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Learning Activity:

Helping Hands for Humanity

This learning activity is designed to introduce students to the concept of designing tools for disabled individuals using a research and development process. In this activity, students will design, construct and test a new tool or redesign an existing tool for a disabled person.

Tools and Materials:

- Common hand tools and gadgets found at home (i.e., hammer, screw driver, can opener, bottle opener)
- Scissors
- Glue
- Graph paper
- Styrofoam
- a Styrofoam cutter
- Foamcore poster board
- Computer Lab/Internet Access (optional)

Objectives:

Upon completion of this learning activity, students should be able to:

- Identify the difference between a model and a prototype.
- Explain what is ergonomics and why it is importance to consider when designing tools or devices.
- Illustrate a strong understanding of the research and development process.

Articulation with Wisconsin Technology Education Academic Standards:

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This learning activity will provide opportunities for students to achieve the following Wisconsin Technology Education Academic Standards.

- Select materials and other resources for a technological design and develop practical solutions. C.12.4
- Identify constraints present in given technological processes. C.12.5
- Apply basic engineering concepts in the design and creation of solutions to various problems or opportunities. C.12.9
- Evaluate a technological solution and make necessary improvement if needed. C.12.10

The Human Connection:

The ability of humans to produce tools and devices that extend their capabilities (whether it be the wrench of an auto mechanic, the brush of an artist, or the scalpel of a surgeon) is an important part of everyone's life. It is important that the concept of tools and their uses be taught to all students.

Throughout history, women have been involved in the invention of tools to extend human capabilities. Women developed the tools used in the process of weaving clothes. Bessie Blount, an African American woman, worked with disabled veterans after World War II. Ms. Blount invented a device that would help people eat by delivering food through a tube one bite at a time. The actress Hedy Lamarr invented a remote-controlled, jam-proof radio communications system for the U.S. military that was patented during World War II.

Technology for disabled persons is a natural vehicle for discussing and illustrating technology as a human enterprise. By developing tools and prosthesis for people who would otherwise not have a specific capability, technology becomes a natural extension of human capabilities.

New devices are being produced to enable more and more people with disabilities to lead normal lives. The Americans with Disabilities Act greatly impacts American industry and architecture. Opportunities exist for students to not only learn about those with disabilities, but to actually be involved in using technology to extend the capabilities of all people.

Background Information

As a result of this activity, students will be introduced to tools and their use in society. A tool is defined as an apparatus used to perform or facilitate manual or mechanical work. As a byproduct of this activity, students will gain an awareness of a variety of

disabilities and how engineers and designers create opportunities for all people.

There are several areas that should be considered to develop the skills and knowledge necessary for this learning unit. The concepts of manufacturing and design and the ability to adapt form and function are fundamental.

Manufacturing a product requires the problem solver to understand and manipulate the proper tools, materials, and processes to actually make (produce) a product. Special considerations need to be made as the designer considers the form and function of the product's need. As an engineer ***designs*** a product he/she conceives an idea and creates a systematic plan to achieve the desired outcome.

A ***model*** of a product is a mock-up idea of the desired outcome. A ***prototype*** on the other hand is a working model of a product that is made of the same materials that will be used during the manufacturing process.

When manufacturing a product, the engineer/designer carefully selects the material that will be used to make the product. In the area of physical therapy, the designer uses ***composite materials*** to develop a desired characteristic such as mass or strength. Composite materials are complex materials, such as wood or fiberglass, in which two or more distinct, structurally complementary substances (especially metals, ceramics, glasses, and polymers) combine to produce structural or functional properties not present in any individual component.

Prosthetics is the branch of medicine or surgery that deals with the production and application of artificial body parts. Ergonomics, on the other hand, is "a multi-disciplinary study of human capabilities and performance capacities. Ergonomists apply knowledge from the fields of engineering, medicine, psychology, and management in order to optimize the fit between people and their consumer products, tools, equipment, environments, and work tasks. The goal of ergonomics is to fit engineering designs to the people that they affect so that those people can live and work pain free.

Careers

A variety of different careers are represented in this unit of study – both in traditional areas of technology education and in other areas that may have appeal with a wider range of students. These include:

- Industrial Engineer
- Modelers

- Research and Development
- Engineers – ergonomic design
- Occupational Therapy
- Physical Therapy
- Pattern Makers
- Recreational Therapy

Many opportunities and challenges exist for those in the area of **occupational and physical therapy**. They design and manufacture custom objects for persons with physical disabilities. The understanding of the design process will assist persons with a career interest in these areas.

Programs at several universities have recently begun study in the field of **ergonomics or human factors engineering**. Opportunities abound for students with a strong background in math, science, and technology to explore this emerging field of engineering.

Implementation Procedure:

1. In a teacher-guided discussion, introduce the students to the concept of design for people with physical disabilities. Ask the students if they know of any apparatuses within the school that are designed for someone with a disability. Using the examples that students give you, ask if they can identify what types of disabilities restrict individuals to use these apparatus. For example, there may be a ramp beside a set of stairs on the school campus, but ask the students to identify some disabilities/diseases that restrict an individual to a wheel chair. Bring into the discussion other disabling circumstances and discuss how theses incidents would restrict or limit an individual from being fully functioning without someone's assistance. Other circumstances could include:

- Auto accidents
- Birth defects
- Age related disabilities
- Sports injuries
- Work injuries
- Eye injuries/blindness
- Strokes

After the discussion, give the students additional examples of devices they may be familiar with, or invite the Special Education Department to demonstrate one or two devices that are used in a special needs classroom.

Invite the Special Education Department within the school to visit your classroom, or ask the Special Education Department if your

class can visit their classroom. Allow your students to explore adaptive tools that are available throughout the room.

2. Show the students several traditional types of tools found in both the Material Processing Lab or at home. Introduce the concept of ergonomics to the students and how ergonomics is considered when tools/devices are designed. Using the "Investigating a Device" handout in Appendix A, ask the students to investigate a tool/device and answer the questions listed on the handout.

3. Discuss, review, or introduce the Research and Development Process. Use Appendix B as a guideline to emphasize to students that product development is a process that includes developing ideas, models and prototypes, testing and evaluating, and producing. Be sure to explain to students the difference between a model and prototype. Create your own examples of a model and prototype. Or contact a local company and ask if a representative from the research and development department could bring examples used during the development of products from the company.

4. Introduce the "Helping Hands for Humanity" handout to the class. Muscular Dystrophy has several different forms. Ask the students to research muscular dystrophy muscular dystrophy and identify one of the muscular dystrophy types as the possible disability Larry possesses and the limitations of Larry's physical ability as a result of muscular dystrophy. Ask students to identify a task Larry would find challenging because of his limited physical ability. Using the research on muscular dystrophy, students should develop a list of specifications to consider while designing their device.

5. Using graph paper, briefly demonstrate to students the drawing process from thumbnail sketches of a proposed solution to a set of working drawings. In design groups, students brainstorm solutions for devices that would assist Larry with the task identified earlier. After a brainstorm list is developed, ask students to develop the solutions in the form of thumbnail sketches.

6. Students should refine their rough sketches and produce a working drawing of their device. Students should develop a prototype out of Styrofoam. Ask the students to carefully test their prototype. Students may need to actually model the disability – for example, they could wear a heavy rubber glove that would restrain movement. Arrange an opportunity for your students to visit a community occupational therapy center or an elementary school to test their prototypes.

7. Have students present their ideas to the class. The class could

assess and critique the presentation. The students could use their design portfolios during the presentation to display to the class the process used to develop the prototype. Invite a local Research and Development Analyst or Industrial Engineer to sit in on the presentations and evaluate the models.

Assessment:

In assessing the students consider the following:

- Do the students know the difference between a model and a prototype?
- Can the students explain the importance of applying ergonomics when designing tools or devices?
- Does work compiled in the design portfolio illustrate a strong understanding of the research and development process?

Extension Learning Opportunities

To apply the students learning of ergonomics outside of the classroom, students could choose to design a tool for one of the following:

- Jamie's grandfather has always loved gardening. In recent years, it has become more difficult to grip tools, such as a trowel, because of his arthritis. Grandpa has become depressed because he can no longer do the things that he was always able to do so well.

- Paula lost three fingers on her right hand in an industrial accident. Her employer would like to retrain her in a quality control area – which would mean some simple repairs using hand tools such as screwdrivers, pliers, and wrenches. Modify one of these tools to allow her continuous use of her hand.

For students who develop an interest in Occupational Therapy, students could design a tool for the student in the following scenario:

- Kim has been unable to use her left arm and hand since birth. She is now in 6th grade and has found it very difficult to work on art and tech ed activities. She is frustrated when using scissors and other hand tools when cutting out and creating projects. Kim has a teaching assistant that works with her, but would like to work independently.

Comments, questions, or more information contact Courtney Reed Jenkins - 608-266-3551

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Deb Motiff - Team Webmaster

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Helping Hands for Humanity

You are an engineer for a firm that specializes in products that emphasize ergonomics, your firm has been asked by a school district to design and manufacture apparatuses that will assist students with physical challenges. You and your design team is asked to design a device to assist an individual with muscular dystrophy.

Larry is a student who has muscular dystrophy. He can get around pretty well with a wheel chair and a walker, but also has problems working with his hands. He is unable to grip objects and has limited use of his arms. Larry is a very creative and intelligent student and would also like to work independently.

Design Challenge: Design a new tool or redesign an existing tool for Larry that will give him an opportunity to feel independent in the classroom environment.

Objectives

Each group is required to

- Chose and research a specific type of muscular dystrophy that confines an individual to a wheel chair.
- Identify a specific task that Larry would have difficulty performing because of his disability.
- Use research to develop a list of specifications to consider while designing the device.
- Create a set of thumbnail sketches, chose a final idea and develop a working drawing.
- Design, develop, construct and test a working model of a final solution.

***By the end of this activity Design Teams are expected to have a Design Portfolio that includes*:**

- A short research paper explaining the nature of a particular type of Muscular Dystrophy, include an explanation of the physical limitations of an individual who may have that disability.
- A list of questions that need to be considered when designing the device

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- Identifies a task that would challenge Larry to performl.
- At least four thumbnail sketch solutions to assist Larry when attempting to perform the task. Each sketch should include anecdotal notes (3 or more) describing the advantages and disadvantages associated with each alternative solution.
- A final working drawing describing and illustrating the final solution.
- A description of how the solution was tested and the results of its effectiveness.
- A working model or prototype.

Each Design Team is required to give a presentation to classmates and several teachers from the Special Education department. This presentation should include:

- Information about the disability.
- How you came up with your idea.

What you did to test the success of the tool.

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Research and Development of a Product

Decide what is desired for a final outcome.

Before a problem can be solved, it must be understood. The first step in understanding a problem is to define it operationally in the form of a brief statement. Write a short statement that defines the problem your team will address. In addition to defining the problem, develop a list of specification or characteristics for a successful solution.

Gathering information.

The next step in the problem-solving process is to gather the information needed to develop a solution to the problem. To focus your inquiries, your team needs to develop a list of questions that need to be answered in order to solve the problem. Your team must also identify potential sources of information for each of your research questions. Use your list of questions and potential resources to gather the information to solve the problem. Make sure you record the questions you develop, the resources that you tapped, and the information you gathered for your design portfolio.

Generating possible solutions to the problem.

Technological problems rarely have one right or wrong answer – just effective and ineffective solutions. To develop the best solution possible, it is important to generate a rich pool of alternative solutions from which a solution to the problem can be found. To develop a rich pool of ideas you need to think freely and be creative. This kind of thinking is often called brainstorming.

During the brainstorming process, quantity is more important then quality. Furthermore, no one is allowed to judge ideas, every idea is recorded and given a chance, even if they seem silly at the time. Depending on the nature of the problem, potential solutions can be recorded in the form of anecdotal notes and/or sketches. Identify

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at least 10 potential solutions that will address the problem described in your design brief. Record your ideas in your design portfolio in the form of simple sketches.

Selecting best ideas to be developed.

The next step is to evaluate the alternative solutions, identify their advantages and disadvantages, and then select the best solution to the problem. The best solution may be one of the alternative solutions or a collection of elements from several alternative solutions. Evaluate each of your alternative solutions and identify their advantages and disadvantages. Record your ideas in your design portfolio. Use your analysis to identify the best solution to the problem described in your design brief. You will probably need to develop another rough sketch with some accompanying note to illustrate your concept for the best solution.

Developing the optimal solution to the problem.

During this stage of the problem-solving process, the optimum solution to the problem evolves from an abstract idea into a concrete concept. Depending on the nature of the problem, a refined concept for the solution to a problem can be represented in the form of a rendering, a set of working drawings, a story board, a three dimensional model, or a computer simulation. During this stage of the problem-solving process, it is important to consider things like function, appearance, safety, ease of service, market appeal, cost, ease of manufacture, and/or durability. Develop the "best" solution into a concrete and detailed concept.

Creating a prototype.

The first working model produced in response to a problem is called a prototype. It is the first one of its kind and it is used to test the design and present the solution to other people. For all practical purposes, it works and looks like the intended product. Develop a prototype for the solution that best solves the problem.

Evaluating and refining the product.

At this point in the problem-solving process, it is time to determine if the solution to the problem works as well in real life as it does in the minds of its creators. One of the primary purposes of producing a prototype is to test and evaluate the solution to the problem. Implement your solution to the problem and determine if it meets the design specifications outlined in your design brief. Develop a simple evaluation instrument to guide the evaluation procedure and document your findings in your design portfolio

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Appendix C: (Examples of Assessment tools)

The problem solving team developed a design portfolio that:	**Excellent** 5	4	**Average** 3	2	**Poor** 1
• presents an operational definition for the problem that needs to be addressed.					
• outlines the specifications for a successful solution to the problem.					
• lists the questions that need to be addressed, the potential information sources for finding the answers to the questions, and the answers a teacher would expect students to discover.					
• describes at least four alternative solutions to the problem.					
• features anecdotal notes (3 or more) describing the advantages and disadvantages associated with					

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each alternative solution.					
• presents a solution to the problem that utilizes components from one or more of the alternative solutions.					
• describes how the solution was tested and presents evidence regarding the effectiveness of the solution.					
Presentation – Overall, the text and illustrations used to present the design are well composed, easy to follow and promotes an understanding of the task.					

Comments:

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Additional Resources for Helping Hands

The recent advent of performance assessment and more authentic measurements for assessing what students known in real-life contexts is consonant with what works best for girls and young women.

a. Have the students "check in" at various times throughout the process. Develop instructor checkpoints at intervals such as after the sketching phase, the research phase, and after the model has been produced.
b. Students could appoint a person in their group as a quality control inspector. That person could make sure various assigned tasks are done on time and surpass the requirements laid out in the design brief.
c. If you ask a group from the community to come in during the design process to work along with students - invite them also to come during the students' presentations. Develop an evaluation instrument that these community volunteers could use.

Resources:

David Macaulay and Neil Ardley (Contribution by)
The New Way Things Work: Revised Edition

Human Factors Design Handbook

http://preview.mcgraw-hill.com/info/com.mcgrawhill_books_0070717680.html?se=ink

www.womeninworldhistory.com/lesson1.html

http://www.easter-seals.org/

Americans with Disabilities homepage - http://www.usdoj.gov/crt/ada/adahom1.htm

Ergonomics

List of Gardening web sites

http://arthritis.about.com/cs/gardening/index.htm?rnk=r2&terms=Ergonomics+Hand+Tools

"Fist Grip" garden tools - www.peta-uk.com

ERGOWORLD: Human factors in Design

http://www.interface-analysis.com/ergoworld/hf.htm

http://www.ie.msstate.edu/labs/ergo/

Women's Wheelchair Building Project in Uganda

http://www.disabilityworld.org/01-02_01/women/uganda.htm

The Importance of Teaching Children to Celebrate and Value Diversity

http://www.disabilityworld.org/01-02_01/children/diversity.htm

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