Prosthetic Arm Design Challenge

STEM: Science, Technology, Engineering, Mathematics

SCHOOL IMPROVEMENT NETWORK

STEM Classroom Series

The STEM Classroom series features lessons that promote understanding of STEM content knowledge, integrate STEM with non-STEM subjects, and increase students' exposure to STEM-related career options.

About this Segment

Students in Ms. Kate Youmans' engineering design class are working in pairs to build models of a working prosthetic arm. The students work through an eight-step engineering design process as they research, design, build, and test their mechanical models.

Application activities (complete all that meet your goals for viewing this segment)

A. Learn more about STEM education

1. Use the table on the next page to identify the elements of effective instruction, as well as the elements of effective STEM instruction, that you observed in this lesson.

2. How could the teacher enhance or add to the elements of instruction in her lesson?

3. How could the teacher enhance or add to the elements of STEM instruction?

B. Replicate this lesson

1. *What are the learning objectives you want your students to achieve?*
   How would you modify the lesson's objectives, outlined in the Lesson Plan below, for your own students and curriculum? What other objectives, if any, will you set?

2. *What content knowledge do you need to acquire or expand?*
   This activity is centered on an eight-step engineering design process. To learn more about this process, visit the Resources to Support Content Knowledge links in the Lesson Plan section of this guidebook.

3. *How will you create the time and space to engage students in this lesson?*
   How much time will this learning activity take to plan and carry out? How can you integrate the activity into your current curriculum map?

4. *What materials and other resources do you need for this lesson?*
   What materials are needed for this lesson? See the Materials section of the Lesson Plan. What collaboration is necessary with administrators and other teachers?

5. *How will you assess student learning?*
   In this lesson, the ultimate assessment happens when students present their models to the class. How will you assess student learning along the way, in each step of the engineering design process?

6. *How can you promote a STEM focus in your instruction?*
   What STEM experiences were students engaged in during this lesson? (See the "Elements of Effective STEM Instruction" below.) What are some others that you could include?

C. Infuse STEM principles into your own lessons

1. Apply the six questions in the "Replicate this lesson" activity to one of your own lessons.

2. Determine challenges you might face in applying these STEM concepts to your own lesson. How can you overcome these challenges?

Elements of Effective Instruction	Elements of Effective STEM Instruction
- High expectations for all students - Rigorous content - Authentic performance tasks - Real-time assessment adapted to student needs - Student-driven learning - Strong relationships among students and between teacher and students - Equitable, culturally relevant content and practices - Evidence of 21st century skills, e.g. critical thinking, problem solving, collaboration, creativity, communication - Technology that enhances learning - Cross-curricular (interdisciplinary) integration	*In addition to the Elements of Effective Instruction left, effective STEM instruction can include:* - Teachers who develop solid STEM-related content knowledge - Hands-on problem-solving activities that have real-world relevance - Integration of STEM into non-STEM subjects, especially art and design - Use of industry-standard software, tools, and procedures such as the engineering design cycle - Increased awareness of STEM fields and occupations, especially among underrepresented populations - Enthusiasm about further STEM-related learning - Connections between in-school and out-of-school learning opportunities - Industry and higher-ed partnerships that encourage hands-on student exploration of STEM-related careers

Sources: California Dept. of Education. (2015). Science, technology, engineering, & mathematics. Retrieved February 21st, 2015, from http://www.cde.ca.gov/pd/ca/sc/stemintrod.asp

President's Council of Advisors on Science and Technology (PCAST). (2010). Prepare and inspire: K-12 education in science, technology, engineering, and math (STEM) for America's future. Retrieved from the Whitehouse.gov website: http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf

General STEM Information and Resources

Utah STEM Action Center (n.d.). STEM Utah. Retrieved January 22, 2015, from http://stem.utah.gov/

California Department of Education (n.d.). Science, technology, engineering, and mathematics. Retrieved January 22, 2015, from http://www.cde.ca.gov/pd/ca/sc/stemintrod.asp

National Education Association. (n.d.). The 10 best STEM resources: Science, technology, engineering & mathematics resources for preK-12. Retrieved March 23, 2015, from http://www.pbs.org/teachers/stem/

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PBS Teachers. (n.d.). STEM education resource center. Retrieved March 23, 2015, from http://www.pbs.org/teachers/stem/

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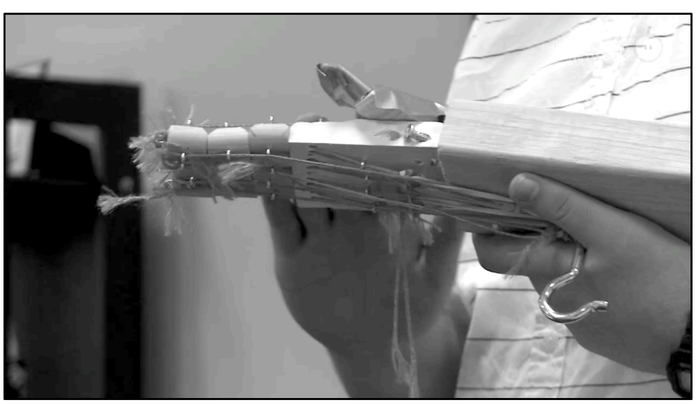


Prosthetic Arm Design Challenge

Lesson Plan

STEM: Science, Technology, Engineering, Mathematics

Teacher: Kate Youmans	**Grade/Content Area**: HS Engineering Design Class
School: American International School of Utah	**Lesson Duration**: seven class sessions of 60 min.

Lesson Objective(s)

Students will design and build a low-cost prosthetic arm with the ability to grasp an object, lift it vertically, and then release the hold.

Key Concepts and Vocabulary

(See below for online resources that support content knowledge)

Engineering Design Process

- Define the problem
- Research prior solutions
- Brainstorm designs and solutions
- Select a design
- Build a prototype
- Analyze the prototype
- Redesign
- Communicate your solutions

Standards Addressed in the Lesson

- Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- Initiate and participate effectively in collaborative discussions.

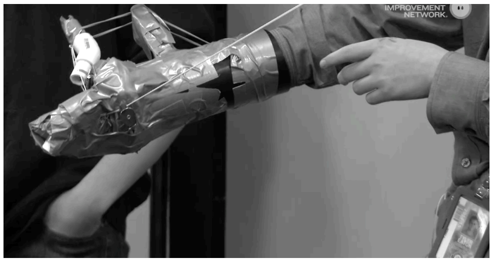
Assessment

As part of the “analyze the prototype” step in the engineering design process, students will present their prosthetic arm models to the class and explain the model’s capabilities, limitations, and what they will do in their redesign to address those limitations.

Students will also complete a challenge: using the prosthetic arm, students will lift a set of beanbags, one by one, out of a bucket and toss them onto a grid marked on the floor. Students win points for distance and accuracy along the grid.

Materials

- Assignment sheet: (see Resources to Support Content Knowledge)
- Materials for research including computers, laptops, or other handheld devices
- Shop Tools: saws, hammers, drills, vices, sanders, etc.
- Materials purchased at a hardware store will vary according to student designs; they may include, but are not limited to: PVC piping, rope, twine, cord, hinges, nails, screws, sandpaper, duct tape, etc. Note: no more than $40 should be spent per model



Differentiating the Instruction

This task permits multiple entry points, thus facilitating track designs with a range of complexity—all of which can yield the desired student learning.

Lesson Procedures

Day 1: Define the problem. Introduce the assignment; watch video footage about prosthetic limbs; divide into teams.

Day 2: Research prior solutions. Students may use the Internet. Teacher and students may wish to visit a hardware store to investigate possible materials. Make no purchases yet.

Day 3: Brainstorm designs and solutions/select a design. Students begin to put their research into action and draw up design plans.

Day 4: Students purchase necessary materials at the hardware store.

Day 5: Build prototypes.

Day 6: Analyze prototypes. Students present their models to the class and explain their capabilities and limitations.

Day 7: Redesign/communicate your solutions: students make adjustments to their models and then test them by lifting a series of objects determined by the teacher. Students also participate in a beanbag toss to measure for distance and accuracy. Finally, students write up the solutions to the problems they encountered when analyzing the prototype.

Resources to Support Content Knowledge

Teach Engineering. (n.d.). Engineering design process. Retrieved April 23, 2015, from https://www.teachengineering.org/engrdesignprocess.php

Prosthetic Arm Challenge. (2014). MESA USA. Retrieved April 23, 2015, from http://www.graniteschools.org/edequity/wp-content/uploads/sites/21/2014/08/2014-2015-MESA-USA-National-Engineering-Design-Challenge-Specifications-Final.pdf

Related Video Lessons and Resources

Lyon, J. (May 2014). Utah prosthetic arm challenge. Retrieved April 23, 2015 from the Utah Public Education website: http://utahpubliceducation.org/2014/05/21/mesa-engineering-challenge/#.VTl5-Lqp3dk

Limbitless Solutions. (n.d.). Meet Alex Pring. Retrieved April 24, 2015, from http://www.limbitless-solutions.org/alexpring/

ABC News. (2015). Little boy gets a robotic arm from Iron Man. Retrieved April 24, 2015, from http://abcnews.go.com/WNT/video/boy-robotic-arm-iron-man-29629070

Kamen, D. (2007). Dean Kamen: Luke, a new prosthetic arm for soldiers. TED Talk. http://www.ted.com/talks/dean_kamen_previews_a_new_prosthetic_arm?language=en

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