# Web Unit Plan

## **Title:** Go-Go Gadget

**Description:** Young inventors put their knowledge of simple machines to the test as they create new, labor-saving machines of their own.

## At a Glance

**Grade Level:** 3–5

**Subject sort:** Science, Math

**Subjects:** Physical Science, Math

**Topics:** Work, Force, Motion

**Higher-Order Thinking Skills:** Creativity, Data Analysis and Interpretation, Problem Solving

**Key Learnings:** Simple Machines, Compound Machines, Mechanical Design

**Time Needed:** 4 to 5 weeks, 45-minute lessons, 3 times per week

**Background:** Texas, United States

## Unit Summary

Students study the concepts of force, motion, and work as they analyze simple machines. They learn about the simple machines in complex machines, and track the transfer of force from input (effort) to output (work). Students collect, organize, represent, and analyze data from a human automation investigation using spreadsheet software. In a design challenge, students become inventors and identify work they want to perform. Then, they invent labor-saving machines to do the jobs. The design steps of planning, drafting, constructing, troubleshooting, and reliability testing are followed before students create advertisements for their gadgets.

## Curriculum-Framing Questions

### Essential Question

How can we make life easier?

### Unit Questions

How do I invent a machine to do my work?

What changes when human work is automated?

**Content Questions**

What are the definitions of force, motion, and work?

What are the six basic simple machines and their uses?

What is the difference between a simple and compound machine?

How can I collect, represent, and analyze data to help me understand?

## Assessment Processes

View how a variety of student-centered assessments are used in the Go-Go Gadget Unit Plan. These assessments help students and teachers set goals; monitor student progress; provide feedback; assess thinking, processes, performances, and products; and reflect on learning throughout the learning cycle.

## Instructional Procedures

### Preparing for the Unit

Read the Simple Machines Glossary, if necessary, to review simple machines. Collect books on machines to have them available for student use.

### Introducing Simple Machines

Pose the questions, *What are machines?* and *Do we need them in our everyday lives?* Have students brainstorm types of machines, how the machines are used, and if they think the machines are needed in everyday life. Record student responses on chart paper or a smart board. Ask students to write their thoughts about machines in their science journals. Have students begin to think about the Content Question, *What are the definitions of force, motion, and work?*

Begin instruction with the definition of *work* and proceed to the use of machines as labor-saving devices. Introduce the six basic simple machines—lever, pulley, inclined plane, wedge, wheel and axle, and screw—to answer the Content Question, *What are the six basic simple machines and their uses?* Show students a variety of simple machines. Divide students into two groups, and have one group investigate the simple machines while the other studies the following simple machine Web sites: Understanding Simple Machines* and Edheads*. Encourage the hands-on group to experiment with the machines and show each other how force is applied to a machine to move a load over a distance (accomplishing work). Take anecdotal observational notes as students work to make sure students understand the difference between effort and work. After a specified time, have groups switch, so all students receive hands-on experimentation and investigation. Ask students to record their findings and what they have learned in a science journal, and then have students share what they have learned with the rest of the class. Write questions on the board for students to use as a guide while they are working.

Following the introduction of simple machines, challenge students to use digital cameras to take pictures of as many examples of simple machines as they can around the school. Have students use graphics software to label and explain their photos, and use the labeled photos for a wall display. Ask students to investigate machines further by completing activities found at the following Web sites: *Design and Discovery*: Session 5 | Making Machines and Marvelous Machines*.

## Conducting Independent Study on Composite Machines

Set students to work in pairs, studying from bookmarked Internet sites. Have them describe the six simple machines and give examples of each on a research worksheet. Student-friendly sites, such as Franklin Institute's Simple Machines* and Inventor's Toolbox*, are good starting points.

Introduce students to the concept of composite, or compound, machines to answer the Content Question, *What is the difference between a simple and compound machine?* Choose an example compound machine (such as an old-fashioned egg beater) to show how simple machines are combined to create a more complicated machine. Show how the force is transferred from simple machine to simple machine in the compound machine. Using a projector, show students the lawn mower site* and analyze the machine to identify all the simple machines that work in concert to make a lawn mower mow. Edheads* could be explored again for more simple and compound machine review.

As a homework assignment, ask students to find fairly simple compound machines they can bring to school. When the class has a large assortment, rotate the machines through small groups, and challenge students to describe the simple machines in each. Take digital photos, import the photos into a drawing program, and then have students analyze the machines, label the component machines, and identify the mechanics through which force turns into work. At this point, have students begin to think about the Essential Question, *How can we make life easier?* As students brainstorm, log their responses on chart paper or a smart board. Students could record their own thoughts in a science journal. Assess students' understanding with the Simple Machines Assessment rubric.

## Asking Thought-Provoking Questions

Post the Unit Question*, What changes when human work is automated?* Organize students into small groups of three or four to discuss the question in a round-robin, allowing each student to give an answer. Take observational anecdotal notes to assess students' level of understanding and to help develop thought-provoking questions for a follow-up discussion. After students have had the opportunity to share their answers, have individuals share with the whole group. Record students' thoughts on chart paper or a smart board. Next, have students begin to think about machines that automate human work, including ATM machines, self-checkout stations at supermarkets, dishwashers, washing machines, and so forth. After students share their ideas, bring the discussion back to the whole group. Have students share their ideas and discuss the changes that occur when work is automated. To facilitate the discussion, ask the following questions:

- *How have machines changed the way people do work at home and at their jobs?*
- *How have machines affected the time and effort people spend doing different kinds of work? Are the changes positive or negative?*

After the discussion, ask students to record their responses in their science journals.

## Conducting a Human Automation Investigation

Introduce the research process by describing how people answer questions and solve problems using the process. Explain that as a class they will be using the process to learn about automation and how to use data to conduct research. Conduct a brief discussion on the importance of accuracy, thoroughness, neatness, creativity, critical thinking, and collaboration in successful research and design.

### Identify a Question

Conduct a discussion on the Content Question, *What tasks at home have been automated?*

Explain to students that they are going to collect some data about how everyday machines make life easier.

### Collect and Analyze Data

For homework, ask students to choose a machine they use at home and time how long it takes to complete a certain task. They then time themselves doing the same job to see how much more or less time it takes. For example, students could run the dishwasher, first counting the number of dishes, cups, and silverware. Then they could wash one of each and multiply or do repeated addition to figure out how long it would take them to do the entire load. Tell students to bring the information to class.

Place students in small groups at a computer and ask students to record their data into an online spreadsheet. Demonstrate how to download the completed spreadsheet and open it with Microsoft Office® EXCEL or OpenOffice® CALC. Use the Intel® Education *Help Guide* to demonstrate how sorting data in different ways and creating different kinds of visual displays from data can help them identify patterns in their data. See human automation data spreadsheet for ideas for presentation. Take anecdotal notes while students work with their data to identify areas to address in large- and small-group instruction.

### Draw Conclusions and Share Findings

Ask students to look at the patterns they found and draw some conclusions about what their data means. Demonstrate how sorting data in different ways and creating different kinds of visual displays can help them identify patterns in their data. Prompt the discussion with the following questions:

- Do you see any possible cause-and-effect links? Possible responses could be:
    - Automation makes outside jobs, like lawn mowing, faster than it makes inside jobs, like washing dishes.
    - Using a computer for some jobs, like writing letters, is much faster.
    - Some machines, like automatic sprinklers are useful because they work without a person being around.
- Can you think of any reasons for the patterns you see?

## Creating Inventions

Explain to students that they will be using what they have learned about simple machines to create a gadget. Throughout the design process, give students feedback on the processes they are using.

## Identify a Problem

Conduct a discussion on the Unit Question, *How can everyday tasks be automated with simple machines?* Tell students that they will take on the role of inventors and use their new expertise to invent novel uses for simple machines. In a whole-class discussion, ask students to brainstorm a list of everyday tasks that could be automated, and record their ideas on chart paper, a smart board, or a class wiki.

Divide students into small groups and ask them to continue thinking of as many ideas as possible, telling them that they will decide on a problem that can be solved by using simple machines, construct a gadget to solve the problem, conduct experiments to test its effectiveness, and then make an advertisement for their gadget. Distribute the Design Project Planner, and ask each group to complete the first step by settling on one type of machine and one kind of work they want it to do in order to build a prototype. Explain the concept of a *prototype* and how inventors use prototypes in the design process. You may decide to distribute the planner one page at a time to keep students on track. Ask students to take photographs or videos of their machine and how it is used as they are developing it. These images may be used in their final projects.

## Collect Data

Explain to students that data will tell them what they need to do to make their machines as good as possible. Introduce the following categories for data collection:

- **Usefulness:** Does the machine accomplish something interesting or important that saves human effort?
- **Usability:** Is the machine easy to use? Can people figure out how to use it without a lot of help?
- **Dependability:** Does the machine work the same way every time it is used?
- **Durability:** Does the machine last?
- **Efficiency:** What kind of work does the machine do? With how much human effort?
- **Aesthetics:** How attractive is the machine? Is it neat? Do colors, shapes, or graphics add to its appearance? (Explain the meaning of the term *aesthetics* and how it applies to machines.)

Using the bunket device in the student sample, elicit ways to test the criteria and record responses on the board or wiki. Review how students used spreadsheets in the previous activity, and introduce the idea of using surveys to collect data.

Refer students to the Design Project Planner to complete this step of the research process.

### Analyze Data

After students have collected data about their prototypes, emphasize that inventors first test their inventions by analyzing their data. Then, they draw conclusions about how the invention could be improved, and make adjustments and changes. Remind students that they can sort their data and create different kinds of visual displays to help them see patterns.

Ask students to look at the data they collected to see what patterns they find. Some patterns they might notice are:

- The gadget quits working after a few uses.
- Half the people who tried the gadget could not make it work correctly.
- Using the gadget takes more effort than just doing the task.
- Boys like the way the gadget looks, but girls think it looks ugly.

The Design Project Planner helps students complete this step.

### Draw Conclusions

After students find patterns in their data, model how to draw conclusions about what they could do to improve their gadgets. Model this by:

- Linking causes and effects
- Predicting based on data
- Making inferences
- Asking further questions that may require more data collection

Some examples of possible conclusions are:

| Patterns We Found | Possible Conclusions We Drew |
| --- | --- |
| The gadget quits working after a few uses. | The materials we are using are too flimsy. The glue is not strong enough. |
| It is hard to get the gadget to work correctly. | The pieces are not connected very well.<br><br>The pieces are too small for most people's hands. |
| Using the gadget takes more effort than just doing the task. | Maybe we need to think of a new gadget or something a little different from this one.<br><br>Maybe we can change it so it does more work |

| | |
|---|---|
| | with less effort. |
| Boys like the way the gadget looks, but girls think it looks ugly. | We need to find out why the girls think it looks ugly. |

Explain that creating an invention is a cycle where inventors create a prototype, test it, make changes, test it again, make more changes, and so on. The steps are repeated until the inventor is satisfied with the results and is ready to share the invention. Remind students to use the Design Project Planner to guide their work.

### Share Findings

Show students an example of a gadget advertisement. Use the gadget advertisement rubric as a guide so students are aware of what quality work looks like. Encourage them to be creative and to challenge themselves technologically when they create their advertisements.

### Concluding Activities

Have students revisit the Essential Question, *How can we make life easier?* in small- and large-group discussions. Students can participate in a mock debate as they begin to discuss the pros and cons of using machines to make life easier using their inventions as evidence. Ask students to reflect on their creativity using the Creativity Checklist and on their research and design process in their journals.

## Prerequisite Skills

- Spreadsheet and multimedia use skills (or set aside time for training students in the use of these tools)
- Prior experience with word processing and file management
- Previous experience with cooperative learning and scientific method/process investigations

## Differentiated Instruction

### Resource Student

- Make modifications as dictated in the student's Individual Education Plan (IEP).
- Use collaborative grouping.
- Present instructions in a variety of ways.
- Break down tasks into component parts.

- Provide teacher-created templates and graphic organizers.

### Gifted Student

- Provide an individual research project.
- Have the student plan and organize a simple machines display.
- Provide extension activities, such as visiting Leonardo's Mystery Machines* where the student can observe a diagram of a machine and identify its purpose.
- Have the student visit RubeGoldberg.com* and invent a Rube Goldberg machine.
- Ask the student to identify the different machines that would help solve the dilemma in Project Treehouse*.

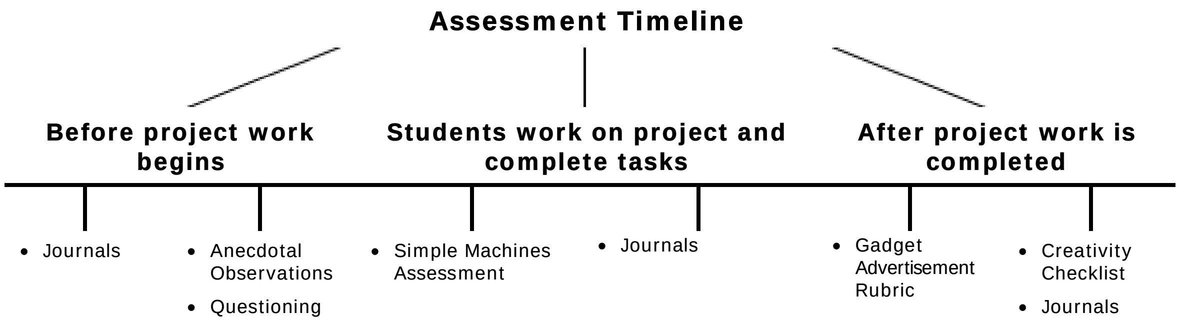
### English Language Learner (ELL)

- Use collaborative grouping.
- When possible, provide resources in the student's native language.
- Provide teacher-created templates and graphic organizers.

# Assessment

## THINGS YOU NEED

### Assessment Plan




Before beginning to study simple machines, use students' journal entries to determine prior understanding of the topic in order to plan instruction and address individual and group needs. As students manipulate various kinds of simple machines and explore relevant Web sites, take anecdotal notes to assess student understanding of the concepts of *force* and *work.*

While students discuss the effects of automation in small groups, take notes to help with the development of questions to deepen students' thinking. During the large-group discussion, ask probing questions to highlight areas of incomplete knowledge and misunderstanding of basic concepts. Use the Simple Machines Assessment rubric to assess students' understanding of science concepts and identify areas for further instruction.

As students work in small groups to create new inventions, ask them to self-assess their processes and write in their journals to reflect on their learning.

As students create products to advertise their gadgets, have them use the Gadget Advertisement Rubric to monitor their progress and make sure they are meeting the project requirements. This rubric is also used to assign a final grade or assessment to the project. Finally, have students reflect on their creativity during the process with the Creativity Checklist and create journal entries describing what they have learned and setting goals for future projects.

## Credits

Two teachers who participated in the Intel® Teach Program contributed this idea for a classroom project. A team of teachers expanded the plan into the example you see here.

## Content Standards and Objectives

### Indiana's Academic Standards for Science 2010

- Students gain scientific knowledge by observing the natural and constructed world, performing and evaluating investigations, and communicating their findings
- Students will learn to use materials and tools safely and employ the basic principles of the engineering design process in order to find solutions to problems
- Define the uses and types of simple machines and utilize simple machines in the solution to a real world problem

### National Educational Technology Standards (NETS)

- Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology.
- Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and

contribute to the learning of others.

- Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.

### Student Objectives

Students will be able to:

- Understand the difference between effort and work
- Describe simple machines and tell how they accomplish work
- Identify how simple machines are used in daily life
- Identify simple machines that work together as components of more complex machines
- Measure and record changes in the position and direction of the motion of an object to which a force, such as a push or pull, has been applied
- Use a spreadsheet to collect, sort, and display data
- Use the research design process to plan, create, and test a new simple machine
- Evaluate mechanisms of newly designed simple machines
- Use technology tools effectively to advertise a new simple machine
- Use language, technology, and understanding of audience to communicate and persuade through an advertisement

## Technology and Resources

### Printed Materials

Hewitt, S. (1998). *Machines we use*. New York: Children's Press.

Hodge, D. (1998). *Simple machines starting with science*. Buffalo, NY: Kids Can Press.

Jones, C. (1991). *Mistakes that worked*. New York: Doubleday Dell Publishing Group, Inc.

Nankivell-Aston, S. (2000). *Science experiments with simple machines*. New York: Franklin Watts.

Richard, J. (2000). *Work and simple machines*. Brookfield, CT: Copper Beech Books.

Wells, R. (1996). *How do you lift a lion?* Morton Grove, IL: Whitman Publishing.

### Supplies

- Science journals
- Data collection and measurement tools, such as stopwatches, balance scales, and measuring tapes

## Internet Resources

**Boston Museum of Science**
www.mos.org/sln/Leonardo/InventorsToolbox.html
Inventor's Toolbox on this site provides information on simple machines

**COSI Science Center, Columbus and Toledo, Ohio**
www.cosi.org/files/Flash/simpMach/sm2.html
Best used as a guided demonstration (Macromedia Flash Player* is required)

**Hands-On Technology, Marvelous Machines**
www.galaxy.net/~k12/machines
Series of experiments involving simple machines

**The Franklin Institute**
http://sln.fi.edu/qa97/spotlight3/spotlight3.html
Simple Machines section shows six simple machines in action

**Rube Goldberg Gallery**
www.rubegoldberg.com
Information about Rube Goldberg, contests, and examples of his machines

***Design and Discovery*: Session 5 | Making Machines**
http://educate.intel.com/en/DesignDiscovery/Curriculum/Fundamentals/Session5/index.htm
Classroom activities for building simple machines

## Other Resources

- Simple machines lab kit (GEMS from the Lawrence Hall of Science offers one, as well as a separate levers and pulleys kit) or other materials for creating simple machines

## Technology—Hardware

- Digital camera to take pictures and videos of simple machines
- Internet connection for online lessons and Web site exploration and research
- Projection system to project relevant Web sites

## Technology—Software

- Database or spreadsheet for graphing activities
- Graphics software for labeling simple machines