Teacher's Guide

The Right Tool for the Job*?*

Purpose
The purpose of this lesson is to encourage students to think about how using tools helps them gather information about the world around them. This is especially important at the nanoscale, where the objects are too small to be seen and the information we gather depends on the tools that we use. This lesson is designed to be part of a learning progression which lays the foundation on how tools and instruments are used in science and engineering. Having elementary students learn about tools and their purpose will allow them to build on these skills as they become middle and secondary students.

Time required:
One to two class periods

Level:
General Science: Elementary K- 3rd grade (Suggested level of the book used with this activity is for ages 3 and up)

Teacher Background
A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (FK-12SE) indicates that students at all grade levels should be able to ask questions about the texts they read and the features of the phenomena they observe. To begin helping students stretch their understanding about the world around them, begin by reading a book about objects that students may be familiar with and then connect that understanding to objects that students may be less familiar with.

In addition, FK-12SE states that at the elementary level, students need support to recognize the importance in recording observations- whether in drawings, words, or numbers. Increasing student familiarity with the role of mathematics in science is central to developing a deeper understanding of how science and engineering works. As soon as students learn to count they can begin using numbers to find or describe patterns in nature by using instruments such as rulers, protractors, and thermometers.

The importance of mathematics is supported by the *National Science Education Standards (NSES)* which states that "mathematics is essential for gathering evidence for interactions and subsequent changes and the formulations of scientific explanations are often clarified through

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quantitative distinctions or measurements. Abilities necessary for young students to do scientific inquiry include employing simple equipment and tools to gather data and extend the senses."

Nanoscale Science and Engineering (NSE) is defined as the understanding and control of matter at dimensions between 1 and 100 nanometers, where unique properties enable novel applications. The emerging field of NSE promises to have extensive implications for all of society. In the book, *The Big Ideas of Nanoscale Science and Engineering: A Guidebook for Secondary Teachers* (BI) (Stevens Et. Al, 2009; NSTA Press) tools and instrumentation is considered to be one of the "big ideas". The BI represent the basic science content necessary to understand nanoscale science and engineering. Development of new tools and instruments helps drive scientific progress. The recent development of specialized tools has led to new levels of understanding of matter by helping us detect, manipulate, isolate, measure, fabricate, and investigate nanoscale matter with unprecedented precision and accuracy. Much of the understanding of tools and instrumentation and how they are used to study the world around us is information that students need in grades 7-12 but the foundation begins in the elementary years. This lesson helps students begin to understand that the right tool is needed to do the job. While this lesson is not centered on NSE, it provides teachers with a means to help younger children develop the concept of the right tool for the right job which is a basic concept of NSE.

The book *Manny's Book of Tools* by Disney Enterprises, Inc. is a delightful introduction to several tools, with each tool found in Handy Manny's tool box having an individual personality and specialized skills. Young readers will enjoy twisting, tapping, and turning the various moveable tools in this interactive book. This lesson helps elementary students develop the understanding that not all tools can be used for a job and this understanding will be further developed in middle school and high school when students learn about special tools that can be used at the micro and nano scales.

Materials

Book- *Manny's Book of Tools by Disney Enterprises, Inc, 2008*
Small toolbox containing a variety of small tools (This lesson uses the following tools:

- hammer
- plastic saw
- wrench
- screwdriver
- tape measure
- magnifying glass
- thermometer
- double pan balance
- ruler
- Fiskars® hand drill
- measuring cup and measuring spoons

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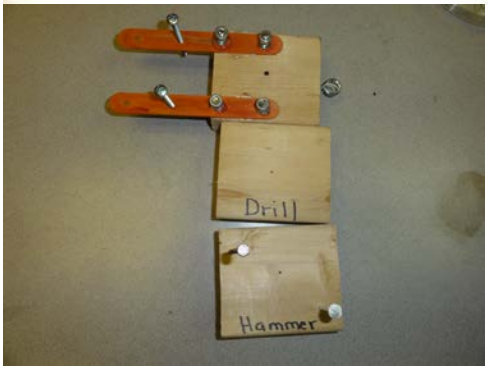
- field microscope
- 3-D glasses and spectrum glasses
- Set of Tool and vocabulary cards (end of lesson)
- MEASURE Bag containing beans
- Container of water (if water is not available in classroom)
- REPAIR Bag containing board with screws, nuts and bolts (picture of example board at end of lesson)
- SEE Bag containing 3-D pictures
- Pair of FEELY SOCKS (picture of socks included at end of lesson)
- Nanooze Magazine-Issue 3 (can be downloaded at www.nanooze.org)

Advance Preparation

This lesson can be conducted as a learning center or as a teacher led lesson. Below are the instructions for preparing materials for the Learning Center.

Preparation for learning center container (tool box, or other container). Place into the container: tools; set of laminated tool and vocabulary cards; plastic bag with **measure** on the outside containing dry beans; plastic bag with **repair** written on the outside that has boards that have screws and bolts; plastic bag with **see** written on the outside that has a set of 3-D pictures; a pair of feely socks (instructions for making follow); container of water. Pictures of an example learning center are below:

Example of Learning Center Box and materials inside.



Example of boards found in **Repair** plastic bag

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To make Feely Socks: You will need a long pair of socks, two small boxes, glue, and two common items (crayon, rubber band, coin, etc.). To construct socks, glue one item into the bottom of each of the two boxes. Once glue is dry, push a box (open box side facing sock entrance) to the bottom of a sock. Repeat with other sock. Below Feely Sock pictures.

Example of objects glued to bottom of boxes and completed pair of Feely Socks

If you are conducting lesson as a Teacher Led activity you will need to prepare enough of the materials so that a small group of students can work together.

Safety Information

Some tools in the activity center may need additional supervision depending on the age of the students.

Directions for the Activity (Teacher Led)

If you done as a Learning Center you may elect to only complete a few of the following steps.

Part 1:"Fix Things"

- Ask students what is a tool? Have several students give you a definition. Decide as a class on a definition and write it on the board. An example definition: "A tool is something that helps you do work or perform a task".
- Write essential question on the board: "Is there a right tool for a job? " Tell students they will be doing activities to answer the question.
- Read to the class the book *Manny's Book of Tools*.
- Explain to students that they will be learning about tools that do the following: Fix things, measure things, and help them see things. List these in columns on the board.
- Have an assortment of tools available for students to investigate. These may include screwdrivers, hammers, wrenches, plastic saws, pliers, measuring tapes, elementary balances, hand lenses, rulers, measuring cups, collecting nets, safety scissors, hot pads, simple can opener, thermometer, stick with markings, 3 D glasses, elementary microscope…… Picking up each tool, one at a time, name the tool.
- Starting with the "Fix Things" column ask students which could be used to fix something. List their suggestions.
- Give the students the following situations and allow them to tell you what tool they would need to use to fix the problem.
    1. A board has fallen off the side of a house.
    2. A bolt has come loose from a metal storage shelf.
    3. A pole is too tall for the space it needs to go into.
    4. A screw needs to be tightened.
    5. A wire needs to be bent.

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- Allow the students to suggest answers to these and decide as a group which tool would be best.

Part 2: "Measure Things"

- Ask students what it means to measure something. Decide on a definition that you write on the board. An example definition might be: To determine the size, amount, or degree of something by using an instrument or device marked in standard units. You may need to help students understand that standard units mean that the markings are the same distance apart – inches, ounces, etc..
- Under the column headed "Measure Things", have the students suggest tools that could be used to measure things and list them on the board.
- Explain what each of the following tools do: measuring cup (measures the volume or amount of space something uses); ruler or measuring tape (a strip of wood, metal or plastic with equally spaced markings to measure the length, width, or height of something); thermometer (measures the temperature or how hot or cold something is).
- Provide students with opportunities to use tools to measure things. Examples might include having them go outside and measure cups of sand or water, weigh sand or rocks, and measure lengths of objects like wood blocks.

Part 3: "See Things"

- Discuss with students what it means to "see" something. Decide on the best definition and write on board. An example might be to perceive by the eye or to form a mental picture of something.
- Under the column headed "Seeing Things" have students suggest tools that help you see things and list tools in the column. Examples might include hand lens, glasses or special glasses like 3-D, microscopes
- Have students choose an object to look at and then draw without and with a hand lens. Distribute spectroscope glasses and have students look at lights. Provide students with 3-D books or images to look at with 3-D glasses. Discuss what can be seen differently with and without these tool.
- Ask students if "tools" can be used to provide information about things we cannot see. Ask if they have ever gone into a dark room and felt along the wall for the light switch? Discuss how they knew when they had reached the light switch? Students will suggest that they knew because of the way that it felt.
- Discuss with students the purpose of a microscope. Have them use the small field microscope in the toolbox. Tell them that some special microscopes called Atomic Force Microscopes (AFM) and Scanning Electron Microscopes (SEM) help us "see" things that are too small for us to see with just our eyes or optical microscopes (nanoscale objects). They help us see by "feeling" the surface of an object or by the forces from electrons.
- Show the video at http://nanozone.org/sem/sem.htm to show how an SEM works or visit Hitachi HTA's site to zoom into objects (http://www.inspirestemeducation.us/)

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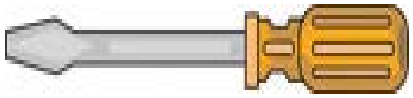
- Discuss with students how you can use your senses as "tools" to gather information. Set up "feely socks" for students to determine what is in each box. Have them discuss with each other what they think is contained in each box.
- Conclude activities by having students complete worksheet.

Student Worksheets - Center Activity Below
(with suggested answers in red)
The Right Tool for the Job
Student Worksheet #1

Name_____

A **tool** is something you use to help you do work.

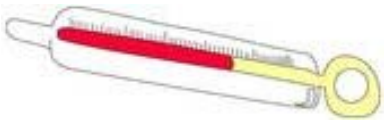
1. Find the following tools in your toolbox and place on your table/desk. Circle each tool after you place it on your desk.









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The Right Tool for the Job
Student Worksheet #2

Name_____

Tool-Word Match

For younger students you may want them to just match words with tool. Remove the Tool-Word Match plastic bag from the tool box. You will have two sets of cards. One set of cards contains pictures of the tools. The other set of cards contain the name of the tool. Match the picture card with the name of the tool card.

After you have matched all your cards turn over the picture and word card and add, substract, multiply or divide the numbers on the back of the cards and place the answers in the blank space on this sheet.

Example: Scissor picture card matches the word scissors

Scissors

When you turn both cards over this is what it says:

Add 3 + **3 =**

On your worksheet for scissors you will put 6.

Hammer__10_____

Wrench____2____

Screw Driver__3_____

Hand Drill___10_____

Measuring Tape____6____

Ruler_____1____

Measuring Spoons___6___

Measuring Cup_____7____

Double Pan Balance____14__

Thermometer___18___

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Magnifying Glass____4__

Spectrum Glasses___7___

Field Microscope__10____

Saw__8___

3D Glasses__3____

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The Right Tool for the Job
Student Worksheet #3

Name_____

Tools that **repair** are tools that are used to put something in working order again.

Tools that **measure** are tools that use a unit or standard of measurement to find a property (for example length, weight, temperature) of an object.

Tools that help us **see** are tools that help us create a mental image of an object.

Directions: Decide if each tool is used to help repair, measure, or see. List each tool on the table below.

Repair	Measure	See
Hammer	Measuring tape	Magnifying glass
Saw	thermometer	Field Microsope
Wrench	Double pan balance	3 D glasses
Pliers	ruler	Spectrum glasses
Hand drill	Measuring cups	
	Measuring spoons	

Repair:

Use one of the tools listed in the repair column along with material provided in the plastic bag labeled REPAIR. Describe how you used the tool below.

__Examples might include: hammering a nail, removing a nut with wrench, driliing a hole_____.

Measure:

1. Use the ruler to measure the length of both of the sides of this paper. Write the amounts below with the correct unit (inches or centimeters)

___28 cm 0r__about 3 inches_____ ___21 ½ cm or_about 8 ½ inches_____

2. Using the beans in the bag labeled MEASURE complete the following:

It would take ___13_____ tablespoons of beans to equal one cup of beans.

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Using the double pan balance find something in the room that has the same weight as a cup of beans. __Example might be a small book or something else that they can balance the beans on the double pan balance (You may use several items just be sure to list everything that you used.)

3. Fill the measuring cup with water. . Using the thermometer take the temperature of the water and list below.

Will depend on the water_____.

See:

Using materials in the bag labeled SEE, complete the following:

1. Look at the picture with just your eyes. What do you notice about the picture?

____They will look fuzzy or out of focus_____.

2. Look at the picture again using the magnifying glass. What do you notice now that you did not notice with just your eyes?

_____Answers will vary_____.

3. Look at the picture again using your 3D glasses. What do you notice now about the picture?

_____They should notice that things look like they are coming out of the picture____.

4. Why do you think the picture now looks different?

_____You see two different images that your brain put together_____.

5. Look at the lights in the room. Now put on the spectrum glasses and look at the lights. Do the lights look different or the same?__Different_____ If different how?

_____They should see rainbow colors or the visible light spectrum_____.

6. Sometimes objects are too small to see even with a magnifying glass or a field microscope. Do you think that you could tell what something might look like if you could not see it?

__Answer will vary_____ If your answer was yes, how would you be able to tell?

_____Examples might be to feel or smell something_____.

7. Find the plastic bag that is labeled FEELY SOCKS. The two socks contain objects in a box. DO NOT LOOK in the sock. Reaching your arm into a sock and using just your fingers feel the object inside the box. What do you think the object is?__Answers will vary

8. Repeat step 7 with the second sock. What do you think the object in this sock is?

_Answers will vary_____.

Sometimes we must use other tools like our senses to help us tell what something looks like. At other times objects are so small (like micro and nano size objects) that we must use very special instruments to be able to see these objects. Read page 7 in Issue 3 of the *Nanooze* Magazine.

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Assessment and rubrics
Correct answers to the tools worksheet should be checked.

Cleanup
Cleanup depends on the activities that were selected for the lesson but most materials can be stored for later use.

Resources:

- *Manny's Book of tools.* Disney Enterprises, Inc., 2008.
- Stevens, S., Sutherland, L., and Krajcik, J., *The Big Ideas of Nanoscale Science and Engineering: A Guidebook for Secondary Teachers,* NSTA Press, 2009
- *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas,* The National Academies Press, 2011

To learn more about nanotechnology, here are some web sites with educational resources:
http://education.nin.org
http://www.molecularium.com
http://pbskids.org/dragonflytv/nano/index.html
http://www.nnin.org/education-training
http://www.youtube.com/watch?v=TuljCWV6gLU&feature=related
http://nanozone.org/sem/sem.htm

National Science Education Standards
K-4**:**
Content Standard A for Science as Inquiry – Employ simple equipment and tools to gather data and extend the senses;
Physical Science Content Standard B- includes properties of objects and materials
Life Science Content Standard C- understanding of the characteristics of organisms.

National Council of Teachers of Mathematics Measurement Standards
Pre-K-2 Expectations: In pre-K through grade 2 all students should

- Recognize the attributes of length, volume, weight, area, and time;
- Compare and order objects according to these attributes;
- Understand how to measure using nonstandard and standard units

Grades 3-5 Expectations: In grades 3-5 all students should

- Understand such attributes as length, area, weight, volume, and size of angle and select the appropriate type of unit for measuring each attribute;
- Understand the need for measuring with standard units and become familiar with standard units in the customary and metric systems;
- Carry out simple unit conversions, such as from centimeters to meters, within a system of measurement

Next Generation Science Standards

- 2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.
- K2-ETS1-2. Developing a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

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