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Physics Around the School: Simple Machines In and Out of the Classroom

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As an elementary school teacher, I explore in this unit the role physics and its principles play in our lives and the way man has become aware of these principles throughout history, utilized them, even when not understood, to both build civilizations and to better our lives. My objective is to bring my students' attention to different classroom and playground objects that make use of the laws and principles of physics, and to encourage students to explore their surroundings looking for these principles.

This unit focuses on the area of mechanics by allowing children to explore and become familiar with the laws of motion and simple machines. Through the use of concrete examples that contextualize and make meaningful the physics principles and processes involved in their day-to-day living, students are able to understand how the above physics principles are essential and integral part of many important objects around us. Therefore, as we uncover and discover the world that surrounds us, we explain the reasons as to why things work the way they do and how they affect our everyday life.

Given the fact children are especially curious as to why everything is the way it is, share an insatiable wonder about their environment and the objects they use as they try to make sense of them. This unit taps into their innate curiosity as we study simple machines.

In another sense this unit will attempt to ignite the students' wondering curiosity as the central force that directs and guides our study of different classroom and playground objects. Finally, students will be able to generalize the learned concepts to their own lives.

For such a purpose I make use of constructivist theories of learning, which have the student create meaning from their interaction between other class members, the adults in the home, the classroom, the school setting, and the community that surrounds the student. Thus, I view learning not as a passive knowledge acquisition process, but as an active awareness and way of knowing by each individual student that originates in one's experiential reality.

This unit's objectives are thus multidimensional, multidirectional, and multidisciplinary in the approach to discussing and covering the mechanical physics principals concerning our everyday life in the classroom and at home.

The playground becomes our laboratory where those principles studied in the classroom, have been introduced and are concrete to the student's experiences. The laws of motion are presented within the context of day-to-day life experiences, the physics principles

Introduction

Throughout this unit I present a series of lessons that meet New Haven Public School's curricular frameworks, and specifically performance standards on science, language arts, and mathematics. These lessons incorporate a wide range of the strategies and techniques implemented in a constructivist classroom as the students make sense and integrate their previous knowledge into the new content. The content of the seminar will be integrated with all other curricular areas as we explore the topic of the science of physics related to simple machines as observed in everyday school objects. For such a purpose, this unit will study classroom objects from the perspective of the physics concepts involved when we use them. By this, I mean that the day-to-day classroom objects are studied as units of analysis from the perspective of a physicist who is mainly interested in explaining and making students understand the physical principles involved in the use of such objects. Initially, a historical perspective will be offered in order to contextualize the reasons and importance of why some objects are in existence. Thus, questions such as, what is the importance of the lever? Why do we need the inclined plane? What was life before the wedge, pulley? Which are the physical principles involved in the function, use, design of the given object? What are some of the most important inventions, utensils that originate in the basic principles and uses of these objects?

Among the objects used to study physics principles, I will include the windows and door, the pencil sharpener, and the weighing scale. Through the presentation of these objects, we will explore and study how the simple machines function and what elements are included and are part of their functions and utility. This, in part, will be accomplished through the implementation of a "structural approach" of cooperative learning in an integrated (science, math, social studies) language arts unit. Outside of the classroom we will study on the playground; the swing, the slide, and the seesaw. The underlying question will be, which are the physic and concepts involved in the structure and the function of the object? How are they simple machines? Within our bodies we will explore what are the parts that act as simple machines, and how they help us to accomplish what we want.

The primary strategies and teaching methods in my classroom, which go beyond any curricular area, are based on inquiry-based, hands-on activities. The topic at hand will allow for many activities related to the physics principles needed for such objects to perform the function intended. Through different activities we will begin exploring simple machines (lever, inclined plane, wedge, pulley, wheel-and-axle) and how they relate to common mechanical objects around the school. In the area of language arts non-fiction books related to how things work will be the focus. In social studies, we will compare the uses different cultures make of simple machines and how they are alike and different around the world as we attempt to understand the importance they have had for the development and progress of human civilization.

Physics in the second grade

Physics and physical principles affect and can describe most anything we do in our lives. We can be describe physics as the scientific study of matter (material substance of the universe that has mass, occupies space, and is convertible to energy), energy (supply or source of electrical, mechanical, or other form of power), force (a physical influence that tends to change the position of an object), and motion and the way in which each of these relate to one other.

There are five major areas that encompass the science of physics:

- Mechanics (laws of motion, simple mechanical objects)

- Heat and thermodynamics (heat, insulation, air-conditioners, cars, etc)

- Time and sound (clocks and musical instruments)

- Electricity and magnetism (electric and magnetic forces, currents and fields, electronics, electromagnetic waves)

- Light, optics and modern physics

As part of the second grade curriculum in the New Haven Public Schools a hands-on unit on balancing and weighing is included as part of the science curriculum. It is through the introduction of trying to balance a construction paper butterfly that the idea of a fulcrum is introduced in the context of what it is that makes the butterfly balance. Later, a beam and a wooden piece are added to students' experiences and they are asked to make the beam balance on the wooden piece. It is via these concrete experiences that students begin to understand the importance the fulcrum plays in balancing any object, and the main function a scale serves. Thus, students begin their journey in understanding measuring and weighing, and in the context of this unit, their departure into the study of simple machines as we explore how they are used in the classroom and around the school.

Simple machines

Simple machines offer a mechanical advantage, however, the same amount of work is needed to perform the same job. The simple machine lessens the effort needed to do the same amount of work, making it appear to be easier. The payoff is that we may have to exert the lesser force over a greater distance.

There are six basic or simple machines, which alone or in combination make up most of the machines and mechanical devices we use. These simple machines are the lever, the pulley, the wheel and axle, the incline, the wedge, and the screw.

The logical order to introduce the six simple machines is that of the complexity involved in its usage, and how it complements or adds to the next machine. Thus, it makes sense to begin the unit by studying the incline as the most simple of the machines. All around in nature we are surrounded by inclines in the form of hills. The amount of work needed to elevate an object vertically is the same as the amount of work used in lifting the same object via an incline to the same place, but the force needed along the incline is much less. Some people do not consider the wedge as a simple machine because it may be seen as two inclines put together back to back. The wedge is discussed as a continuation of the incline and it is later compared to another of the simple machines: the screw.

The lever would be the next of the machines to be studied. Here a distinction between first, second, and third class levers is made. Samples are given for each of the lever types. This will be followed by the study of the axle and the wheel. In terms of the importance to the building of humanity, this machine must be one of the greater one in importance.

The pulley can be looked upon as a combination or a special case of the axle and the wheel, with the main difference being the inclusion of a groove in the wheel to allow the string to fit and rotate the wheel and axle when it is pulled. The study of different pulleys will demonstrate how by adding a couple of pulleys, a lesser force is needed to lift a weight.

Newton's laws of motion

Prior to the study of the previous basic or simple machines, it is necessary to take a look at the laws of motion formulated by Isaac Newton (1642-1727). These laws are basic to the study of physics and therefore a necessity in a course on simple machines.

The first of these laws states that inertia is a "tendency of all objects and matter to stay still, or if moving, to continue in the same direction, unless acted on by some outside force." Thus, in order to move an object at rest a force must be applied. The greater the object's mass is the greater the force is needed to be applied. The force that is applied to an object times the distance the object is moved gives us the amount of work done (W=F*d). Therefore if there is no force applied there is no work involved.

Newton's second law of motion describes how the force to move an object is equal to its mass times its acceleration (F=M*A). The third and last of the laws describes how for every action there is an equal and opposite reaction.

History of Simple Machines

It is difficult to pin point exactly the beginning or discovery of the basic or simple machines that have made possible the construction and building of entire civilizations. Nonetheless, we can simply observe the magnitude of the different architectural fits in the history of the humankind. We then understand that without basic machines such as the wheel and the axle, or the incline and the lever, civilizations such as the Egyptian, the Romans, and the Greeks could not have built their most admirable architectural landmarks such as the pyramids, the Roman Coliseum, or the many temples that remain as vestiges of ancient cultures. They also could not have conducted wars since the catapult made use of some of those simple machines such as the lever, wheel, and the ramp.

Although we still know little about the ancient Egyptian technology for handling the huge blocks of stone, there is no evidence they had knowledge of the pulley or the capstan (Boorstin, 1992). They mainly used sleds, rollers, and levers to move the blocks, and ramps or incline planes to raise the blocks into their place of rest.

Another tool used throughout history and also a sample of a universal invention in that it occurs in different parts of the world about the same time, is the plow. A sample of a wedge, the plow makes it possible to separate or break the soil in order to plant crops. Among other sample of universal inventions that are simple machines we have the ax, and the hoe.

Among the best know inventors throughout the history of human kind we must mention Archimedes and

Leonardo daVinci. Archimedes, a predecessor to Leonardo, was the inventor of the Archimedes' screw, a device used to lift water consisting of a spiral tube wrapped around an inclined rod.

Simple Machines

A machine is a device that allows people to do work with less effort. Simple machines have few or no moving parts to them. These machines help us to move objects closer, apart, or to raise them to different levels by increasing the force or changing the direction of the force.

Machines offer us mechanical advantage by allowing us to use less force to do the same amount of work. The six simple machines are the incline, the wedge, the screw, the lever, the pulley, and the axle and wheel. Most machines in existence are considered complex machines because are composed of two or more of these simple machines.

The incline

The incline can be best described as a ramp or slanted surface, which decreases the amount of force needed to move an object to a higher level. Although the object travels a larger distance, it takes less effort force to move it.

There are many samples of inclines around us that facilitate the amount of work needed to move an object and that provide us with mechanical advantage. Without the use of the incline, the Egyptians would have been unable to build their pyramids. In the playground we find that the slide is an incline plane, the stairs to climb up and the ramp for the wheel chair are inclines too.

The wedge

Shaped liked an incline plane, the wedge could be defined as that of a moving incline. In this case the effort force moves the incline forward while the object being moved (load) is pushed aside. It is easier to pry something open with a wedge once the point has been inserted in the opening than by attempting to pry it open with your hands.

Among the best-known samples of wedges are the nail, sewing needles, scissors, toothpicks, the ax, and different types of chisels. Even the zipper is a wedge.

The screw

The screw can be seen as an inclined plane wrapped around a cylinder with a grove in the center of it.

The advantage offered by the screw is that as it turns the rotary motion is converted into a forward or backward motion, which brings together or separates two objects. You need a much greater force to take apart two objects affixed with a screw. A sample of a screw in an everyday object is the lid of the peanut butter jar, or the inside of the pencil sharpener.

The lever

The lever is possibly one of the oldest simple machines in existence. The lever consists of a bar that turns around a point called the fulcrum. Levers are everywhere around us. Some samples of levers we do not think about include the doorknob, light switch, a stapler, a shovel, wheelbarrow, or our forearms.

There are three different kinds of levers according to where the fulcrum is in reference to the effort force (the work needed to move an object) and the load (the object being moved). The three different types of levers are: first-class lever, second-class lever, and third-class lever.

The first-class lever always has the fulcrum between the effort force and the load. The closer the fulcrum is to the load the less effort you need to make in order to move the object. The lever also changes the direction of force. Examples of first-class levers are the hammer when used to pull a nail out and a crow bar.

The second-class lever has the load between the fulcrum and the effort force. A wheel is the most important example of this type of lever. The closer the load to the fulcrum, the less effort is needed to move the object. A bottle opener is a good example of second-class lever.

In a third-class lever, the effort force is between the fulcrum and the load. This type of lever is the most inconvenient one in that no matter how far the load is from the fulcrum, the effort needed to lift the load needs to be greater than the load. A pair of twisters, forearm, and a rake are samples of this type of lever.

The axle and the wheel

The precursor to the axle and the wheel could be considered to be the roller or a long cylinder such as the trunk of a tree placed under the load. The wheel and the axle can also be described as a rolling incline plane. The advantage offered is that they remove friction thus making it easier to move a load with less effort. Of all the simple machines, it is possibly the most important of them all in that allows

A special type of the axle and the wheel is a gear. A gear consists of a wheel with teeth cut into it. Gears are used to change direction, control different things at once, and to slow or speed things up.

The pulley

The pulley is a simple machine that consists of an axle and a wheel with a grove usually in the middle of it. There is no mechanical advantage to the use of a pulley. The advantage it offers is that of changing the direction of the force or effort we use to do the work.

There are three types of pulleys: fixed, movable and a combined pulley. The fixed pulley stays in place and does not move. An example of a fixed pulley is the one located at a flagpole in order to raise a flag. The movable pulley moves with the load. Among the better-known machines that make use of pulleys is the crane.

Standards

This unit focuses on grade one, two, and three science content standards in the areas of scientific inquiry and physical science. As part of the science curriculum, students begin to apply science to real world problems involving critical thinking and hands-on experiences (Science Higher Standards,2000)

Additionally, this unit will be implemented with English Language Learners (ELLs) and takes into consideration the importance that having language objectives has in aiding these students to acquire the content language needed to compete with those who are monolingual English speakers.

Scientific Inquiry

Students will:

- Draw an inference from observations

- Use repeated observations of events to predict an occurrence.

- Identify what is done and observed during an investigation.

- Demonstrate the use of variables by identifying conditions that cause a change.

- Use observations and prior knowledge to predict an outcome.

Physical Science

Students will:

- Explore how things move

- Integrate math into the study of matter.

- Explore forms of energy

- Study simple machines

Methods

One of the main goals and objectives in writing this unit is the integration of the New Haven district's content standards in the areas of language arts, social studies, science, mathematics, and social development through the study of simple machines. The scientific connections in the curriculum between simple machines and science are obvious. This unit's attempt to integrate the social studies, language arts, mathematics, and social development curriculum may not be as clear, yet an important focus of the unit that I hope to get across to the reader.

I focus on four content standards in my aim to create an integrated unit of study on physics. Though it may be too broad as a goal, many other standards that are not here listed will be required, introduced, used, or touched upon. I have chosen at least one of each of the standards on reading, writing, social studies and library media, and technology as the core of the unit.

Although the unit can be adapted to meet the needs of diverse learners, I write it with the content standards in mind for science, mathematics, social studies and language arts specific in the second grade. A list of the content standards that this unit aims to cover in its duration and the tasks the child should be able to perform is located in Appendix A.

With the selection of these content standards I intend to set up an environment where the students will be able to explore and learn about the physics concepts involved in simple machines. The question we seek to answer is: what role do simple machines play in our lives?

Students will create representations (visual, written, model, etc.) that reflect the basic principles learned, tell what the principles are, provide information, have a point of view, or demonstrate an appreciation and understanding of simple machines.

The work habits that the unit will focus on will be 1.attending to details, and 2.accuracy. This will be accomplished through questioning techniques, models, reports, and games. The thinking skills that will be focused on will be to sequence and list different simple machines. As a way of developing an interpretation, and making connections, the children will contrast and compare certain elements of one of the simple machines and relate them to classroom and home objects. They will also look for simple machines within complex machines.

Children will be provided with many opportunities to observe the physics principals, with opportunities to create objects with Legos®, links , through writing, by making special projects, movement, etc., which show reflection upon the simple machines and their uses in today's society.

As the unit progresses, broadening the scope of the questions and making connections among the different simple machines will be the focus. These simple machines will be presented and discovered during science classes and there will be a period to respond to them. At times this will be done individually, in pairs, or small groups. The overall objective is to bring alive some of those principles that are part of the human race and to begin to have a better understanding of all that surrounds us.

Sample lessons and guidelines

The topic "Physics Around the School: Simple Machines In and Out of the Classroom" is intended to help the students take into account the importance that objects around us have on basic physics principles.

I intend to start by checking for background knowledge regarding the children's own interpretation of the machines we use. These lessons play a very important role in the implementation of the unit since they will act as the foundation from which the children will build knowledge regarding the physics principles of simple machines. Most of the tasks will be performed in pairs and as a whole class, providing the students with opportunities to share the work with the rest of the class. The teacher logs each of the comments after each whole class sharing session, followed with the next question for the children to work in pairs. A similar lesson regarding the creation of the simple machines will follow.

I want to emphasize that these discussions of what the children think about the origin of simple machines will be completed before they come into contact with any of the machines. My hope is that these discussions will put the children in a position to understand the importance of these machines and they will also give a context into which to place their reaction to the machines.

Children will use index cards to write and name some of the simple machines that are the focus of the stories. This will provide the student with a visual representation of the machine and a name to which to refer in discovering the importance of the simple machine. It will provide the student with the "comprehensible input" with which to make sense in participating in the sample lessons. The back of the index card will later be used to write the name of the other gadgets on which the simple machine is based. By the time the children finish their index card collection they could have ten or twenty cards with pictures, drawings, and the names of each of the six simple machines and the related machines based upon their basic principles.

These cards will also be used in performing each of the tasks that follow. The lesson plans have been broken down into tasks so as to allow focus on the performance and content standards on which this unit is centered. They have been written with the student in mind. The descriptions give the student a clear understanding of what they are expected to do, how they have to do it, and how they are going to be assessed. The students will receive copies of the assessment by which they will evaluate their work. Some of the tasks once introduced, can be used throughout the school year and with other gadgets or machines.

I suggest the teacher make tapes of one of the non-fiction books in order to provide the student with many opportunities to listen to the principles involved. These could be used at the listening center after they have been introduced to the class. In each retelling, as an extension of the story, the teacher can reinforce or focus on a different content standard (i.e. the teacher can do a mini lesson on note-taking, writing, etc.). The following is a list of suggested strategies to meet the goals and objectives of this unit.

Language arts: Introduce the story as a read-aloud, focusing on listening skills, doing a shared-reading lesson, whole class, in guided-reading with smaller groups of students (make a copy of any of the stories in book format). As a listening center, taping a story (like The Lever). As a writing prompt, consider changing one of the main characters (How do you lift a lion?).

Art: Making graphic representations (Task 1). Making machine models (inclines, levers).

Science: Classification. Machine basic principles and characteristics.

Social Studies. Maps, models, find places of birth of physicists such as Newton, Archimedes, Leonardo da Vinci.

Games: Make a set of cards with fantastic and invented machines.

It is important to note that the performance tasks are to be given to the students prior to the beginning of the task. It is the road map that the student, will use to be able to perform what we are asking them to do. As part of the process the students will also be able to preview the assessment tool by which they will be evaluated. Please look at Appendix B for a list of the rubrics.

Performance Task 1

Title: Machines in the world

Background: There are many machines we use everyday that make our lives easier. You already know many of these machines. Many more machines are made and designed to help us build things, transport, destroy, or simply help to do things more easily. We are going to read and discover in person many of these machines; but let us first find out how much we already know about machines.

Task: You will work with another partner in making, taping, and writing a list of all the machines you can think of. Afterwards you will classify them according to whichever rule you choose. You need to tape and write your answers to some questions.

Purpose: To put all the machines we know into categories and give reasons how and why they came into existence, and why they are important.

Procedure:

List all the machines you can think of.

Make groups of machines.

Read each question and write down the answers.

Why are there so many different types of machines?

Where do machines come from?

Why do we need machines?

Who made the machines?

Were there machines before there were humans?

Why are machines different?

How do machines communicate?

Can machines talk to people? What about people talking to machines?

Can you think of a machine that does not yet exist? What will it do?

Audience: Classmates and teacher

Assessment: Please see Performance Task Listing/Categorizing - APPENDIX B

Extension: Have children draw machines on the back of an index card. Write the name and a major characteristic of that machine.

Give the students categories by which to make the classification. i.e., machines that transport us, that open things, sharpen, etc.

Performance Task 2

Title: The lever.

Background: The lever is possibly one of the oldest simple machines in existence. The lever consists of a bar that turns around a point called the fulcrum. There are three different kinds of levers according to where the fulcrum is in reference to the effort force (the work needed to move an object) and the load (the object being moved).

Task: You will listen to and read stories about simple machines and in specific about levers. Afterwards you will create an outline or other organizer and will retell the story to your partner. You need to write down the important parts so you can tell what levers are all about to someone else.

Audience: Partner

Purpose: To retell the story heard or read to a partner with as much detail as possible with the use of 5 drawings or sentences that you are going to draw or write.

Procedure: Make an organizer by writing the name of the book in the middle of a blank page and, as you listen to or read the book, write the most important parts (what is a lever, where, why are levers important? how does a lever work?) in the rest of the space.

Now you can listen to or read the book.

Draw 5 pictures or write 5 sentences using your organizer about levers.

On the back of each picture write something you learned about levers.

Retell the book to another classmate with the help of the pictures you drew, the organizer, and the index cards.

Assessment: Please see Performance Task Retelling - APPENDIX B.

Extensions: This lesson will be repeated with each of the non-fiction books listed in the Student Bibliography section at the end of this unit. Thus, there will be five other tasks, one for each of the other simple machines.

Performance Task 3

Title: Machines Scavenger Hunt

Background: There are many machines around the classroom that help us do work. Machines offer us mechanical advantage by allowing us to use less force to do the same amount of work.

Task: You will work with your group in drawing and labeling all the machines you can find around the classroom. Afterwards you will classify them according to which of the 6 simple machines is the most prominent one. You need to draw and write the name of each of the machines on a 3 by 5 index card.

Purpose: To list all the machines around the classroom and categorize them by what simple machine is the most important one in each.

Procedure:

Take 10 to 15 index cards.

Look around the classroom for machines or objects that have movable parts.

Draw each object or machine on a different card.

Write the name on the back of the card.

Continue the same steps until you have a card for each object/machine.

Write the name of the simple machines (lever, wedge, axle and wheel, pulley, screw, ramp) on a separate card each.

Draw a picture of the simple machine

Place the objects/machines behind each of the cards with the simple machines, according to the most prominent part.

Audience: Classmates and teacher

Assessment:

Please see Performance Task Machines Scavenger Hunt - APPENDIX B.

Extension: Go to the library, playground, gymnasium, cafeteria, etc. and perform the same scavenger hunt.

Introduce Venn-diagrams to show how machines have similarities and differences.

A mathematics unit studying machines characteristics and classification could also originate through this activity. Thus, at the same time we learn about different simple machines, we uncover and discover how complex machines are made up of multiple simple machines.

Performance Task 4

Title: The Unloading of the Truck

Background: We just received the order placed for school materials, which include new chairs, tables, books for the library, mathematic manipulatives, construction paper, etc. Some of the materials come in boxes. Others come in big cylinder containers. The principal asks our classroom to stay after school one day to help Mr. Mark, the custodian, since we are studying simple machines and we can be of assistance.

Task: You need to come up with a plan to move all the materials to where they belong in the school. First, you will work with a different partner in reporting to the class the answers to the following questions. You need to record your answers to present to the class.

What simple machine would provide the most mechanical advantage to unload the truck?

What simple machine would provide the most mechanical advantage to bring the materials from the truck to the school? What about to bring them upstairs?

Explain in full sentences, the reason why you chose the machine you chose.

Audience: Classmates and teacher

Purpose: To describe what simple machines would be used to move objects.

Procedure: Think about the objects in the truck.

List all the simple machines we have studied and write how each can be used in downloading the truck, and bringing the load upstairs.

Choose which of the simple machines would give you the most mechanical advantage to download the truck. Write a sentence.

Choose which of the simple machines would give you the most mechanical advantage to move the load from the truck to the building. Write a sentence.

Choose which of the simple machines would give you the most mechanical advantage to bring the load from the first floor to the second floor. Write a sentence.

Extensions: Community workers and the machines they use.

Teacher bibliography

Ardley, N. (1992). *The science book of machines.* San Diego, Harcourt Brace Jovanovich.

Contains great illustrations with step-by-step instructions to perform simple experiments that illustrate mechanical principles.

Carnegie Library of Pittsburgh. Science and Technology Dept. (1997). *The handy science answer book* . Detroit, Mich., Visible Ink Press.

This is a must have reference book for the science classroom teacher. It includes thousands of everyday questions and simple brief answers in the areas of physics and chemistry, space, earth, climate and weather, minerals and other materials, energy, environment, biology, etc.

Fowler, A. (2001). *Simple machines.* New York, Children's Press.

Describes and compares the four kinds of simple machines, levers, pulleys, wheels, and ramps.

Friedhoffer, R. and J. Hosking (1996). *Physics lab in a hardware store* . New York, Franklin Watts.

This book includes brief chapters on simple machines as they relate to tools. Examines such topics in physics as mass, weight, gravity, and pressure with experiments using common household tools.

Friedhoffer, R. and J. Hosking (1996). *Physics lab in a house wares store* . New York, Franklin Watts.

Explores such topics in physics as levers, friction, heat transmission, and density with experiments using common household utensils.

Go nick, L. and A. Huffman (1991). *The cartoon guide to physics* . New York, NY, Harper Perennial.

An easy to read book about mechanics, electricity and magnetism physics. The book is written in cartoon form with simple to understand explanations, yet complex enough to serve as a great reference book.

Lampton, C. and C. Nicklaus (1991). *Marbles, roller skates, doorknobs : simple machines that are really wheels.* Brookfield, CT, Millbrook Press.

Explains how simple machines that are actually wheels work, including the pizza cutter, bicycle, and water faucet.

Macaulay, D. and N. Ardley (1998). *The new way things work* . Boston, Houghton Mifflin Co.

Text and numerous detailed illustrations introduce and explain the scientific principles and workings of hundreds of machines. Includes new material about digital technology.

Marshall, J. (1995). *Working machines* . Vero Beach, Fla., Rourke Book Co.

Describes simple machines and how they work, including the inclined plane, levers, wheels and axles, the wedge, screws, and pulleys.

Marson, R. and P. Marson (1998). *Try this on for science! : a hat rack of lessons and teaching tools adapted from 41 Tops books* . Canby, OR, TOPS Learning Systems.

This is a compilation of the best lessons based on the TOP book series, which includes hands on experiments with scientific drawings, task cards with directions, and explanations for the teacher to each step and question the students perform.

Moyer, C. F. and R. L. Pettit (1994). *Simple machines : an introduction to the physical sciences for children ages 8-14 : teacher's manual* . Lewisville, N.C., Science for Kids.

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

Explores the properties of simple machines through experiments, using material readily available in most homes and schools.

Potter, J. (1995). *Science in seconds for kids : over 100 experiments you can do in ten minutes or less* . New York, Wiley.

Has some great experiments such as : lever lift, pulling pulleys, easy move and pull ups which offers a list of materials, procedure, and easy explanation that demonstrate how simple machines work.

Richards, J. (2000). *Work & simple machines* . Brookfield, CT, Copper Beech Books.

Uses simple experiments to explore wheels, pulleys, levers, friction, and lift in terms of inventions and discoveries underlying the modern mechanical world.

Tocci, S. (2003). *Experiments with simple machines* . New York, Children's Press.

Describes various kinds of simple machines, showing how they can be made out of easily obtainable objects and detailing experiments that show how they make tasks easier to perform.

VanCleave, J. P. (1991). *Janice VanCleave's physics for every kid : 101 easy experiments in motion, heat, light, machines, and sound* . New York, Wiley.

Presents 101 experiments relating to physics using materials readily available around the house.

VanCleave, J. P. (1993). *Janice VanCleave's machines : mind-boggling experiments you can turn into science fair projects* . New York, Wiley.

A must read book for the young scientist including a collection of science projects and experiments exploring simple machines.

Whittle, F. and S. Lawrence (1998). *Simple machines* . Austin, Tex., Raintree Steck-Vaughn.

Instructions for twelve projects involving the basic principles of simple machines.

Student Bibliography

Armentrout, D. and P. Armentrout (2002). *¿Cómo podemos utilizar el tornillo?* Vero Beach, Fla., Rourke Pub.

Defines screws, explains their functions, and suggests simple experiments to demonstrate how they work.

Armentrout, D. and P. Armentrout (2003). *¿Cómo podemos utilizar el plano inclinado?* Vero Beach, Fla., Rourke Pub.

Defines incline planes, explains their functions, and suggests simple experiments to demonstrate how they work.

Armentrout, D. and P. Armentrout (2003). *How can I experiment with--? A leverr* . Vero Beach, Fla., Rourke Pub.

An excellent source for the emergent reader. Defines levers, explains their functions, and suggests simple experiments to demonstrate how they work.

Armentrout, D. and P. Armentrout (2003). *How can I experiment with--? A pulleyy* . Vero Beach, Fla., Rourke Pub.

An excellent source for the emergent reader. Defines what a pulley is, explains their functions, the different types of pulleys there are, and suggests simple experiments to demonstrate how they work.

Armentrout, D. and P. Armentrout (2003). *How can I experiment with--? A wedgee.* Vero Beach, Fla., Rourke Pub.

Another excellent source of information. Defines wedges, explains their functions, and suggests simple experiments to demonstrate how they work.

Armentrout, D. and P. Armentrout (2003). *How can I experiment with--? An inclined planee* . Vero Beach, Fla., Rourke Pub.

An excellent source for the emergent reader. Defines incline planes, explains their functions, and suggests simple experiments to demonstrate how they work.

Armentrout, P. (1997). *The inclined plane* . Vero Beach, FL, Rourke Press.

Text and pictures introduce the inclined plane, a simple machine consisting of a slanted surface or ramp to make work easier.

Armentrout, P. (1997). *The lever* . Vero Beach, Fla., Rourke Press.

Text and pictures introduce the lever, a simple machine used to change force and motion.

Armentrout, P. (1997). *The pulley* . Vero Beach, Fla., Rourke Press.

Text and pictures introduce the pulley, a simple machine used primarily to lift heavy objects.

Armentrout, P. (1997). *The screw* . Vero Beach, Fla., Rourke Press.

Text and pictures introduce the screw, a simple machine used primarily as a fastening device.

Armentrout, P. (1997). *The wedge* . Vero Beach, Fla., Rourke Press.

Text and pictures introduce the wedge, a simple machine placed between objects to split, tighten, or secure a hold.

Armentrout, P. (1997). *The wheel* . Vero Beach, Fla., Rourke Press.

Text and pictures introduce the wheel, a simple machine used primarily to make it easy to move heavy loads.

Canizares, S. (1999). *Simple machines* . New York, Scholastic.

Rhyming text and photographs explore the many tasks that can be performed by such simple machines as springs, ramps, and pulleys.

Dahl, M. (1996). *Inclined planes* . Mankato,MN, Bridgestone Books.

Describes many different kinds, uses, and benefits of inclined planes.

Dahl, M. (1996). *Levers* . Mankato, Minn., Bridgestone Books.

Describes many different kinds, uses, and benefits of levers.

Dahl, M. (1996). *Pulleys* . Mankato, MN, Bridgestone Books.

Describes many different kinds, uses, and benefits of pulleys.

Dahl, M. (1996). *Wheels and axles* . Mankato, MN, Bridgestone Books.

Describes many different kinds, uses, and benefits of wheels and axles.

Rockwell, A. F. and H. Rockwell (1972). *Machines* . New York,, Macmillan.

Briefly describes simple machines, machine parts, and the powers that move them.

Wells, R. E. (1996). *How do you lift a lion?* Morton Grove, Ill., A. Whitman.

Provides a simple introduction to the use of levers, pulleys, and wheels to move heavy objects.

Electronic resources

Brain, M. How Stuff Works, HowStuffWorks, Inc. **2003** http://www.mos.org/sln/Leonardo/.

A must visit site for almost any question as to how something works. It offers plenty of interactive graphics, with extensive explanations. Most appropriate to middle and high school students. A great source of information for the teacher with lots of up to date links.

Class, M. J. s. S. Simple Machines. **2003** http://www.geocities.com/andrewaaron2002/simplemachines.html.

Simple enough for a second grader to read. Includes a glossary of terms and illustrations of the simple machines.

Industry, C. O. S. a. (2000). Simple Machines, COSI/Columbus. **2003** http://www.cosi.org/onlineExhibits/simpMach/sm1.html.

Through the use of QuickTime, this site allows the user to observe simple machines in motion. Very well designed interactive and discovery-based site.

Kranz, T. Simple Machines Learning Site. **2003** http://www.coe.uh.edu/archive/science/science_lessons/scienceles1/finalhome.htm.

Simple web page explaining each of the 6 simple machines. It offers concise definitions and provides the students with activities for each of the machines.

Macaulay, D. and Dorling Kindersley Multimedia (Firm) (1998). The new way things work. New York, NY, DK Interactive Learning,.

Helps children 8 and older to understand scientific principles, materials and properties. Features “digital age” technologies, machines, inventions, and twenty-two basic principles of science. Includes videos, animations, and illustrations.

Network, S. L. (1997). Exploring Leonardo, The Museum of Science. **2003** http://www.mos.org/sln/Leonardo/.

This site can be used to explore the life of Leonardo da Vinci, and the different machines he invented. It can also be used as a culminating activity where the student has to list the different simple machines they see in the inventions.

Saskatchewan Learning (2002) Elementary Science Curriculum Guide. Grade 3 Science- Simple Machines **2003** http://www.sasked.gov.sk.ca/docs/elemsci/gr3uhesc.html

This is possibly one of the most extensive presentations of simple machines on the net. This exemplary site includes directions on how to perform experiments for each of the simple machines. It also includes a list of factors to take into account. A much needed resource to implement the unit.

Tomecek, S. M. (2003). Dirtmester Science Reporters: Simple Machines, Scholastic Inc. **2003** http://teacher.scholastic.com/dirtrep/simple/invest.htm.

A very accessible and simple site for the elementary age student. Provides the student with other students’ sample reports of common objects as they relate to the simple machines that they are made of.

Appendix A

Social studies performance standards

Use a computer to access information

Compare traits found in family and neighborhoods from another time or place with those of the students

Language arts performance standards for grades K-4

Read at least 5 books on the topic of simple machines

Make a special project requiring oral both and written presentation through the use of the writing process (first draft, conference, revision, edit, and final draft)

Participate in technology for reading and writing

Social development performance standards for grades K-4

Acquire good listening skills

Learn to define and look ahead at consequences.

Practice good decision-making skills

Suggest laws and the consequences of not obeying them.

Science

Identify different properties that can be used for classification.

Mathematics

Use different representations of the same number.(the children will learn how to write basic formulas on motion)

Library Media and Technology

Retell materials heard

Create a product related to the material heard, viewed and/or read

Use a self-assessment tool prepared by the teacher/student

Appendix B

CLASSROOM ASSESSMENT LIST

LISTING / CATEGORIZING - ELEMENTARY SCHOOL

1. List

T: I have written the name of all the machines I could think of.

O: I have written the name of some machines I could think of.

N: I haven't written the names of any machines.

2. Groups

T: I have made many different groups of machines and I have written

why they are in the groups.

O: I have made some groups of machines and I have written

why they are in the groups.

N: I have not made any groups of machines and I have not written

any reasons they are in the groups.

3. Questions

T: I have answered all the questions and I have written them down.

O: I have answered some of the questions and I have written them down.

N: I have answered some of the questions but I have not written them down.

Did I do my best work?

Terrific OK Needs Work

CLASSROOM ASSESSMENT LIST

RETELLING - ELEMENTARY SCHOOL

1. Drawings

T: I have drawn 5 pictures.

O: I have drawn 3 pictures.

N: I have not drawn any pictures.

2. Plan Labels and Details

T: My drawings are labeled and detailed and show all the parts.

O: My drawings are partly labeled and detailed and show some of the parts.

N: My drawings aren’t labeled or detailed.

3. Writing

T: I have written a complete sentence in the back of each of the cards.

O: I have written a complete sentence in the back of some of the cards.

N: I have not written complete sentences in the back of any of the cards.

4. Retelling

T: I have retold the book using all the pictures, and naming all the parts of the simple machine.

O: I have retold the book using some of the pictures, and naming some of the parts of the simple machine.

N: I have told some parts of the parts using the pictures, and naming some of the parts of the simple machine.

Did I do my best work?

Terrific OK Needs Work

CLASSROOM ASSESSMENT LIST

MACHINE SCAVENGER HUNT - ELEMENTARY SCHOOL

1. Drawings

T: I have drawn 10 to 15 pictures.

O: I have drawn 5 to 10 pictures

N: I have drawn 0 to 5 pictures.

2. Plan Labels and Details

T: My drawings are labeled and detailed and show all the parts.

O: My drawings are partly labeled and detailed and show some of the parts.

N: My drawings aren’t labeled or detailed.

3. Simple machines labels

T: I have made a complete set of cards.

O: I have made a partial set of cards.

N: I have not made any cards.

4. Sorting

T: I have sorted all the object/machines.

O: I have sorted some of the objects/machines

N: I have not sorted any of the objects/machines.

5. Presentation

T: I have presented all of my categories.

O: I have presented some of my categories.

N: I have not presented any of the categories.

Terrific OK Needs Work