Humans, Robots & Machines: Simplifying The Lives of Our Community

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Abstract:
The purpose of this unit is to use inquiry and real world situations to teach students the function of simple machines in their community through the use of a case study format. Students will be lead to empathize with the older generations by recognizing the challenges that aging faces and feel a sense of accomplishment when they've redesigned the living space of that person to allow them to utilize robots to assist them in their everyday life. Hopefully this will encourage students to take action in being helpful to the elder members of the community.

Rationale:

As a teacher in a title one school in the Philadelphia School District, each year I am faced with the challenge of having students with several different learning levels who may have developed a distaste for learning in general. We don't have the resources of the wealthier school districts and management is just as much a struggle as the varied academic levels of our students. I feel it is my job to create an environment that nurtures the inquisitive nature of children and to utilize that nature to build a foundation for a life of learning.

Playing and exploring are the natural ways of learning. Babies learn to walk regardless if they overly motivated toddler or the complacent toddler that prefers to crawl. Children learn to dress themselves through trial and error, eventually perfecting the skill. The beginning of life is spent observing and investigating our environment first, then selecting what we want to imitate or accomplish. This is what the inquiry based instruction model considers in its design. Students first observe and question or acknowledge a problem and then attempt to answer their questions or solve the problem through more investigation or experimentation. Through this experience stamina builds, ego softens, failure becomes a tool and leaders are forged.

When presented with the opportunity to expand my toolset as a teacher with robotics skills, I couldn't resist! What is more engaging than the idea of a robot? Robots are futuristic and cool toys! To be able to program a toy to do something you want it to do is a strong motivation and just like the video games that become more challenging, students will endure through the obstacles because they never lose sight of their goal.

S.T.E.M education is a real trend right now in education. As a science and math teacher I have a vested interest in this particular trend. The education system has not changed much from how it was originally designed so it is still primarily built around the concept that we are a world of manufacturers. This is no longer true yet children are

expected to take a teacher's word as fact and not challenge their elders. They need to learn methods and formulas and follow the rules. The Inquiry based model begins to steer classrooms away from that parochial model and allows students to question while helping teachers to become comfortable not knowing the answers or accepting that there is more than one answer in most situations. Thinkers are being encouraged to create a new way. Those thinkers become innovators. Those innovators become leaders. That is what we are meant to do as educators, produce leaders.

How am I going to take this new tool and apply it in a way that aligns to my classroom culture? The 7th grade curriculum for science includes simple machines. Robots are machines. Robots that are mobile could use simple machines to create solutions to mobility challenges.

There's much that can be done with robots and simple machines. But we're using robotics in healthcare and the healthcare field and I don't know how that would fit in the unit on simple machines in a way that would make it meaningful. We could just focus on the mobility and prosthetics but I want to make the experience deeper than the surface level of what we know about robotics in healthcare. So after attending seminars that gave us the vast application of robotics in healthcare, education and life I decided that to make this a meaningful and memorable experience I would have my students do a case study where they identify a person who has a disability or experiences the strife of old age. They would then create an action plan including the use of a robot that would address their needs. This was suggested in our seminar as a way to personalize our units for each student. They will need to determine what type of robot would best serve their client and what renovations would need to be made to the living space to maximize the robots performance. Through the process they will develop an empathy for people who need accommodations and hopefully spark an interest in a career that serves their community through technology.

Background:

The beginning of the journey into the modern era of robotics in technology is understanding what exactly makes something a robot. The typical assumption is that a robot is "an autonomous machine able to perform human actions. The attributes are broken down into three categories; Physical nature, autonomy and human likeness.

Physical Nature: it can displace itself in the environment and carry out actions in the physical world.
Autonomy: in robotics it means the capability of carrying out an action on its own, namely, without human intervention.
Human likeness: the similarity to human beings."

In the seminar, the criteria includes the ability to be programmed, containing an inertial sensing unit (IMU) and a proximity sensor.
Surprisingly the regulations for the behavior of robots is governed by the three laws originally developed in 1942 by Issac Asenolf. The first law states that a robot may not injure a human being or allow a human to come to harm through inaction. The second law deems that a robot must obey all instructions given by humans, except those that conflict with the first law. The third law is that a robot must protect its own existence as long as this does not involve conflicting with the first two laws. (2)

Robots are categorized mostly by their appearance but also by their function. The categories of robots that are most popular are animaloids, humanoids and prosthetics. The type of robot used would be determined by its purpose. Areas where robots are utilized in healthcare range from therapeutic application to physical disabilities to cognitive deficiencies to practical application. The robots are used to compensate for the humans shortcomings. They are not equipped to completely replace a human in a task because a part of what makes them a robot is that they are controlled or programmed by humans therefore the relationship between the robot and the human is the first consideration in the design of the robot for any particular purpose. The human must be placed at the center and the robot designed to meet the needs of that human. Designers must understand the needs of the user such as their goals, aversions, strengths, weaknesses, disabilities and the cause of those disabilities. After getting a full assessment of the user, then the robot is selected/designed to meet their needs.

When designing a robot things that are considered are the method of mobility if any, types of input (sensors) and output (feedback), cost, appearance and level of intelligence. In therapeutic environments, robots may have a set program that administers instructions to the patient and then collects the data and gives feedback. They may also be able to make adjustments to the tasks based on the data collected to either increase or decrease difficulty. The data can be analyzed by the robot and used to assess the patient.

Robots don’t always need to have a mobility component. Robots used to socialize patients also can perform their responsibility without having a mobility factor such as the Paro. Paro moves but isn’t mobile. The motion demonstrated by Paro is enough to allow patients to perceive it as an animal that they can interact with providing the patient comfort and companionship. Prosthetics need to have movement that allows them to perform the task of the limb that is being replicated.

The ability for robots to interact with the world around them is achieved through the input of sensors. The sensors allow a robot to process sound, determine position, accept nonverbal cues and react to light. Processing input through various sensors can allow a robot to make more complicated decisions and give more accurate feedback. Feedback is also provided through various mediums such as a sound or movement.

The robot is programmed to respond to the sensors being triggered to allow it to interact with its environment. The response given when a sensor is triggered is determined by the programmer. A program can be a cause and effect script or it can be complicated and the robot has to use algorithms to determine the best option out of possible responses. In this unit, the sensors being used will be standard range finding sensors, auditory sensors and motion sensors.

The focus group for this unit is the aging. Our population of elderly is increasing each year as people are living longer and staying independent longer. "It is clear that more intensive therapy is associated with significant improvements in motor recovery following stroke" 3 and the proportion of therapists to patients shows an extreme deficit of human therapists therefore the use of robotics in therapy is a feasible application. Robots can extend the time that a loved one can stay in the comfort of their home and lighten the load for caregivers by providing security, administering health assessments, distributing medication, providing companionship and assisting in basic household tasks. Developing an understanding and empathy for the elder population is beneficial to the character of the younger generations. Along with determining a robot that would satisfy the needs of their subject, students will also utilize simple machines to help adapt the subject's living space and reduce the workload for the robot.

Unit 5- Days
7th grade 3rd Quarter

Unit Objective: Students will develop an understanding of simple machines through the completion of a case study project in order to demonstrate the function they have in real world situations.

Content Standards:

3.2.8.B6: PATTERNS Explain how physics principles underlie everyday phenomena and important technologies.

3.4.6.C1. Recognize that requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.

3.4.7.C1. Describe how design, as a creative planning process, leads to useful products and systems.

3.4.8.C1. Evaluate the criteria and constraints of a design.

3.4.6.C2. Show how models are used to communicate and test design ideas and processes

3.4.7.C2. Explain how modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.

Aligns with Term 3 Science Scope and Sequence for Philadelphia School District.

Day 1:

Objective: Students will learn and understand the vocabulary associated with simple machines through the development of a song.

Relationship to Unit Objective: Students learning and understanding the vocabulary associated with simple machines will allow students to intelligently discuss and explore the role simple machines play in real world situations.

Preparation: Prior to beginning the lesson, create one set of vocabulary cards for each student with the word and the formal definition on one side and blank on the other side. Pre cut the vocabulary cards to save time

lever – a simple machine that consists of a bar that pivots at a fixed point called a fulcrum
pulley – a simple machine that consists of a wheel over which a rope, chain, or wire passes
wheel and axle – a simple machine consisting of two circular objects of different sizes; the wheel is the larger of the two circular objects.
inclined plane – a simple machine that is a straight, slanted surface, which facilitates the raising of loads; a ramp
wedge – a simple machine that is made up of two inclined planes and that moves ; often used for cutting
screw – a simple machine that consists of an inclined plane wrapped around a cylinder
compound machine – a machine made of more than one simple machine
work – the transfer of energy to an object by using a force that causes the object to move in the direction of the force

Assign a number to each machine and label a chart paper with the machine name and number. Label a chart paper with Simple Machine Song and display it in the front.

Select a song that is available in instrumental form on YouTube to be used for the Simple Machines Song. Make sure it's a song that is very familiar to the students. It can be as simple as Twinkle Twinkle Little Star although a modern song that is age appropriate is suggested. Separate the two first verses into 3 parts.

Opening: 10 minutes
Distribute recording sheet and vocabulary cards and through discussion, redefine and have students write each definition in their own words and draw a picture definition.

Count students out by sixes and tell them to write their number on the top left corner of their record sheet.

Separate into their small groups according to the number given earlier. Give students 3 minutes to come up with as many relationships between vocabulary words as they can and write each relationship down on the recording sheet. Explain a relationship could be any way that two things are similar or how they can work together. One sorted in small groups students will share out their relationships, adding any that their peers may have established that they haven't.

Task 20 minutes
Each group is challenged to write a portion of a song for the machine assigned to their number. Their finished work must include a definition, description and a real world example of the machine. Use the relationships and definitions that you came up with earlier in the lesson to create your song lyrics.
Each group will also write their own version of the hook using the word work, force, load and complex machine.
Once completed, one student will write their song portion on the chart paper labeled with their machine name.

Once all song components are written, Students will vote on the best hook and teacher will transcribe the song lyrics on a chart paper to be used as an anchor chart.

Closing: 10 minutes
Return to whole class. Whole class will learn the song one verse at a time, each time a new verse is added, going back to the beginning of the song and singing it three times. Beginning with the hook

Format:
Hook, hook, hook

Verse 1 part 1, verse 1 part 1, verse 1 part 1
Verse 1 part 2, verse 1 part 2, verse 1 part 2
Verse 1 part 3, verse 1 part 3, verse 1 part 3

Hook, hook, hook

Verse 2 part 1, verse 2 part 1, verse 2 part 1
Verse 2 part 2, verse 2 part 2, verse 2 part 2

Verse 2 part 3, verse 2 part 3, verse 2 part 3

*attach vocabulary cards and recording sheet.

Day 2: 45 minutes

Preparation: Create sample Tri-fold chart on chart paper, Cue video so that when you play it, it starts at the intro to the Georgia Tech robot named

Start the class with the song playing on speakers and ask the class to sing along as they unpack and get settled. Lead one choral session of the song and then introduce the objective for the day.

Objective: Students will complete the planning stage of the design process through the analysis of a real world case study in order to identify and prioritize the problems of aging.

Relationship to the Unit Objective: Students understand the basic human needs and assess how those may be affected by aging. Students will create ownership of their case by selecting someone who is close to them.

Opening: 10 minutes
Show Video (start at 6:49 minutes)
https://theconversation.com/how-robots-could-help-bridge-the-elder-care-gap-82125
Discuss: in general, what types of things would a person need help with? How could a robot help them? What are things a robot might not be able to do?

Task:
Brainstorm: 5 minutes

Think of a person you know who is older than 70. How does being old affect their life? How does it make life hard? What's hard about it? Write a list of possible challenges they face.

Task:
Think pair and share: 12 minutes
Write a list of challenges - 4min
Turn to your neighbor and share your person's story and your list of ideas. 4 minutes each

Make a tri-fold graphic organizer - 10 minutes

Label the sections from left to right, Challenge, Solution, Problem

In the first section you will list the challenges you came up with in the opening. In the center portion come up with a possible solution to that challenge. In the last section consider what might prevent the solution from happening.
An example could be that walking up stairs is a challenge. The solution is to put an elevator in the house. The possible problems with that solution is it would cost too much or there's no room in the house. You can come up with as many solutions as you want.

To complete the first part of the design process sort your challenges by writing a number next to them 1 representing the most important challenge to fix and decreasing from there. Be able to rationalize why your top five are the most important.

Closing: Discussion: Have class share one of their top 5 and then discuss why it's so important.

Day 3:

Objective: Students will be able to adjust designs and solve problems using simple machines as tools through the completion of experimental tasks.

Relationship to Unit Objective: Using the simple machines to solve basic problems will prepare students to analyze a house and see what challenges a robot would need to overcome in order to effectively service the subject of their case study.

Preparation: Write tasks on the cards
Purchase or collect blocks and objects that you can use to replicate components of the home. Have simple machines kit available as well as sample loads and some packing twine. (If you go to big chain home improvement stores and ask, many times they will give you end cuts from wood and allow you to take some of the twine inside the door for securing purchases)

Write tasks on index cards for each station (do not include the expected response which is written in red)

Sort materials into stations throughout the classroom and display a timer set for 7 minutes.

Have song playing while students enter and lead a choral round with the class.

Opening:
Explain the lab for the day: 5 min
There will be 6 challenge stations set up with: a fully charged sphero mini, a task written on an index card, a ruler, all 6 simple machines and various other materials such as duct tape, string, blocks, sandwich bags of sand (to weigh objects down and to use as the load) wood dows of various sizes. Students are challenged to come up with at least one way that the task can be accomplished by a robot using the materials provided. First develop a theory and then test the theory using the sphero. Repeat until you run out of ways to complete the task or time. Which did you try? And which worked the best? Be prepared to share and explain your thinking.
You will have 7 minutes at each station.

Completion of Tasks: 45 minutes

Students can remain in their song writing group or you can regroup. Assign which station students will begin at by group. They will cycle through 6 stations completing the tasks.

First Station: Task: Move load from a low location to a location 8 inches higher it's too heavy for a robot to lift or push very far. pulley

Second Station: Task: Move a load across a 12 inch path that has various size hills in between the start and finish. Wheel axle

Third Station: Task: Get the object out of the container in one piece. Clay in a jar or container. lever

Fourth Station: Task: Divide the clay into two parts. Wedge

Fifth Station: Task: Move a load to a higher location 4 inches higher and 12 inches in distance. It is too heavy to lift but able to be pushed. Inclined plane

Sixth Station: Task: Attach two object together. Screw

Closing:
Regroup, review, discuss 10 min
On the chart paper on the front of the board write all ways that students share as solutions. Use conversation starters to facilitate discussion as to differences and similarities between solutions. Be certain to not use judgmental words such as better or easier. Translate responses using vocabulary
Ex:
Students says, "Mine was better because it's easier to use the pulley to lift the load"….
Teacher says, "what I hear you saying is using a pulley takes less power so it requires less work but did both theories work?". The purpose of this task is to identify multiple solutions and be able to articulate why they chose the option they did and what role the machine played in it.

Students are asked to write a three sentence response. In what cases might it be the better choice to select the solutions that require more work?

Days 4 and 5

Objective: Students will apply prior knowledge from simple machines activities in order to design a home that will address the needs of an aging adult.
Song playing and a group round sung
Play video from day one again.

Opening: Thinking of the tasks that were done in the lab yesterday, which ones do you believe robots could have done better than humans? Were there any tasks that a robot couldn't accomplish?

Task: Over the two day period students are expected to analyze the home of their case study subject and identify what might be an obstacle that will prevent a robot from accomplishing a goal. If the subject needs help with laundry and the laundry is down in the basement and a top load washer, what will keep a robot from doing the laundry?

You will do your best to replicate the obstacle and then redesign that portion of the home to address the obstacle. Since an entire home model would be too large to replicate, students will build a rube goldberg machine to demonstrate their redesign. You will have the ability to use a sphero in your demonstration in any way you feel inclined.
Requirements: You must address at least 5 obstacles. The solutions may be a combination of simple machines or in multiple steps. You must be able to relate each portion of your machine to a challenge your subject faces. You must be able to explain each component. Additional materials may be used. There will be 2 days to design and build. They will have 2 minutes to present their machine.

Possible adjustments or accomodations:

Students may work in partners

If spero minis aren't available, hex bugs or $5 robots from 5 below can be used.

If no simple machine kits are available in your school, solicit hardware stores, construction sites or donors choose to acquire them.

If students have robotics experience, they may be asked to build a robot for their rube goldberg machine

Unit can be extended by including a research component asking students to research the common solutions used to eldercare problems.

Follow up: as a writing piece students can write the case study with the following components: research, subject, focus and suggestions.

Students can design a robot to service their subjects.

Special Ed:

Vocabulary can be given ahead of time and re-written at their reading level

Modeling for all lessons

Simplified instructions

Shorter responses required or only verbal responses as opposed to written

Speech to text enabled iPads to record responses
Provide special education teachers a preview of the lesson to identify areas of need for individual students.