may create a hybrid idea from all of the team's ideas).
- Go over the criteria for the "Imagine" section of the process.
    - What did you do at this step of the process?
    - Do you have any questions on this step of the process?
    - Teacher may check with rubric to see if students met the criteria for this step of the process.

Plan (Step 3):

- Draw a diagram of your team's prototype simple machine. Make sure to label possible materials to use when creating your simple machine.
- Remember… your drawings should be the same for all members in the same group.
- After the team decides how they will create that one simple machine prototype, each member draws and labels that same prototype onto their journal. They should check with each other to see if all of their drawings and labels are the same and complete where everyone has the same plan to follow.
- Go over the criteria for the "Plan" section of the process.
    - What did you do at this step of the process?
    - Do you have any questions on this step of the process?
    - Teacher may check with rubric to see if students met the criteria for this step of the process.

Create (Step 4):

- Follow your team plan as closely as possible when building your prototype.
- Share out with the large group your prototype simple machine, stating what modifications were made to your plan and why.
- Go over the criteria for the "Create" section of the process.
    - What did you do at this step of the process?

- Do you have any questions on this step of the process?
- Teacher may check with rubric to see if the students met the criteria for this step of the process.

Experiment (Step 5): Test it out!

- Bring your team's simple machine to the hole.
- Students will attempt to get the ball into the hole with the help of their simple machine.
- Students will test their simple machine on the number of attempts it takes to get the ball into the hole.
- Log data onto their journals.
- Go over the criteria for the "Experiment" section of the process.
  - What did you do at this step of the process?
  - Do you have any questions on this step of the process?
  - Teacher may check with rubric to see if students met the criteria for this step of the process.

Improve (Step 6):

- Have each team review the results from data.
- Repeat the EDP to optimize your product.

Note: You may go through this EDP cycle many times to get an optimized product that you want. It all depends on the amount of time you have available.

Ask: What worked? What didn't work? Why?

Imagine: Which variables of the simple machine could you change to increase the success rate of putting the ball into the hole? Why?

Plan: Draw the diagram of the team's 2nd prototype. Label the parts.

Create: Build your second prototype following your team's design. Keep to the plan.

Experiment: Students test their simple machine on designated hole on the course. Record your data. Write 3 facts comparing the data tables for prototypes 1 and 2. Analyze the data and explain the results that you find.

3. Summary and Conclusions

- Have each team share their simple machine, how they modified their simple machine, a rationale for their changes, and the results. They may also share what they learned about simple machines.

- Complete KWL chart. Discuss what students have learned about the Engineering Design Process.
- Complete Simple Machines EDP Journal.
- Have students complete EDP Summative Assessment (Use EDP Rubric).

4. Next Steps

- The grade level will design a miniature golf course.
- Each group will name their hole and design a label. (Economics).
- Customers will be invited to play on the miniature golf course.
- Students can count the amount of money collected each day to reach their goal.
- Graphs can be created to show the profits made during the week.

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7)
Completed by teacher after instruction has taken place

4. Teaching and Collecting of Evidence of Student Learning:
Teacher Notes:

5. Analysis of Student Products/Performances - Formative:
Teacher Notes:

6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson):
Teacher Notes:

7. Teacher Reflection: Replanning, Reteaching, Next Steps:
Teacher Notes:

Name of Engineer: _____ Date: _____

Simple Machines Engineering Design Process Journal

Performance Task: Our school is having a fundraiser to raise funds for our new STEM Center. Each grade level is responsible for creating a fundraising project. Your grade level will be designing a miniature golf course. Your engineering team's task is to design a simple machine to help players get a ball into a designated hole, e.g. ramps, lever, wheel and axle, pulleys, gears, wedges. Players must be able to get the ball into the hole within three tries with the aid of your team's simple machine. Your team's simple machine will be tested through trials that demonstrate your ability to get the ball into the hole within three tries.

What is the problem?

_____

What is your task?

_____

Criteria:

- The simple machine must fit into their designated course area.
- The simple machine will be constructed with recycled materials and items provided by the teacher.
- Students are welcome to use recycled materials brought in from home.

STEP 1: ASK: Ask questions that pertain to completing the performance task.

1.
_____
_____

2.
_____
_____

3.
_____
_____

4.
_____
_____

STEP 2: IMAGINE: Use your background knowledge to design a simple machine prototype that will get a ball into a designated hole. These are the things you should consider as you create your simple machine:
1) Did the simple machine move the ball?
2) Did the simple machine move the ball to the correct location?
3) Did the parts of the simple machine stay together?
4) Did the simple machine have the force to make the ball reach the hole?

Draw your possible designs and label the parts. Be ready to share and discuss your design and explain the rational for your design choices. Your group will be choosing one to develop.

Materials Needed:
1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

STEP 3: PLAN: Draw out a diagram of your group's prototype. Remember to label your parts, state the type of material you will be using for that part, and possible measurements.

Side View:
Top View:

STEP 4: CREATE: Build your prototype simple machine following your group's design. Keep to the plan.

STEP 5: EXPERIMENT:

Data Table 1: Test Trials of Simple Machine

Trial #	Tally of Strokes
1	
2	
3	
Average of Strokes	

STEP 6: IMPROVE:

ASK: Looking at your data, answer the following questions:

- What worked? Why?
- What didn't work? Why?

Things to Consider	Did it work?	Why or why not?
Movement of the ball	Yes A little No	
Speed of the ball	Yes A little No	
Distance of the ball	Yes A little No	
Direction of the ball	Yes A little No	
Sturdiness of the simple machine	Yes A little No	
Location of the simple machine	Yes A little No	

IMAGINE: Which variable(s) of the simple machine will you change to ensure the ball will go into the hole? Why?

_____

_____

_____

_____

_____

_____

PLAN: Draw out a diagram of your group's 2nd prototype. Remember to label your parts, state the type of material you will be using for that part, and possible measurements.

Side View:

Top View:

CREATE: Build your prototype simple machine following your group's design. Keep to the plan. Use the materials listed as well as the measurements that your group decided on.

EXPERIMENT:

Data Table 2: Test Trials of Simple Machine

Trial #	Tally of Strokes
1	
2	
3	
Average of Strokes	

Write three facts comparing Data Tables 1 and 2.

Fact 1	
Fact 2	
Fact 3	

Data Analysis: Compare the data from prototype 1 and prototype 2.

1. Which simple machine was more effective? **#1** **#2**

Conclusions: What changes did you make to your prototype? What effect did those changes make to your final simple machine design? (cause/effect)

_____

_____

_____

_____

Do you think your simple machine help move the ball into the hole? Explain.

_____

_____

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IMPROVE: If you had more time and materials, what would you do to optimize your simple machine even more? Explain your thinking.

_____

_____

_____

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_____

_____

Engineering Design Process Rubric

	Advanced(ME)	Proficient(M)	Partially Proficient(DP)	Novice(WB)
ASK	Clarifies the problem clearly Forms the conditions and limitations on their own Obtains information from prior knowledge and other sources with citation by self	Clarifies the problem States all the conditions and limitations Obtains information from prior knowledge by self	Needs more clarification of the problem States most conditions and limitations Obtains information from prior knowledge (drawn out by teacher)	Problem is unclear States few (or no) conditions and limitations Information given by teacher
IMAGINE	Brainstorms a variety of innovative ideas Innovative ideas are relevant to the problem	Brainstorms a complete idea Idea is relevant to the problem	Brainstorms an incomplete idea Idea is somewhat relevant to the problem	Unable to brainstorm ideas, teacher assistance needed Brainstormed ideas have little relevance to the problem
PLAN	Chooses the best possible idea that is testable Draws a useable and accurate prototype design with more than 2 views to scale Lists all materials needed that are affordable, obtainable, and safe	Chooses one idea that is testable Draws a useable prototype design with multiple views to scale Lists all materials needed	Chooses an idea that may be testable Draws a somewhat useable prototype design with multiple views with inaccurate or incomplete measurements Most materials needed are listed	Chooses an idea that is not testable Draws an unusable prototype design with one or more views Incomplete or inaccurate lists of materials (assistance needed)
CREATE	Able to follow their design plan accurately Able to improve original design to optimize performance	Able to follow their design plan, with some inaccuracies Able to add to the original design to make the design work	Able to follow most of their design plan with multiple inaccuracies Able to add to the original design, but design may still not work	Unable to follow their design plan Sticks to original design although it may not work
EXPERIMENT	Collects and records detailed data accurately and completely Analyzes data by comparing patterns and relationships accurately with logic	Collects and records data accurately and completely Analyzes data by showing patterns or relationships accurately	Collects and records data. Some data may be incomplete or inaccurate States obvious patterns or relationships	Data collection inaccurate and incomplete States obvious patterns or relationships with assistance
IMPROVE	Reviews data to make logical decisions to optimize product Repeats process until an optimized product is reached with greatly improved data	Reviews data to make decisions to redesign product Repeats process to optimize a product. Data may/may not show improvement	Reviews data to make decisions to redesign product with assistance Repeats process to improve product with some assistance	Unable to review data to make decisions to redesign product (assistance needed) Does not repeat process to improve product or repeats process with much assistance

Name: _____

Engineering Design Process Summative Assessment

1. Write the letter (a-f) that matches each of the Engineering Design Process steps.

1. Ask: ___ 2. Imagine: ___ 3. Plan: ___ 4. Create: ___ 5. Experiment: ___ 6. Improve: ___	A. Test out prototype and collect data. B. Brainstorm ideas of possible solutions. C. Identify the problem and get more information about that problem. D. From your possible solutions, chose the best idea and draw a prototype. E. Review data and redesign your product to make it better. F. Follow the plan and make your design.

2. Explain what you did in this project for each step of the Engineering Design Process.

Ask:

_____

_____

Imagine:

_____

_____

Plan:

_____

_____

Create:

_____

_____

Experiment:

_____

_____

Improve:

_____

_____

3. Why do people engage in the Engineering Design Process?

_____

_____

_____