Getting to the Core

Grade 7 Unit of Study

TEACHER EDITION

Bionic Hand

Santa Ana Unified School District Common Core Unit Planner-Literacy

Unit Title:	**The Human and Bionic Hand**	
Grade Level/Course:	**Grade 7 Science**	**Time Frame: 15 days**
Big Idea *(Enduring Understandings)*:	**Big Idea:** Evidence & Models ***Enduring Understandings: Systems have parts that work together to complete a task***	
Essential Questions:	*What tasks and movements can be done by the human hand?* *What structures are found in the human hand?* *How do the parts of the human hand work together to complete a task?* *How can engineers develop an artificial hand that mimics the human hand?*	

Instructional Activities: Activities/Tasks

Lesson: Day 1-2 – Lesson 1

Complex Text: Angel Measure

- **Read** 1 — Activity: Drawing Angles/ How to use a goniometer
- **Read 2** — Activity: Range of Motion Activity
- **Read 3** — Activity: Range of Motion Data Analysis

Lesson: Day 3-4-5 – Lesson 2

Complex Text: NASA I want to hold your hand instructions and video clips

- **Read** 1 — Activity: Unencumbered Read
- **Read 2** — Activity: Create Flow Maps of steps
- **Read 3** — Activity: View NASA video to check steps

Lesson: Day 6-7 – Lesson 3

Complex Text: Structures of the hand: Bones & Joints, Ligaments in the Fingers and Hand, Muscles in the Hand, Tendons in the Hand

- **Read 1** — Activity: Unencumbered read
- **Read 2** — Activity: Text dependent questions/Sum-marize on Matrix
- **Read 3** — Activity: Orally present information to Base group

Lesson: Day 8-9 – Lesson 4

Complex Text: Video Clip - Prosthetic Hands: Range of Motion

- **Read 1** — Activity: Unencumbered viewing
- **Read 2** — Activity: View with Text Dependent Questions
- **Read 3** — Activity: Evidence from video for Extended Anticipatory Guide

Lesson: Day 8-9 – Lesson 4

Complex Text: DOD working toward fully functional prosthetic arms

- **Read 1** — Activity: Unencumbered Read (Teacher reads orally)
- **Read 2** — Activity: Do/Say Chart
- **Read 3** — Activity: Evidence from text for Extended Anticipatory Guide

Lesson: Day 10 -14 – Lesson 5

Complex Text: Engineering Design Process Challenge

- **Read 1** — Activity: Unencumbered read EDP article
- **Read 2** — Activity: Pull Quote from EDP close read
- **Read 3** — Activity: Round Robin Read of “Defining the Problem”

Lesson: Day 15 –Lesson 6

Complex Text: RAFT Prompt

- **Read 1** — Activity: Unencumbered Read (Teacher reads only)
- **Read 2** — Activity: Professional Response Letter
- **Read 3** — Activity: Writing RAFT

21st Century Skills:	**Learning and Innovation:** ☒ Critical Thinking & Problem Solving ☒ Communication & Collaboration ☒ Creativity & Innovation **Information, Media and Technology:** ☒ Information Literacy ☒ Media Literacy ☒ Information, Communications & Technology Literacy	
Essential Academic Language:	**Tier II: (academic vocabulary other than science content)** **Lesson 1 - Preparing the Learner**: structure, anatomy, injury, heal, limitations, recuperating, angle, degrees, rotate, range of motion, trace **Lesson 2 –** following procedures, materials, flex, construct, assemble, reconnect prepare, attaching, segment **Lesson 3:** function, functional unit, complex, flex, tilted, fixed, disc, extends, elongated, rotate, flexible, fibrous, bind, intact, severe, tear, rupture, swelling, bruising, degeneration, repetitive, tenderness, sheath, lubricant, compressed, distortions **Lesson 4**: artificial, pharmacy, braces, mechanical, centerpiece, functionality, extremity, limb, revolutionizing, wounded warriors, science fiction, torque, feedback, fluid movement, grip, independently, residual, joy stick, tremendous, feedback, goal, background, misconception **Lesson 5**: lanyard, segmented, connecting, constraints, prototype, precision, open-ended design, iteration	**Tier III: (science content specific)** **Lesson 1 - Preparing the Learner**: amputation, prosthetic, Range of Motion, goniometer, bionic, physical therapist **Lesson 3**: bones, joints, ligaments, muscles, tendons, hinge joint, extension, flexion, tissues, sprain, abduction, adduction, inflammation, sensations **Lesson 4**: prostheses, neural control, degrees of freedom, myoelectric, engineers, amputees, grip, clinical studies **Lesson 5:** flexor, palm, wrist, forearm, ligament, tendon, joint, bone, muscle

What pre-assessment will be given?	How will pre-assessment guide instruction?
Quick Write on Injury (functions of hand or foot) Extended Anticipatory Guide on Bionic Hand	Teacher will use student quick write to see what they know about the hand or foot. Teachers will evaluate students' opinions to see what students know about prosthetic arms.
Content Standards	**Assessment of Standards** (include formative and summative)
Next Generation Science Standards (2nd Draft) **MS-LS1 From Molecules to Organisms: Structures and Processes** **MS. Structure, Function, and Information Processing** **MS-LS1-3.** In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions**.** **MS-LS1-8.** Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. **MS-LS1-d.** Design and conduct an investigation to gather evidence to support explanations that the body is a system of interacting subsystems composed of groups of cells working to form tissues and organs specialized for particular body functions, and that scientific advances in understanding of those systems have led to improvements in nutrition, health, and medicine. **Developing and Using Models** Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to support explanations, describe, test, and predict more abstract phenomena and design systems. (MS-ETS1-4) **Influence of Engineering, Technology, and Science on Society and the Natural World** Technologies can have deep impacts on society and the environment, including some that were not anticipated. (MS-LS1-a),(MS-LS1-d) **Science is a Human Endeavor** Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness	**Formative** Quick Write on Injury to either Hand or Foot (Lesson 1) Range of Motion Activity (optional) (Lesson 1) Teacher observation of student discussions after viewing video Jigsaw Matrix Parts of the Hand (Lesson 2) Extended Anticipatory Guide The Bionic Hand (Lesson 3) DO/SAY Chart for DOD Article Thinking Map for construction of hand (Lesson 4) **Summative:** Completed Extended Anticipatory Guide from Lesson 3 (Day 5 has facts and evidence) Constructed hand from Lesson 4

to new ideas. (MS-LS1-d)	Letter from Lesson 5 (Summative Assessment)	
Common Core Learning Standards Taught and Assessed (*include one or more standards for one or more of the areas below. Please write out the complete text for the standard(s) you include.)*	**What assessment(s) will be utilized for this unit?** *(include the types of both formative assessments (***F***) that will be used throughout the unit to inform your instruction and the summative assessments (***S***) that will demonstrate student mastery of the standards.)*	**What does the assessment tell us?**
Bundled Reading Literature Standard(s): NA		
Bundled Reading Informational Text Standard(s): RI.7.1 Cite several pieces of textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text. RI.7.8 Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims.	**F** -Jigsaw Matrix Parts of the Hand (Lesson 2) **F -** Thinking Map for construction of hand (Lesson 4)	Did students understand the complex text?
Bundled Foundational Skill(s) Standard(s): *(K-5 only)*		
Common Core Learning Standards Taught and Assessed (*include one or more standards for one or more of the areas below. Please write out the complete text for the standard(s) you include.)*	**What assessment(s) will be utilized for this unit?** *(include the types of both formative assessments (***F***) that will be used throughout the unit to inform your instruction and the summative assessments (***S***) that will demonstrate student mastery of the standards.)*	**What does the assessment tell us?**
Bundled Writing Standard(s): W.7.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 7.1–7.3.) W.7.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.	**F -** Completed Extended Anticipatory Guide from Lesson 3 (Day 5 has facts and evidence) **S –** Letter using RAFT strategies (Lesson 5)	Can student write evidence to support their claim?

W.7.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.		
Bundled Speaking and Listening Standard(s): SL.7.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.	**F -** Three Step Interview (Lesson 1) **F-** Pair Shares (multiple lessons) **S** – Explanation of redesign (process 5) **S** – RAFT letter explanation (lesson 6)	Can students explain their thinking and design process?
Bundled Language Standard(s): L.7.3 Use knowledge of language and its conventions when writing, speaking, reading, or listening. L.7.6 Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.		

Resources/ Materials:	**Complex Texts to be used** **Informational Text(s) Titles:** Lesson 2*: Bones and Joints, Ligaments in the Fingers and Hand, Muscles in the Hand, Tendons in the Hand;* Lesson 3*: DOD working toward fully functional prosthetic arms(article), Vocabulary, Cornell Notes and Pulled quote from Engineering Design Process for Lesson 6.* **Literature Titles: NA** **Primary Sources:** **Media/Technology:** *Structure of the Hand (graphic*); Video clips from Discovery Streaming: A Segment of: Prophets of Science Fiction: George Lucas; Dean of Invention: Building the Bionic Body Video Clips from NASA: Robotics: I Want to Hold Your Hand Video Clip from You Tube: Thomas Viloteau plays Fuga by M. Ponce **Other Materials:** masking tape, cardboard, centimeter ruler, scissors, scotch tape, drinking straws, fishing line (nylon string or lanyard), rubber bands
Interdisciplinary Connections:	**Cite several interdisciplinary or cross-content connections made in this unit of study (i.e. math, social studies, art, etc.)** Measuring angles as part of Range of Motion activity

Differentiated Instruction:	**Based on desired student outcomes, what instructional variation will be used to address the needs of English Learners by language proficiency level?** Three Step Interview Sample Language to use to Discuss Structures of the Hand Discussion Sentence Frames	**Based on desired student outcomes, what instructional variation will be used to address the needs of students with special needs, including gifted and talented?** **Special Needs:** Vocabulary Power Point for unit Sample Language to use to Discuss Structures of the Hand Discussion Sentence Frames Finger Assembly items written for Thinking Maps **GATE:** Design a hand with a thumb

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SAUSD Common Core Lesson Planner Teacher:

Unit: The Human Hand Lesson #: 1 &2	Grade Level/Course: Grade 7/ Life Science	Duration: 2 class periods Date:
Common Core and Content Standards	**Big Idea: Systems have parts that work together to complete a task.** **Essential Question: What tasks and movements can be done by the human hand?** **Content Standards:** **MS-LS1-3.** In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions**.** **MS-LS1-8.** Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. **MS-LS1-d.** Design and conduct an investigation to gather evidence to support explanations that the body is a system of interacting subsystems composed of groups of cells working to form tissues and organs specialized for particular body functions, and that scientific advances in understanding of those systems have led to improvements in nutrition, health, and medicine. **Developing and Using Models** Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to support explanations, describe, test, and predict more abstract phenomena and design systems. (MS-ETS1-4) **Influence of Engineering, Technology, and Science on Society and the Natural World** Technologies can have deep impacts on society and the environment, including some that were not anticipated. (MS-LS1-a),(MS-LS1-d) **Science is a Human Endeavor** Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (MS-LS1-d) **Common Core Anchor Standards:** **CCSS Reading for Literacy in Science Grade 6-8**: 3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. **CCSS Speaking and Listening Grade 7:** Students engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly. **CCSS Writing Grades 6-8:** Students produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	

<table>
<tr><td>Materials/ Resources/ Lesson Preparation</td><td colspan="3">Teacher Resource 1.0: Video Clip: Luke Skywalker's Bionic Hand
Student Resource 1.1: Quick Write on Injury
Student Resource 1.1: Three Step Interview Instructions
Student Resource 1.1a: Goniometer picture and protractor
Student Resource 1.1b: Angle Measure
Student Resource 1.1c: Drawing Angles
Student Resource 1.1d: Wrist Range of Motion Instructions
Student Resource 1.1e: Wrist Range of Motion Data Sheet</td></tr>
<tr><td>Objectives</td><td colspan="2">Content:
Students will be able to describe some of the functions of the hand.

Students will be able to accurately measure and draw angles using a protractor.

Students will be able to accurately measure the range of motion of their wrists.</td><td>Language:
Students will produce clear and coherent writing about a personal experience.

Students will engage in a collaborative discussion about their personal experience.

Students will summarize their partner's personal experience and share it with their group members.</td></tr>
<tr><td>Depth of Knowledge Level</td><td colspan="3">☒ Level 1: Recall ☒ Level 2: Skill/Concept
☐ Level 3: Strategic Thinking ☐ Level 4: Extended Thinking</td></tr>
<tr><td>College and Career Ready Skills</td><td colspan="3">☐ Demonstrating independence
☐ Building strong content knowledge
☒ Responding to varying demands of audience, task, purpose, and discipline
☐ Valuing evidence
☐ Comprehending as well as critiquing
☐ Using technology and digital media strategically and capably
☒ Coming to understand other perspectives and cultures</td></tr>
<tr><td>Common Core Instructional Shifts</td><td colspan="3">☐ Building knowledge through content-rich nonfiction texts
☐ Reading and writing grounded from text
☒ Regular practice with complex text and its academic vocabulary</td></tr>
<tr><td rowspan="2">Academic Vocabulary (Tier II & Tier III)</td><td rowspan="2">TEACHER PROVIDES SIMPLE EXPLANATION</td><td>KEY WORDS ESSENTIAL TO UNDERSTANDING</td><td>WORDS WORTH KNOWING</td></tr>
<tr><td>injury
limitations
function
protractor
vertex
Range of Motion
trace</td><td>prosthetic
bionic
physical therapist</td></tr>
</table>

	STUDENTS FIGURE OUT THE MEANING	Angle axis	goniometer
Pre-teaching Considerations		Students need to be placed in groups of four. They need to be designated as Student A, Student B, Student C and Student D. Preview the Star Wars video clip of Luke Skywalker bionic hand. Students will need protractors to measure the angles for part of this lesson. There is a protractor printed on the student page that has the picture of the knee which they could cut out if they don't have a protractor. There is also a sheet of protractors in the teacher guide that could be printed on transparencies. NOTE: Towards the end of the unit students will be writing a letter about prosthetic hands and how they can be made to do tasks such as playing a guitar which means the prosthetic hand must have an adequate range of motion. The range of motion activity in this lesson will introduce them to the concept of Range of Motion.	
Lesson Delivery Comprehension			
Instructional Methods		**Check method(s) used in the lesson:** ☒**Modeling** ☒**Guided Practice** ☒**Collaboration** ☒ **Independent Practice** ☐**Guided Inquiry** ☐ **Reflection**	
Lesson Opening		**Prior Knowledge, Context, and Motivation:** **Star Wars video of Luke's arm 4:37 min** The teacher will introduce the Star Wars video clip. Tell students that this clip is from one of the Star Wars movies, *The Empire Strikes Back*, which premiered in 1980. From Luke Skywalker's light saber to Darth Vader's Death Star, the *Star Wars* franchise is one of the defining science fiction works of the later twentieth century. George Lucas' prolific imagination has already inspired two generations of scientists and engineers to push the envelope of technology. By introducing computers into the film making process, he changed the way movies are made, and the way we all see the future. **NOTE: This video clip should be watched before the lesson. While not gory or graphic in nature, some images (fake hand with a hole through it) may be upsetting.**	

Lesson Continuum			
	Body of the Lesson: Activities/ Questioning/ Tasks/ Strategies/ Technology/ Engagement	**Quick Write about Hand or Foot Injury (15 min.)** 1. The teacher will begin by telling a story about a time that they or someone they know suffered an injury to their hand or foot (3 min). The teacher should include limitations that he/she or the person had while recuperating from the injury. 2. Distribute the Lesson 1 Quick Write-Three Step Interview Student Handout. 3. The teacher will read the Quick Write prompt out loud to the class. 4. The teacher will allow 1-2 minutes of think time, followed by 3-5 minutes of writing time. (Students should be directed to write in the top space provided on their Lesson 1 Quick Write-Three Step Interview Student Handout.) Students should not be copying other student's work but listening and writing what they hear.	**Differentiated Instruction:** **Students Who Need Additional Support:** • Students work in scaffolded pairs for immediate support. • Teacher proximity for immediate feedback. • Graphics to contextualize vocabulary terms. • Modeling how to use a protractor on the document camera.

Lesson Continuum

Body of the Lesson: Activities/ Questioning/ Tasks/ Strategies/ Technology/ Engagement

Three Step Interview (16-18 min)

1. The teacher should have students seated in groups of 4. Within the group of 4, each student should be assigned a letter A, B, C, or D. Student A should be seated beside Student B. Student C should be seated beside Student D.
2. Students will begin by working in groups of 2.
3. Step One: Student A will interview Student B (3 min), taking notes on the bottom of the Lesson 1 Quick Write-Three Step Interview Student Handout. At the same time, Student C will interview Student D (3 min), also taking notes.
4. Step Two: Student B will interview Student A (3 min), taking notes, and Student D will interview Student C (3 min), also taking notes. (This is a reverse of Step One)
5. Step Three: Now all 4 students will work together. Each student will take a turn telling the others in the group what they heard when they interviewed their partner (4-6 min).

Discussion (5-10 minutes)
After students engage in the Three Step Interview, discuss with them the relationship between structure (injury to a specific part of the hand/foot) and function (limitations caused by injury).

Connection to Discussion Activity - Have students tape their thumb to their palm and either write or tell their elbow partner the problems they have picking up items such as a pen or small ball or tying their shoes.

This will begin on day 2: Tell students that for the next lesson they will be learning more about the structures of the hand and the function of each structure.

For the remainder of this lesson students will be learning about how the hand moves by doing a **Range of Motion Activity**. You can start this activity in class and students can finish it for homework.

Range of Motion Activity

1. Introduce the term Range of Motion. Generally speaking, range of motion refers to the distance and direction a joint can move to its full potential. Each specific joint has a normal range of motion that is expressed in degrees after being measured with a goniometer (**go·ni·om·e·ter [**gō-nē-ˈä-mə-tər\], an instrument that measures angles from axis of the joint). Use the graphic provided in the student workbook that shows a goniometer measuring the Range of Motion for a knee. There is also a protractor printed on this page if students need to cut one out.

Accelerated Learners:

- Encouragement to use online resources to investigate advances in artificial limb research
- Pair share to provide immediate support
- Scaffold groups of accelerated learners together

Lesson Continuum			
	Body of the Lesson: Activities/ Questioning/ Tasks/ Strategies/ Technology/ Engagement	2. Distribute the Angle Measure Handout and protractors. The teacher may choose to demonstrate how to use the protractor, depending on the prior protractor experience of the students. 3. Distribute the Drawing Angles Handout. Again, the teacher may choose to demonstrate how to draw angles using the protractor. 4. Distribute the Wrist Range of Motion (ROM) Handout. The teacher may choose to demonstrate some or all of the 5 steps. 5. You may choose to have students share their data with the whole class. ROM data can be written on the white board or smart board, or students can enter their data onto a teachers computer in an excel sheet which can be projected. NOTE: entering data into an excel sheet makes it easy to compare data from class to class, to identify outliers in the data and to look for patters (Do girls have a great ROM than boys? Does age matter?) **Extending the Lesson - End of class/homework writing assignments** **Exit Slips** - Have students write a sentence describing what you think we will be learning about in this unit. Use evidence from what we did in class today to support your answer.	

Teacher Reflection Evidenced by Student Learning/ Outcomes	

Video Clip - Luke Skywalker's Bionic Hand

From: DiscoveryStreaming - A Segment of: Prophets of Science Fiction: George Lucas
Time: 4 minutes, 27 seconds
Link: http://player.discoveryeducation.com/index.cfm?guidAssetID=6C32B66F-403B-471B-A1C7-53D245B1FF17&productcode=US

Presents Luke Skywalker's bionic hand in Star Wars and reveals new advancements in bionic limb technology today. NOTE: This program contains content that may be disturbing to some viewers (Fake hand with a hole burned through it). Please preview.

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HAND - Lesson 1 Name__________________________ Period_____

Quick Write on Injury

I am person ______ (A, B, C, or D). Think about a time that you or someone you know suffered an injury to your hand or foot. How did the injury occur? How long did it take for the injury to heal? What were some of the limitations you or the person had while recuperating from the injury? Write about it in the space below:

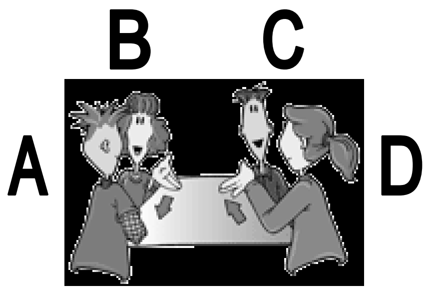
I am going to interview person _____(A, B, C, or D). Interview your partner. Ask them to tell you about a time that they or someone they know suffered an injury to their foot or hand. Write notes about what they say. Be sure to include the limitations they had while recuperating from the injury. Bullet points are fine. Get as many details as possible. You will be using these notes to report out to the other two members of your base group.

THREE STEP INTERVIEW

(Kagen)

Three Step Interview:

How it Works



Step One: A interviews B

while

C interviews D

Step Two: B interviews A

while

D interviews C

Step Three: 1. A reports to the whole group about B

2. B reports to the whole group about A

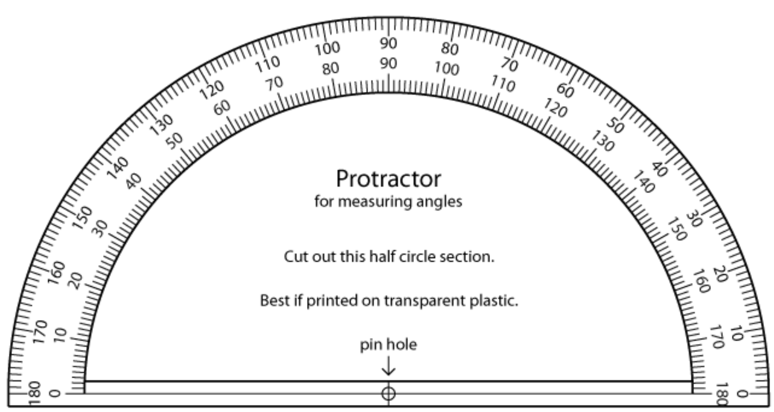
3. C reports to the whole group about D

4. D reports to the whole group about C

Using a goniometer to measure Range of Motion for a knee joint

http://www.idass.com/acatalog/goniometer.jpg

You can use your own protractor or cut out the one below to measure the angles on the next pages:



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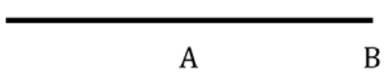
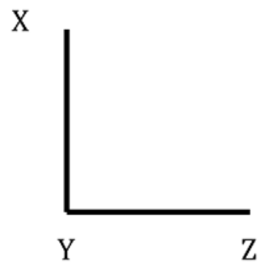
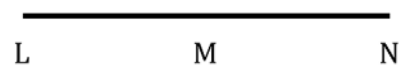
Lesson 1 Name ____ Period _______

Angle Measure

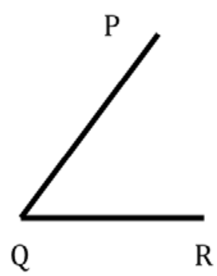
Use a protractor to measure each of the angles given and write your answer in the space provided.

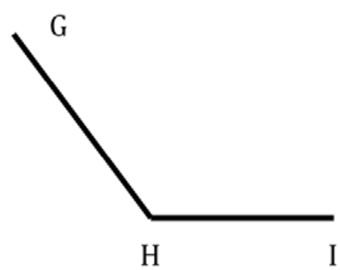


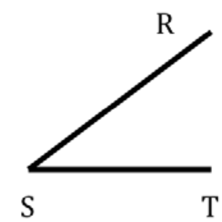




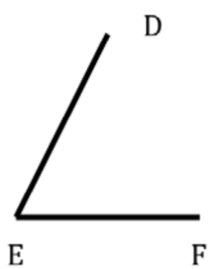
∠ ABA ______ ∠ XYZ ______ ∠ LMN ______

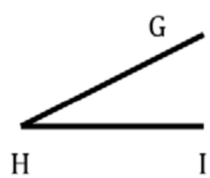


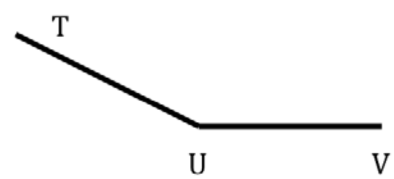




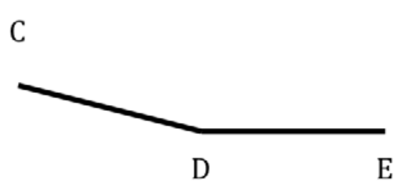
∠ PQR ______ ∠ GHI ______ ∠ RST ______

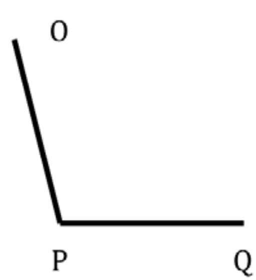


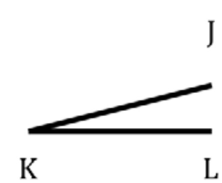




∠ DEF______ ∠ GHI ______ ∠ TUV ______







∠ CDE ______ ∠ OPQ ______ ∠ JKL ______

HAND Lesson 1 Name ____ Period _______

Drawing Angles

Directions

- Use a protractor to help you draw each of the angles given below
- Use the points given as the vertex while drawing 1-inch legs for each angle

▪ 90^{o} ▪ 45^{o} ▪ 30^{o}

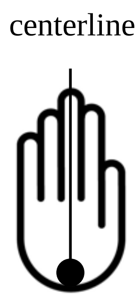
▪ 60^{o} ▪ 180^{o} ▪ 120^{o}

▪ 10^{o} ▪ 110^{o} ▪ 0^{o}

Wrist Range of Motion (ROM) Instructions

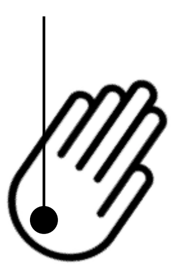
Step 1

Place the bottom of the palm of your right hand onto the circle • on the next page of this ROM Data Sheet with the middle of your hand along the ‘centerline’.



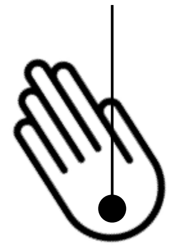
Step 2

Rotate your hand as far as you can to the right without picking your hand off of the paper then trace your hand again. Your wrist and arm MUST stay flat on the paper.



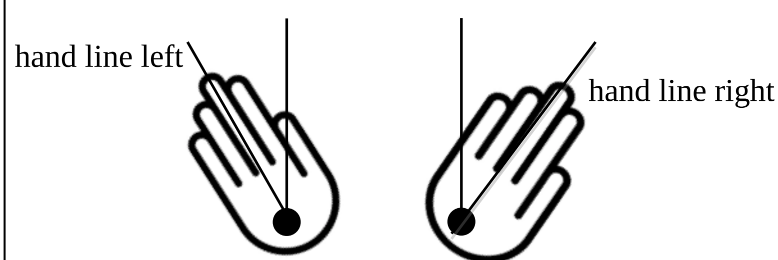
Step 3

Rotate your hand as far as you can to the left without picking your hand off of the paper then trace your hand again. Your wrist and arm must stay flat on the paper.



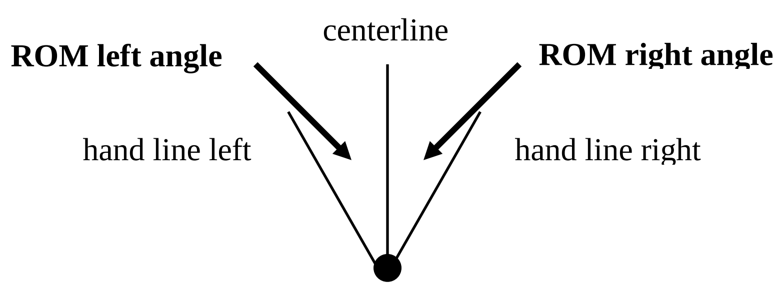
Step 4

Use a ruler to draw a straight line onto the paper starting at the ‘centerline’ circle and passing through the middle of each of the hand tracings you made in Steps 2 and 3.



Step 5

Use a protractor to measure the angle between the ‘centerline’and each of the rotated ‘hand lines’ for both the left and right hand.



Step 6

Enter your rotation data from Steps 1 through Steps 5 into the Range of Motion (ROM) Data Chart then repeat the experiment for your left hand.

Wrist Range of Motion (ROM) Data Chart

_______________ Hand

ROM right _________

ROM left _________

<table>
<tr><td>Unit: The Human Hand Lesson #2
Constructing a robotic hand</td><td>Grade Level/Course:
Intermediate 7/ Life Science</td><td>Duration: 3 class periods
Date:
NOTE: KEEP models for students for week 3 for modifying and improving (gallon baggies per group, labeled)</td></tr>
<tr><td>Common Core and Content Standards</td><td colspan="2">Big Idea: Systems have parts that work together to complete a task.
Essential Questions: How do the parts of the human hand work together to complete a task?

Content Standards:
MS-LS1-3. In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.
MS-LS1-8. Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories.
MS-LS1-d. Design and conduct an investigation to gather evidence to support explanations that the body is a system of interacting subsystems composed of groups of cells working to form tissues and organs specialized for particular body functions, and that scientific advances in understanding of those systems have led to improvements in nutrition, health, and medicine.
Developing and Using Models
Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to support explanations, describe, test, and predict more abstract phenomena and design systems. (MS-ETS1-4)
Influence of Engineering, Technology, and Science on Society and the Natural World
Technologies can have deep impacts on society and the environment, including some that were not anticipated. (MS-LS1-a),(MS-LS1-d)
Science is a Human Endeavor
Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (MS-LS1-d)
Common Core Anchor Standards:
CCSS Reading for Literacy in Science Grade 6-8: 3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
CCSS Speaking and Listening Grade 7: Students engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others’ ideas and expressing their own clearly.
CCSS Writing Grades 6-8: Students produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</td></tr>
<tr><td>Materials/ Resources/ Lesson Preparation</td><td colspan="2">Teacher Resource 2.0a: Robotic Hand Template
Teacher Resource 2.0b: Video Clip: NASA I want to hold your hand
NASA I want to hold your hand video clips parts 1-4 (Part 1:Finger Assembly, Part 2:Finger Assembly Continued, Part 3:Attaching the Fingers to the Palm, Part 4:Attaching the String to the Fingers Map)
Teacher Resource 2.0c: Transcript – I Want to Hold Your Hand
Student Resource 2.1: NASA I want to Hold Your Hand Activity Sheet
Student Resource 2.1a: Flow Map Part 1</td></tr>
</table>

<table>
<tr><td colspan="2"></td><td colspan="2">Student Resource 2.1b: Flow Map Part 2
Student Resource 2.1c: Flow Map Part 3
Student Resource 2.1d: Flow Map Part 4
Student Resource 2.2: Blank Flow Map Activity
Teacher Resource 2.2a: Key: Tiles for Flow Map Activity
Per Student Resources: Piece of Cardboard, centimeter ruler, scissors, tape, drinking straw fishing line, nylon string, or lanyard</td></tr>
<tr><td colspan="2">Objectives</td><td>Content: Using several resources students will create a procedure that will be used to create a mechanical hand. To accomplish this task, students will collaborate with others in addition to working independently.</td><td>Language:
Listening-students will gather information presented in a series of four video clips and write the steps of constructing a bionic hand in flow charts.
Speaking-students will discuss and justify their flow map procedural orders with selected classmates</td></tr>
<tr><td colspan="2">Depth of Knowledge Level</td><td colspan="2">☒ Level 1: Recall ☒ Level 2: Skill/Concept
☒ Level 3: Strategic Thinking ☐ Level 4: Extended Thinking</td></tr>
<tr><td colspan="2">College and Career Ready Skills</td><td colspan="2">☒ Demonstrating independence
☐ Building strong content knowledge
☒ Responding to varying demands of audience, task, purpose, and discipline
☐ Valuing evidence
☐ Comprehending as well as critiquing
☒ Using technology and digital media strategically and capably
☐ Coming to understand other perspectives and cultures</td></tr>
<tr><td colspan="2">Common Core Instructional Shifts</td><td colspan="2">☒ Building knowledge through content-rich nonfiction texts
☒ Reading and writing grounded from text
☒ Regular practice with complex text and its academic vocabulary</td></tr>
<tr><td rowspan="3">Academic Vocabulary (Tier II & Tier III)</td><td rowspan="2">TEACHER PROVIDES SIMPLE EXPLANATION</td><td>KEY WORDS ESSENTIAL TO UNDERSTANDING</td><td>WORDS WORTH KNOWING</td></tr>
<tr><td>model
lanyard</td><td>NASA</td></tr>
<tr><td>STUDENTS FIGURE OUT THE MEANING</td><td>joint
tendon</td><td></td></tr>
<tr><td colspan="2">Pre-teaching Considerations</td><td colspan="2">Watch the videos on constructing the robotic hand
Gather materials (you may want to have students bring in cardboard boxes-provided 2013-2014 school year)</td></tr>
<tr><td colspan="4">Lesson Delivery Comprehension</td></tr>
<tr><td colspan="2">Instructional Methods</td><td colspan="2">Check method(s) used in the lesson:
☐Modeling ☐Guided Practice ☒Collaboration ☒ Independent Practice
☐Guided Inquiry ☒ Reflection</td></tr>
</table>

Lesson Continuum

Lesson Opening	**Prior Knowledge, Context, and Motivation:** **Lesson opening and engagement:** Students are told that soon, they will be creating their own robotic hand and that today, they will be creating a procedure to help guide the construction of their robotic hand. To create this procedure, students will be using a the written procedure from the I Want to Hold Your Hand activity and a series of four video clips to correctly order a list of procedures in a total of four different flow maps.	
Body of the Lesson: Activities/ Questioning/ Tasks/ Strategies/ Technology/ Engagement	**Steps of Construction:** 1. After the lesson introduction, each student will look at the "I Want to Hold Your Hand" lab procedure in their student workbook. Students are then instructed to practice a 5-7 minute unencumbered read of this article. 2. Following this read, students look at the four flow maps in the student workbook that correspond with this day's activities. Students are instructed that their job is to place the letter from each procedural step in the correct order in Flow Map One. This should be done using pencil so that if necessary, students can easily change their answers. Remind students that the steps on the actual flow map are jumbled but that the first and final steps have been completed for them. To accomplish this task, students will work either in pairs or independently (according to student need) and will use the "I Want To Hold Your Hand" written article. 3. After approximately 5 minutes or when students have put the procedural steps in what they believe to be the correct order, they are to compare their results with other classmates in their group and discuss any similarities or differences that they may have. 4. At this point, the teacher instructs the class that in a moment they will be viewing a video clip that will outline the procedures that they just ordered in Flow Map One. While viewing this video, the teacher explains that the students' job is to self-check the order of the procedural steps they placed in flow map one, and to make any necessary corrections to their flow map. To focus the students, the teacher should explain that they will not be allowed to start building their model until all of the procedures in their flow map are placed in the correct order.	**Differentiated Instruction:** **Students Who Need Additional Support:** • Pair share for immediate support and feedback. • Cooperative Groups • Multiple opportunities to speak and receive feedback. • The steps have been printed in boxes that students may cut apart (a page in their student workbook) for those students who have difficulties writing. • The ordering of the procedural steps may be done as a whole class activity. • Teacher proximity to provide immediate feedback for students struggling with the procedural steps. **Accelerated Learners:** • Students are to watch each video clip, and create their own procedural flow map with detailed steps that they create. • All of jumbled procedural steps are combined into one large group and students must match the details to their correct flow map and then in the correct order.

Lesson Continuum			
	Body of the Lesson: Activities/ Questioning/ Tasks/ Strategies/ Technology/ Engagement	5. At this point, the teacher shows the class the NASA video clip part one. After the students have viewed this clip, the teacher will allow the students time to make any adjustments or corrections to their flow map. As a final check, students may check their flow map order with others in the class. 6. When students have completed Flow Map One, they then repeat steps 2-5, completing and revising flow maps 2-4. The teacher should show the corresponding NASA video clip after students have completed the ordering of the procedures in each flow map. Allow students time to make any necessary corrections to their flow map. **7.** Once students have finished writing the correct letters in each of their four flow maps, they should go back and write in the procedural sentences that match each letter. This is important as students will be using these flow maps in Lesson 5 as a major resource to create their robotic hand. This can be done in class or can be assigned as homework. **8. Note: The key to the flow map is provided in Teacher Resource 2.2a.** **Construction of Model Hand Directions For Teachers** <u>Teacher:</u> 1. Check students' accurate completion of the four Flow Charts from Lesson 4 (Parts 1-4) before materials are passed out to students. 2. Have student pair-read the *Purpose* and *Background* of the handout "I Want To Hold Your Hand" while you distribute materials to each group. 3. Teacher gives materials to pairs of students. They should have enough materials so that each of them can construct a hand. 4. Students work together to create the hands using the steps from their flow charts and the pictures from the NASA activity sheet. 5. When students have their hand completed they should try to pick up either an empty soda can, Styrofoam cup, or ping pong ball.	

	If time allows, briefly discuss the extensions that will be completed during Week 3: 1. Think back to when you folded your thumb in toward the palm of your hand in the first lesson. Could they tie their shoes, put a button through a buttonhole, or fasten a snap? Can they catch a ball? If students didn't complete this activity, have them complete it now by wrapping a piece of masking tape around their hand to immobilize their thumb. This is a great contextualizing activity for students who have never had an injury that limited their ROM. 2. Make a Double Bubble Map or Venn diagram to compare their hand to the robotic hand they made. 3. Add more fingers or a thumb to your robotic hand. Does it make a difference? 4. In their science journal, draw or write about some of the things they can and cannot pick up. Write why they think some things cannot be picked up with your robotic hand. How might they make adjustments to their model to improve its function?	

Lesson Reflection	
Teacher Reflection Evidenced by Student Learning/ Outcomes	

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Video Clip – NASA "I want to Hold Your Hand"

From: NASA Summer of Innovation – Engineering – Robotics: I Want to Hold Your Hand
Time: 10 minutes, 34 seconds, broken into 5 shorter clips
Link: http://www.nasa.gov/629824main_I_Want_to_Hold_Your_Hand.m4v

This video clip starts by explaining how robots are used by NASA and then describes how to create a "robotic hand" using cardboard, tape, straws, and string.

Start of Video
(Time for this part of the segment 2:29)

Start for Part One: Finger Assembly (2:29)

Part Two: Finger Assembly Continued (4:41)

Start for Part Three: Attaching Fingers to the Palm (6:16)

Part Four: Attaching the String to the Fingers (7:12)

Transcript of NASA video on “I Want to Hold Your Hand” activity

Welcome to NASA’s Summer of Innovation Lesson Support videos. I’m Steve Culivan, NASA Aerospace Education Specialist at the John C. Stennis Space Center in Mississippi.
This video lesson will guide you through the NASA Summer of Innovation activity, “I Want to Hold Your Hand”. In this activity, we will construct a simple robot hand to help us explore how NASA designs, builds and uses robotic hands, or as they are sometimes called, end effectors.

Robotics has always been a major component of NASA missions and research. We use robots to study our Earth and worlds far out in our solar system or beyond. The word “robot” comes from a Czechoslovakian word, robota, meaning “forced labor” and was first used in 1920. We like to think of robots as giving us a hand. One place we currently use robots is on the International Space Station.

These robots assist the astronaut crew to keep the space station in top working condition. Onboard the ISS you may find astronauts using a robotic arm to work outside the space station. Or you might find R2 (Robonaut 2) – a dexterous robot helping with work inside the space station.

Here are some images of an end effector at the end of a robotic arm on the International Space Station. These end effectors are what is used to grapple objects and move them around. Their use is similar to our human hands but mechanically much simpler as you see in these images. The image on the right is an image of the space station robotic arm itself. The image on the left is a close-up looking inside the end effector. This end effector uses a series of three cables that rotate and criss-cross each other to grapple objects.

This is an example of a NASA robot that has end effectors, or hands, similar to you and me. This is Robonaut 2, otherwise known as R2. a helping hand with work in the space station.

In the activity, “I Want to Hold Your Hand”, we’ll construct a working robot end effector model that more closely matches our own hands. These are the materials you’ll need.

This materials list can be found on page one of the activity.

Before you begin, I want to share some helpful tips I have discovered over the years. First, no matter what age you are working with it really helps to cut those rubber bands, straws, and strings ahead of time. If the students cut out the cardboard make sure you have rulers with centimeter measurements and scissors that can cut through cardboard. If you want to save time or need to cut the pieces for smaller children, you can cut the pieces ahead of time and have them ready to go in individual sets. Students can also work in cooperative teams of two or three for this activity.

Now, I’ll be using a separate camera to show you how we do each step in the construction of our robot hand.

Part 1:
The 10 cm X 10 cm piece of cardboard will represent the palm of your robot hand (You can place that to the side for now). To start, the three 2 cm X 9 cm pieces will each represent one finger. Take one of the “finger” pieces of cardboard and cut into three equal length as shown in this image.

To complete the next step, place the three equal finger pieces together with the short side of the rectangles as the joints. Next, use a piece of tape to reconnect them. Label the side of the finger with the tape “inside”.

PART 2:
Cut a rubber band 5 cm long. Next, turn the segmented finger over so the “inside” is facing down. Put the rubber band across the middle of the first joint. Tape the rubber band on both sides of the joint, making sure to leave about ½ centimeter of the ends of the rubber band untaped.

Fold the untaped ends of the rubber band so that they rest on top of the tape and tape them firmly in place.

This extra taping prevents the rubber bands from slipping.
Now, we repeat these steps for the second finger joint.

PART 3:
Now, turn the finger over so the “inside” is facing up and tape the finger to the “palm”.
Turn your hand back over so the “inside” is once again facing down. Tape another 5 cm piece of rubber band across the last joint onto the palm the same way we did the first two finger joints.

You will repeat these steps for each of the other remaining fingers.

After the other two fingers have been completed, cut three pieces of nylon string each 35 cm long. It is best to tie a knot on each end of the string to keep them from unraveling. Tape the end of one piece of string onto the end of the first finger on the side with rubber bands.
When taping the string, let the knot at the end hang out from the tape. This will help prevent the string from slipping out the tape.

Turn the hand over so the rubber bands are facing down. Cut four pieces of straw 2 cm each and thread each piece of straw through the string taped onto the finger.

Tape a piece of straw onto each finger segment and onto the palm. Be sure not to tape the string to the straws or joints.

Repeat the steps we used to build this finger to construct the other two fingers.

Congratulations! You now have a robot hand. You can operate the fingers by pulling on the strings. The string simulates the muscles in our hand and the rubber bands simulate the tendons.

Now that you have your robot hand constructed, you can have your students use their robot hand and discuss the "Conclusion" questions in the activity. Also, observe the "Extensions" in the activity to challenge your students to design and build different and perhaps better robot hands with more functionality.

http://robonaut.jsc.nasa.gov/default.asp

To see what robotic hands can do, you can follow the adventures of Robonaut 2 on Robonaut's website and see how this dexterous robot's hands are put to work at NASA!

http://www.nasa.gov/audience/foreducators/robotics/home/index.html

You can also visit the NASA Robotics website to explore even more about NASA and robotics. Thank you for joining us as we explore robotics together in NASA's Summer of Innovation! And, special thanks to the many education specialists and the NASA Digital Learning Network who helped make this video lesson possible.

2004–20 N05 ASA SCI Files™

National Aeronautics and Space Administration

I Want To Hold Your Hand

Purpose

To construct a robotic-like hand and to demonstrate how data are collected when using robotic technology.

Background

A robot is a machine that collects information from its surroundings. It uses that information to follow instructions and to complete a task. Today's Robots have multiple sensors and are able to make their own decisions based on given information. Robots come in all shapes and sizes. The jobs they do are also varied. Some robots are used in factories. Others are experimental robots that use artificial intelligence. Artificial intelligence allows robots to behave more like human beings and to act independently in a changing environment. Today, robots are used in hospitals, space and ocean exploration, and other dangerous areas.

Materials Per Person

Narrow rubber bands

Drinking straws

Cardboard

Tape

Scissors

Nylon cord, fishing line, or lanyard

Centimeter ruler

Pen

Procedure

1. To make the palm of the robotic hand, cut a piece of cardboard 10 cm x 10 cm.
2. To make the fingers, cut three pieces of cardboard 2 cm x 9 cm.
3. To make one of the fingers jointed, cut one of the cardboard pieces into three equal pieces. See diagram 1.

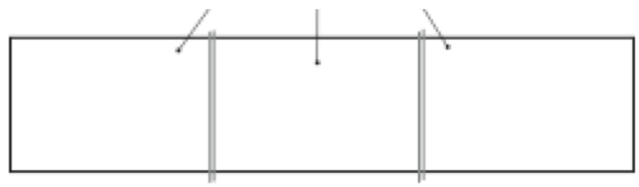


Diagram 1

4. Place the three equal finger pieces back together and use tape to reconnect them. Label one side of the taped finger "inside." See diagram 2.

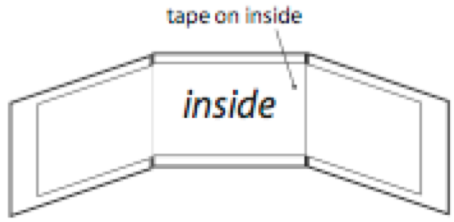


Diagram 2

5. Cut a rubber band 5 cm long.
6. Turn the segmented finger over so the "inside" is face down.

7. Put the rubber band across the middle of the first joint. See diagram 3.

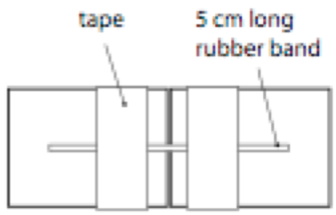


Diagram 3

8. Tape the rubber band on both sides of the joint, making sure to leave the ends of the rubber band untaped.
9. Fold the ends of the rubber band so that they rest on top of the tape and tape them firmly in place. See diagram 4. Taping prevents the rubber bands from slipping.

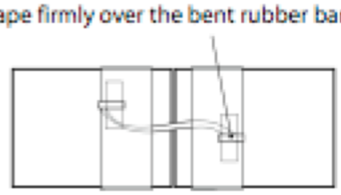


Diagram 4

10. Repeat steps 5 through 9 for the second joint.
11. Tape the finger onto the palm with “inside” facing up.
12. Turn the hand over.
13. Cut a rubber band 5 cm long.
14. Put the rubber band across the last joint (touching the palm).

15. Repeat steps 8–9 for the last joint, connecting the finger to the palm. See diagram 5.

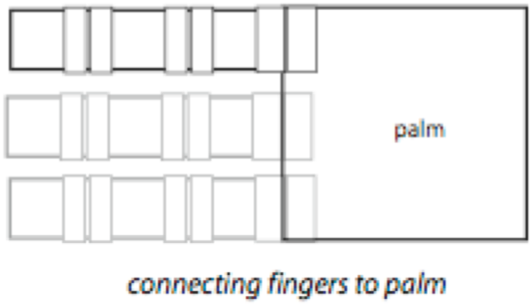


Diagram 5

16. Cut a piece of nylon cord 35 cm long.
17. Tape one end of the nylon cord over the end of the finger. See diagram 6.

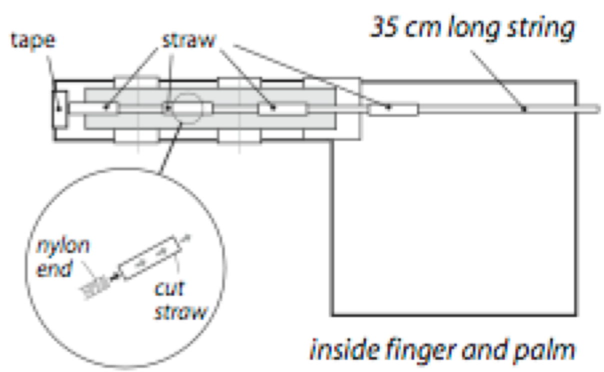


Diagram 6

18. Cut four pieces of straw 2 cm each.
19. Thread the pieces of straw onto the nylon cord.
20. Tape a piece of straw in the middle of each finger section.

21. Tape the last straw to the palm. See diagram 7.

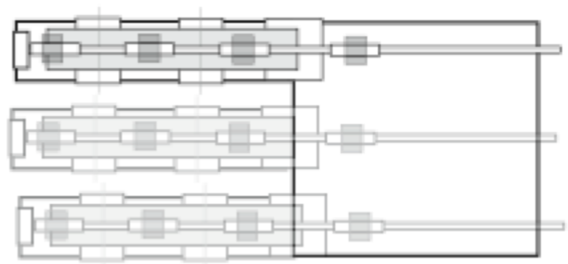


Diagram 7

22. Repeat steps 3–21 for the last two fingers.
23. Operate the hand by pulling the nylon cord.
24. You should be able to pick up an empty soda can or other lightweight objects.

Tips:

- May need to cut the tape pieces to make them thinner.
- Make sure the rubber bands are taped firmly. If there is any loose area, the hand will not work properly.

Conclusion

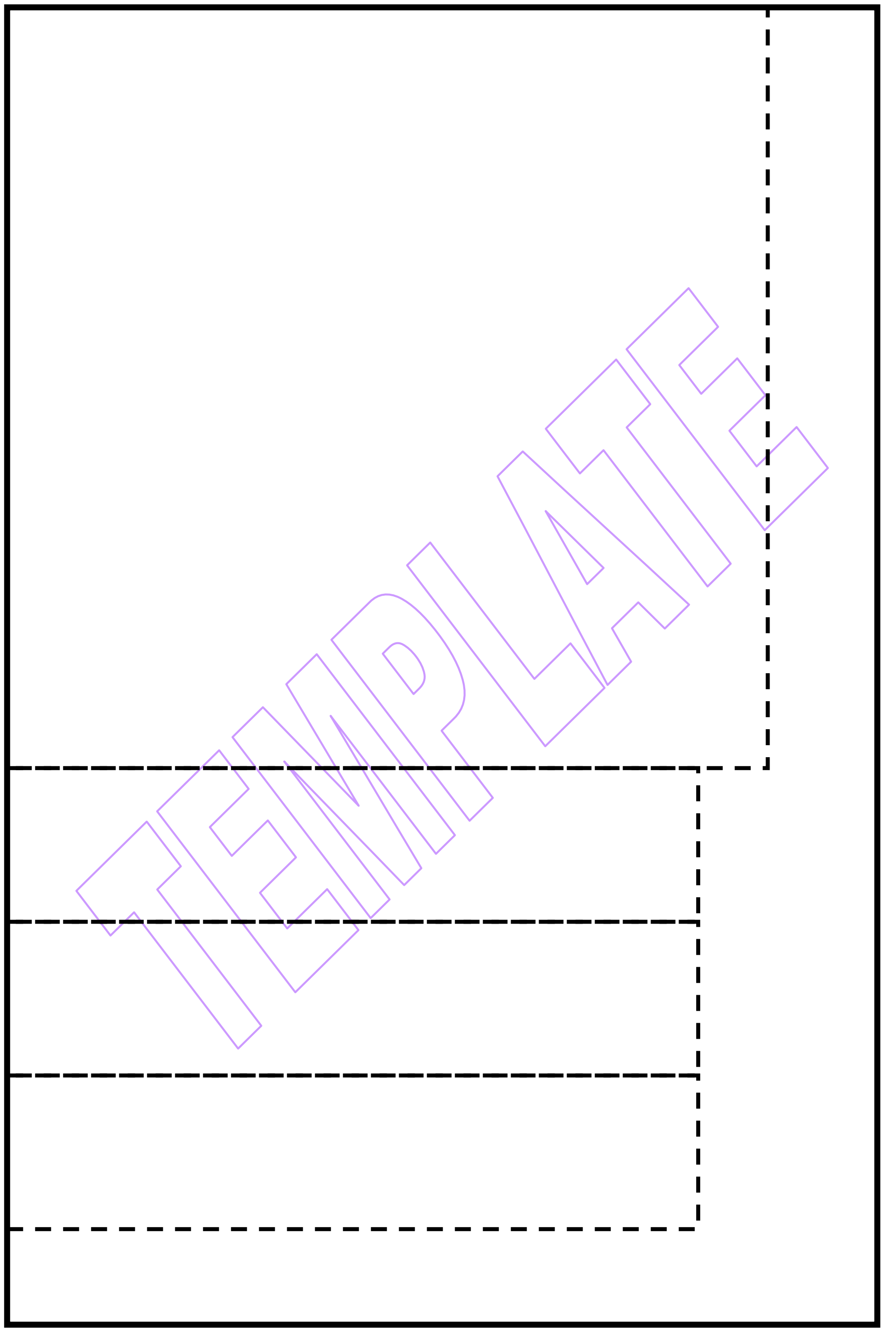
1. What items can you pick up with your robotic hand? You need to be able to at least pick up a crumpled piece of paper. Can you complete this task? If not, what is wrong with your robotic hand that prevents you from picking up the paper?

2. What would happen if you added more fingers? Think about this for the Engineering Process at then end where you will have opportunity to redesign your project in the last week.

3. What would happen if you added a thumb? Think about what happened when you taped your thumb to the palm of your hand. Again, think about ways you might want to modify your hand.

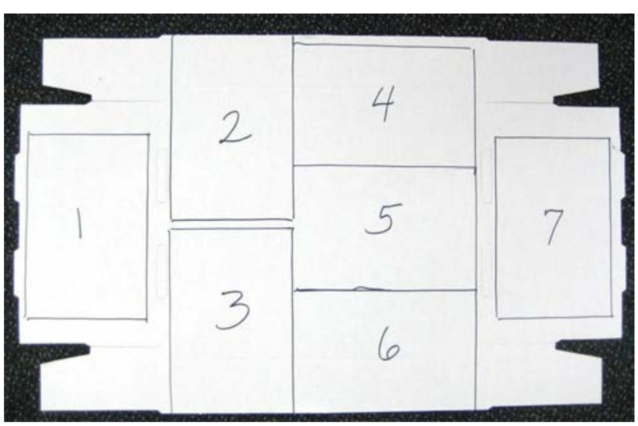
4. Why is it difficult to pick up certain items with your robotic hand? Are they to big, too heavy, too long?

Robotic Hand Template for Grade 7 Science Common Core Unit - Bionic Hand



Width of cardboard: 11.5 cm

Height of cardboard – 17.5 cm



Cardboard Tray/
Student Storage

SAUSD Warehouse
W036340

Placement of template to get 7 hands out of each piece

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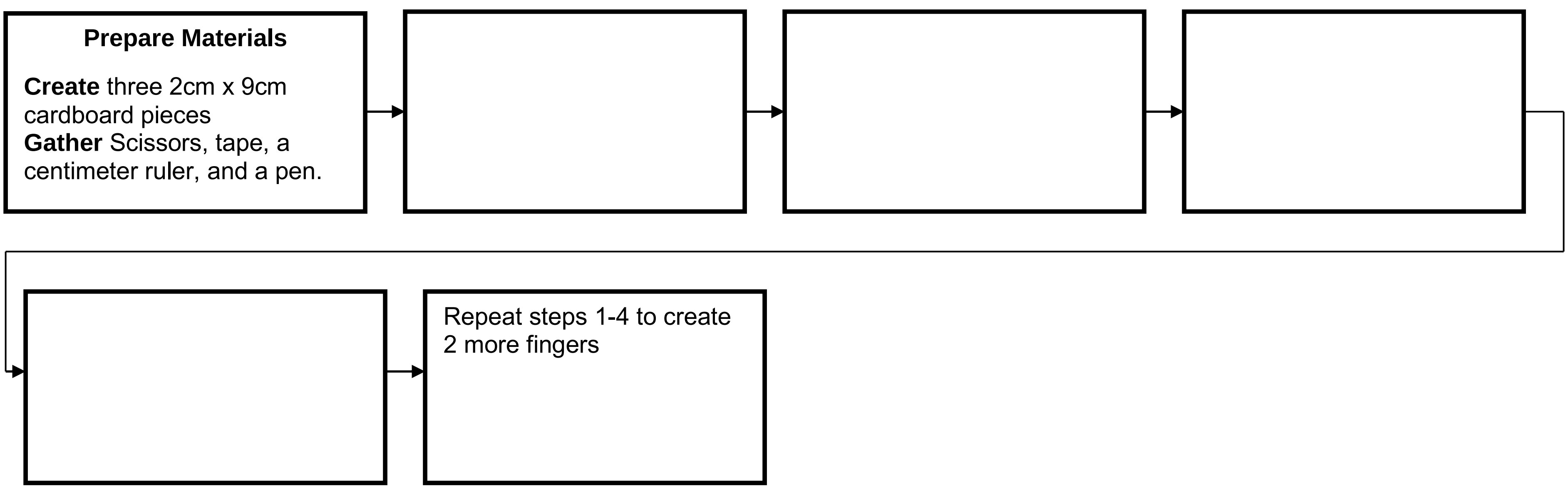
Part One: Finger Assembly

Directions-Use the procedure section from the **I Want to Hold Your Hand** handout to arrange steps A-D in order. When you have figured out the correct order, and confirmed with your teacher, write the sentences in their correct order in the Flow Map below. Notice the first and final boxes have been completed for you. Self check the order of your flow map procedure when you watch the video. Use pencil to make revisions easier.

NOTE: These are NOT in the correct order. You need to determine the correct order.

A. Use a piece of tape to reconnect them
B. Cut 1 piece of cardboard into three equal lengths
C. Label the side of the finger with tape "inside"
D. Place the three equal finger pieces together

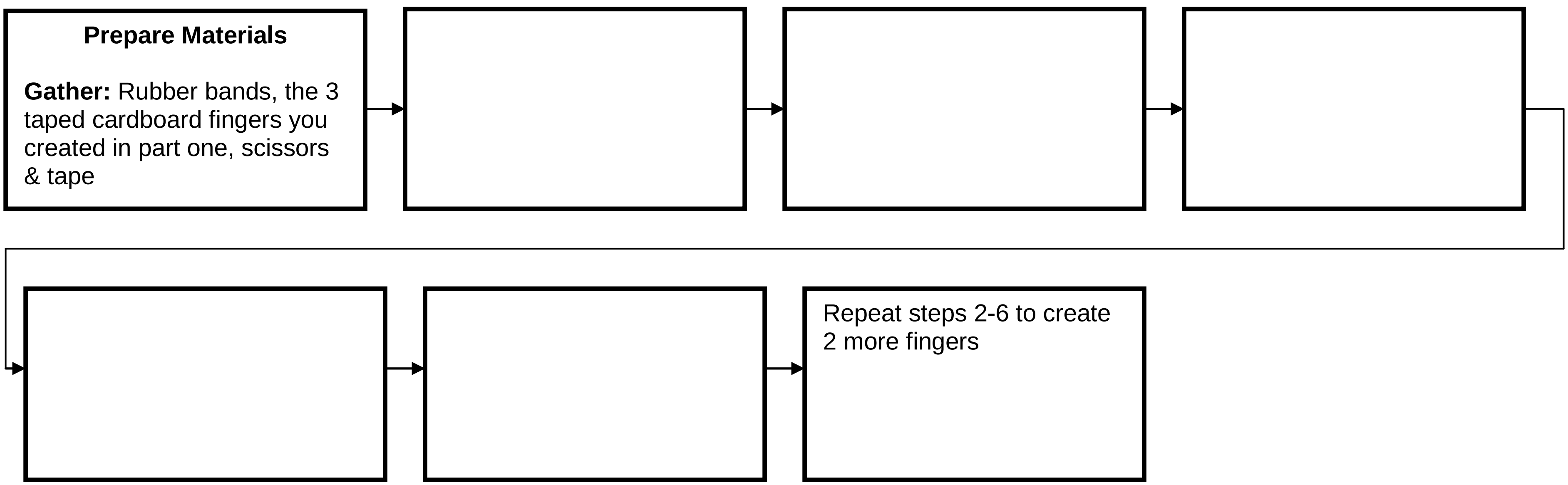


Part Two: Finger Assembly Continued

Directions-Use the procedure section from the **I Want to Hold Your Hand** handout to arrange steps A-E in order. When you have figured out the correct order, write the sentences in their correct order in the Flow Map below. Notice the first and final boxes have been completed for you. Self check the order of your flow map procedure when you watch the video

NOTE: These are NOT in the correct order. You need to determine the correct order.

A. Tape the rubber band on both sides of the joint, leave about ½ centimeter of the ends of the rubber band un-taped
B. Cut a rubber band 5 cm long
C. Put the rubber band across the middle of the first joint.
D. Turn the cardboard finger over so the "inside" is facing down
E. Fold the un-taped ends of the rubber band so that they rest on top of the tape and tape them firmly in place



Part Three: Attaching the Fingers to the Palm

Directions-Use the procedure section from the **I Want to Hold Your Hand** handout to arrange steps A-C in order. When you have figured out the correct order, write the sentences in their correct order in the Flow Map below. Notice the first and final boxes have been completed for you. Self check the order of your flow map procedure when you watch the video

NOTE: These are NOT in the correct order. You need to determine the correct order.

A. Turn your hand back over so the "inside" is once again facing down.
B. Tape another 5 cm piece of rubber band across the last joint onto the palm the same way we did the first two finger joints.
C. Turn the finger over so the "inside" is facing up and tape the finger to the "palm"

Prepare Materials
Create: One 10cmx10cm cardboard palm
Gather: Rubber bands, the 3 taped cardboard fingers that you built in parts one and two. centimeter ruler & tape.

→ [ ] → [ ] → [ ] →

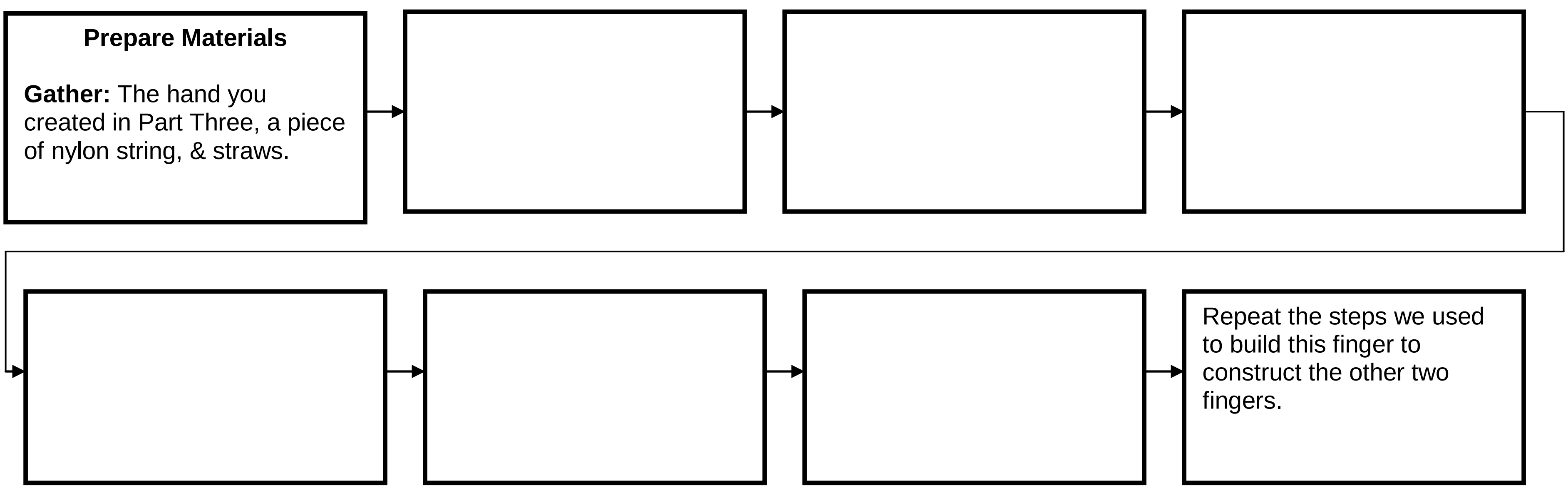
You will repeat these steps for each of the other remaining fingers.

Part Four: Attaching the String to the Fingers

Directions-Use the procedure section from the **I Want to Hold Your Hand** handout to arrange steps A-F in order. When you have figured out the correct order, write the sentences in their correct order in the Flow Map below. Notice the first and final boxes have been completed for you. Self check the order of your flow map procedure when you watch the video

NOTE: These are NOT in the correct order. You need to determine the correct order.

A. Turn the hand over so the rubber bands are facing down
B. Cut four pieces of straw 2 cm each and thread each piece of straw through the string taped onto the finger
C. When taping the string, let the knot at the end hang out from the tape
D. Tape a piece of straw onto each finger segment and onto the palm. Be sure not to tape the string to the straws or joints
E. Cut three pieces of nylon string each 35 cm long, and tie a knot on each end of the strings
F. Tape the end of one piece of string onto the end of the first finger on the side with rubber bands



Part One: Finger Assembly

Use a piece of tape to reconnect them

Cut 1 piece of cardboard into three equal lengths

Label the side of the finger with tape “inside”

Place the three equal finger pieces together

Part Two: Finger Assembly Continued

Tape the rubber band on both sides of the joint, leave about ½ centimeter of the ends of the rubber band un-taped

Cut a rubber band 5 cm long

Put the rubber band across the middle of the first joint.

Turn the cardboard finger over so the “inside” is facing down

Fold the un-taped ends of the rubber band so that they rest on top of the tape and tape them firmly in place

Part Three: Attaching the Fingers to the Palm

Turn your hand back over so the “inside” is once again facing down.

Tape another 5 cm piece of rubber band across the last joint onto the palm the same way we did the first two finger joints

Turn the finger over so the “inside” is facing up and tape the finger to the “palm”

Part Four: Attaching the String to the Fingers

Turn the hand over so the rubber bands are facing down

Part Four Continued: Attaching the String to the Fingers

Cut four pieces of straw 2 cm each and thread each piece of straw through the string taped onto the finger

When taping the string, let the knot at the end hang out from the tape

Tape a piece of straw onto each finger segment and onto the palm. Be sure not to tape the string to the straws or joints

Cut three pieces of nylon string each 35 cm long, and tie a knot on each end of the strings

Tape the end of one piece of string onto the end of the first finger on the side with rubber bands

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SAUSD Common Core Lesson Planner Teacher:

Unit: The Human Hand Lesson #: 3 *Structures of the Hand*	**Grade Level/Course:** Grade 7/ Life Science	**Duration:** 2 class periods **Date:**
Common Core and Content Standards	**Big Idea: Systems have parts that work together to complete a task.** **Essential Questions: What structures are found in the human hand?** **How do parts of the human hand work together to complete a task?** **Content Standards:** **MS-LS1-3.** In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions**.** **MS-LS1-8.** Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. **MS-LS1-d.** Design and conduct an investigation to gather evidence to support explanations that the body is a system of interacting subsystems composed of groups of cells working to form tissues and organs specialized for particular body functions, and that scientific advances in understanding of those systems have led to improvements in nutrition, health, and medicine. **Developing and Using Models** Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to support explanations, describe, test, and predict more abstract phenomena and design systems. (MS-ETS1-4) **Influence of Engineering, Technology, and Science on Society and the Natural World** Technologies can have deep impacts on society and the environment, including some that were not anticipated. (MS-LS1-a),(MS-LS1-d) **Science is a Human Endeavor** Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (MS-LS1-d) **Common Core Anchor Standards:** **CCSS Reading for Literacy in Science Grade 6-8**: 3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. **CCSS Speaking and Listening Grade 7:** Students engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly. **CCSS Writing Grades 6-8:** Students produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	

<table>
<tr><td>Materials/ Resources/ Lesson Preparation</td><td colspan="3">Teacher Resource 3.0a: Jigsaw for Structures of the Hand articles KEY
Student Resource 3.1: Jigsaw for Structures of the Hand articles
Student Resource 3.2: Anatomy of the Hand
Student Resource 3.2a: Bones and Joints Article
Student Resource 3.2b: Ligaments Article
Student Resource 3.2c: Muscles in the Hand Article
Student Resource 3.2d: Tendons in the Hand Article
Student Resource 3.3: Sample Language to use to Discuss the Structures of the Hand</td></tr>
<tr><td>Objectives</td><td colspan="2">Content:
Students will be able to describe the parts of the hand and the functions.</td><td>Language:
In groups of four, students will act as experts and write down and verbally express facts pertinent to their assigned part of the hand.

Students will listen to information presented verbally by their peers and summarize important facts about the hand.</td></tr>
<tr><td>Depth of Knowledge Level</td><td colspan="3">☒ Level 1: Recall ☒ Level 2: Skill/Concept
☐ Level 3: Strategic Thinking ☐ Level 4: Extended Thinking</td></tr>
<tr><td>College and Career Ready Skills</td><td colspan="3">☐ Demonstrating independence
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<tr><td>TEACHER PROVIDES SIMPLE EXPLANATION</td><td>palm
wrist
forearm</td><td>flexor
joint
extend
complex
precision</td></tr>
<tr><td>STUDENTS FIGURE OUT THE MEANING</td><td>bone
joint
muscle
tendon
ligament</td><td></td></tr>
</table>

<table>
<tr><td>Pre-teaching Considerations</td><td colspan="2">Before beginning this lesson you will need to have students sitting in groups of four. This will be their Base Group. You also need to have four areas with enough space for 8-10 students each in the classroom where the expert groups will move to.
**NOTE: Try to have enough space between the Expert Groups so their conversations don't interfere with the other groups.

Base Groups:
The Base Group should be made up of 4 students, one for each Expert Group. After the students get information in their Expert Groups they will return to the Base Group to tell the other students in their Base Group the information to write into their Jigsaw chart.

Expert Groups:
There will be four Expert Groups. In the Expert Groups students will read, discuss, and come to consensus about the main ideas/information needed to fill in their part of the matrix, and have a chance to practice what they will report back orally to their Base Groups.</td></tr>
<tr><td colspan="3">Lesson Delivery Comprehension</td></tr>
<tr><td>Instructional Methods</td><td colspan="2">Check method(s) used in the lesson:
☒Modeling ☒Guided Practice ☒Collaboration ☒ Independent Practice
☐Guided Inquiry ☒ Reflection</td></tr>
<tr><td>Lesson Opening</td><td colspan="2">Preparing the Learner:
1. The teacher has students take a minute to reflect on what they learned so far about the hand. Teacher explains what a generalization is and its purpose and the teacher models general statements on familiar topics. For example, "A knee joint is a hinge joint and bends like a hinge on a cabinet. The top of human ears is level with our eyes. We use more muscles to frown than smile."
2. Each group will write down a general statement "When I think about how my hands work, I think about..." (you may want to use sentence strips or construction paper for these general statements)
3. Then taking turns, group will orally say their statement and the teacher will post them on the wall. With teacher's, have students help note similarities in their ideas, and perhaps come up with a representative group of general statements. The goal of using these statements to either support or refute evidence from upcoming text.</td></tr>
<tr><td>Body of the Lesson:
Activities/ Questioning/ Tasks/ Strategies/ Technology/ Engagement</td><td>Interacting with the Text:
Have students examine the structures of the hand on the Hand Anatomy graphic provided in the student workbook. Be sure students know the basic parts of the hand (fingers, thumb, wrist, and arm).

Jigsaw Activity on Structures of the Hand
1. The students should already be seated in their Base Groups. **Note: Have four stations where the expert groups will move to. Locate these throughout the classroom in places that will maximize the distance between the four groups. Each student will have a copy of the article for their base group in their Student Workbook. The stations are as follows:</td><td>Differentiated Instruction:

Students who need additional support
• Pair share
• Clarifying bookmarks
• Multiple opportunities to speak and develop academic language</td></tr>
</table>

Body of the Lesson: Activities/ Questioning/ Tasks/ Strategies/ Technology/ Engagement	Station 1 – Bones & Joints (Lexile 1188) Station 2 – Ligaments (Lexile 1273) Station 3 – Muscles (Lexile 1300) Station 4 – Tendons (Lexile 1530) **NOTE on LEXILE**: Technical language in these articles significantly increased lexile level, though it is NOT the emphasis for students when reading. The associated task with these articles is lower in complexity, balancing the advanced lexile. Remind students it is OKAY if they do not understand every technical term in the article. 2. The teacher will assign each student a number that corresponds to the station they where will be going (1, 2, 3, or 4). 3. The teacher will send students to their assigned station (expert group). (There should be 8-10 students per station in a class of 32-40 students). **First Read:** 1. When the students are settled, the teacher will tell the students they will be reading their article silently on their own for 6 minutes. The teacher will remind them that the goal is not necessarily to finish in the allotted time, but to understand what they do read. These are difficult articles due to new vocabulary terms, but not impossible! Also, if they finish before time is called, the students should reread their article. The Teacher will focus the students' attention on looking for: a) a general description of their part of the hand b) the various functions of their part of the hand c) the possible limitations when that part of the hand is injured The teacher will note the time and instruct students to begin reading. The teacher will call out how many minutes remain at the end of each minute. At the end, the teacher will remind students that it is acceptable if they did not finish. They will have other chances to finish reading the article. **Second Read:** 2. When pairs of students finish their 1st read, the teacher will have students look at the Parts Of The Hand matrix in their student workbook. Tell students that they will NOT be writing in the matrix yet, they are just using it to guide their reading. 3. Each student with their partner will reread their article with a pencil in hand, marking the answers to the questions on the matrix that corresponds with their structure.	• Copy of their article to take home to pre-read or provide continual support • Cooperative groups to build capacity and complexity of argument **Accelerated Readers** • Students could create podcasts of the jigsaw articles for other students to listen to.

<table>
<tr><td rowspan="1">Body of the Lesson:
Activities/ Questioning/ Tasks/ Strategies/ Technology/ Engagement</td><td>4. At the conclusion of the silent read, encourage students to finish reading or reread as necessary. Students should then discuss their group answers within their expert groups. Once they come to consensus on the best answer they will write the information on their own matrix.
5. Be sure to give the expert groups time to rehearse what they will say when they report back to their base groups. Tell students that they are required to use key science terms and academic language when sharing the information with their base group.

Return to Base groups:
1. With at least 20 minutes remaining, direct students to go back to their "base groups".
2. The teacher should assign a random student to begin in each base group. This will ensure that the students don’t listen to what groups near them are saying and change their own responses.
3. That first expert student will orally share which part of the hand they read about and explain the information to fill in on that section of the Jigsaw matrix. As the first expert is sharing his/her information, the other members of the base group will take notes on the Jigsaw Matrix.

NOTE: Students should not copy from the other students’ charts. It is important that they tell the other students the information so they have the opportunity to practice the academic language.
4. Once the Jigsaw Matrix is completed, provide students with the opportunity to practice using the scientific terms with their peers (in pairs or base groups). For examples, students can ask each other questions and respond using sample language frames provided in the Student Workbook</td><td></td></tr>
<tr><td></td><td>Extending the Learning

Range of Motion Application – Refer back to the Range of Motion Activity that students either completed in class in Lesson 1 or did for homework. Have students compare their Range of Motion with their partner’s Range of Motion. What may be the cause for any differences? They should refer back to their Jigsaw Matrix for the names and functions of the structures in the hand.
NOTE: This is a great opportunity for data analysis and working with students to look for patterns, trends, and outliers in a pool of data.</td><td></td></tr>
<tr><td colspan="3">Lesson Reflection</td></tr>
<tr><td>Teacher Reflection Evidenced by Student Learning/ Outcomes</td><td colspan="2"></td></tr>
</table>

Name: ___________________________ Period: _____

Jigsaw Matrix – Parts of the Hand KEY

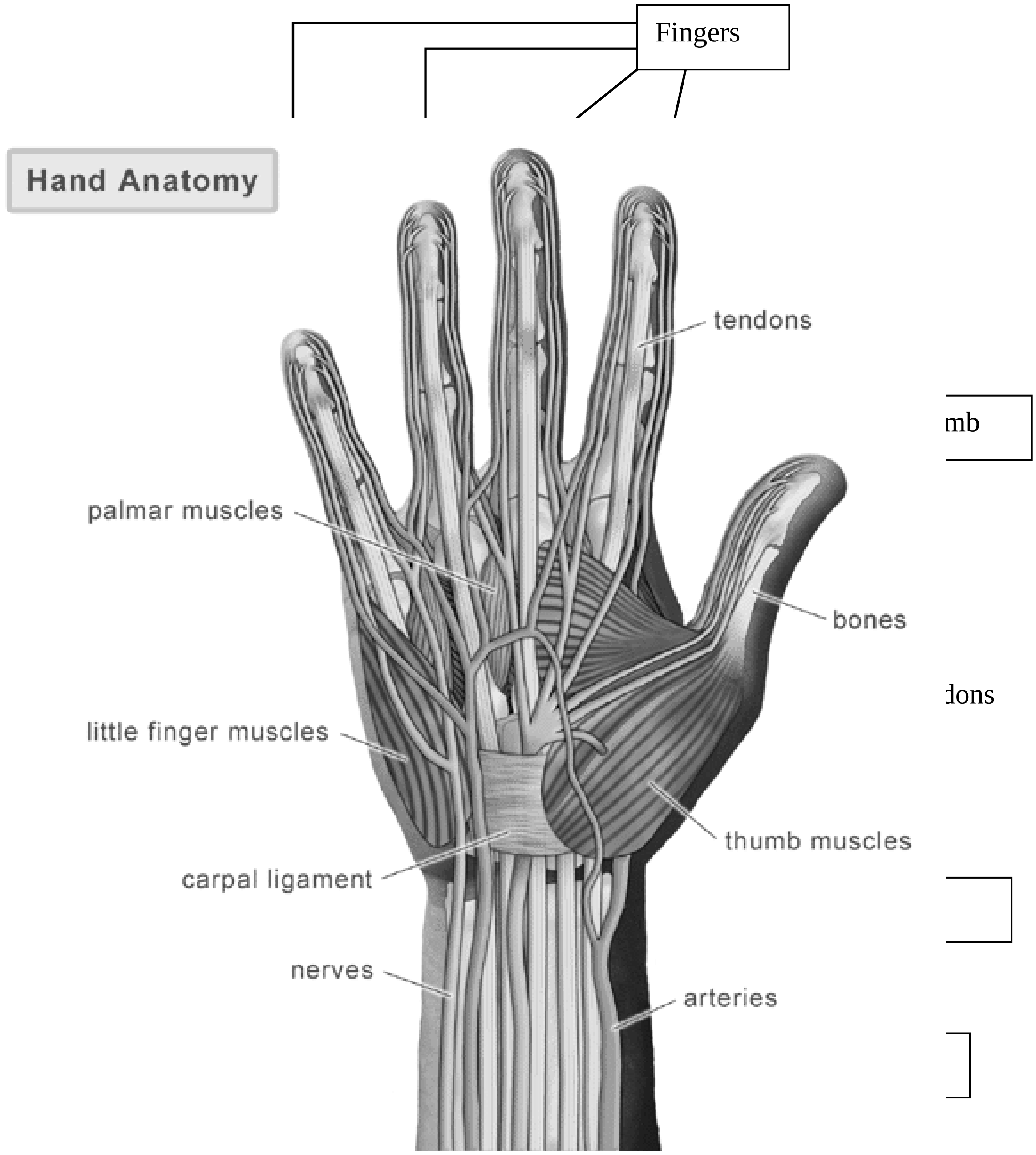
	Bones & Joints	Ligaments	Muscles	Tendons
Material in the "Bionic Hand Model" (Day 4)	Cardboard	Tape holding cardboard together	student pulling on strings or fishing line	string or fishing line
Describe this part of the hand.	Hard white long sticks	White	Look like meat. Made of long fibers.	Connective tissue that is very stringy like a rope.
What is the function of this part of the hand?	Give structure to the hand.	Connect bones to bones.	Muscles are connected to bones by tendons. Muscles can contract to move parts of the hand.	Connect muscles to bones.
What is one interesting fact about this part of the hand?	There are 27 individual bones in the hand.	A sprain is an injury that damages a ligament.	The muscles that move the hand are in the forearm.	Tennis elbow is caused by inflamed tendons.

Name ___________________________ Period _________

Jigsaw Matrix – Parts of the Hand

	Bones & Joints	Ligaments	Muscles	Tendons
Material in the "Bionic Hand Model" (Day 4)				
Describe this part of the hand.				
What is the function of this part of the hand?				
What is one interesting fact about this part of the hand?				

Structure of the Hand



Graphic from:
http://maksimiliana.pl/3/anatomy-of-hand

Bones and Joints

The human hand has a complex structure made up of a total of 27 individual bones: 8 carpal bones, 5 metacarpal bones, and 14 finger bones (also called phalanges [fah-lan´jēz]) are connected by joints and ligaments. About one fourth of all our body's bones are found in our hands.

The hand can be viewed in three sections by joint function:

Wrist

The wrist is made up of two parts working together as one functional unit. It allows us to flex or extend the hand. The hand can also be tilted in the direction of the little finger or the thumb.

Carpus

The carpal bones are held together tightly by ligaments, and are more or less fixed in relation to one another. They form two rows: four carpal bones are in the first row closer to the forearm. Two of these, together with the radius bone form the inferior radioulnar joint, which is very important for the movement of the hand. The ulna is separated from the carpal bones by a cartilage disc. The other joint is located between the two rows of carpal bones.

Metacarpus

The metacarpus extends from the second row of the carpal bones. It has five elongated metacarpal bones. You can feel them quite well through the skin on the back of your hand. One of the metacarpal bones together with the thumb's proximal phalanx makes up the carpometacarpal joint of the thumb, giving the thumb better freedom of movement compared with the other fingers.

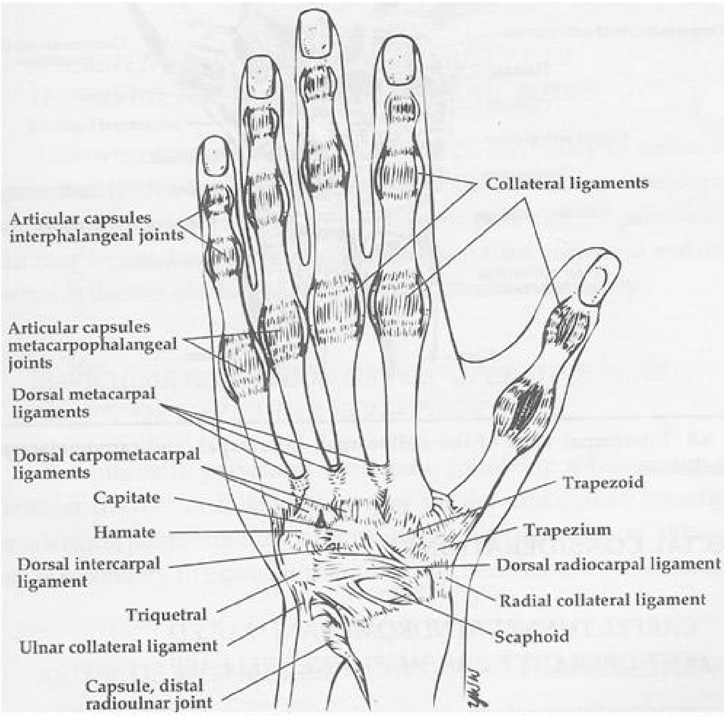
Fingers

The five fingers make up the freely moveable part of the hand. Each has three individual bones – except for the thumb, which has only two. In each of these four fingers there are three hinge joints, which can only be extended away (extension) or bent inwards (flexion). The thumb, however, can also rotate owing to the carpometacarpal joint so that it can also be positioned opposite the other four fingers.

Adapted from: Informed Health Online [Internet]. Cologne, Germany: Institute for Quality and Efficiency in Health Care (IQWiG); 2006-. How does the hand work? 2010 Aug 31 [Updated 2012 Jan 12]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK83668/

Ligaments in the Fingers and Hand

Hand ligaments are tough but flexible bands of tissues that connect the bones of the human hand with each other and with the bones of the wrist and forearm. While the fibrous bands of tissues called ligaments can serve to connect bones to cartilage or other tissues, they most often connect bone to bone and serve to keep joints intact.



Dorsal view of the radiocarpal, intercarpal, and carpometacarpal articulations

http://www.prolo.ca/images/hand1.jpg

The hand is given structure and flexibility by hand ligaments, which bind together the various small bones that make up the hand and connect it to the wrist. Two large ligaments bind the bones of the hand and wrist to the radius, a bone of the forearm. The first is on the back of the hand and is called the dorsal radiocarpal ligament, and the second, on the palm side of the hand, is called the palmar radiocarpal ligament.

A sprain is an injury that damages a ligament. Grade 1 and 2 sprains are less severe. The internal structure of the ligament in damaged but the ligament remains intact. Grade 3 sprains are more severe. They include complete tears of the ligament. Grade 3 sprains are sometimes called torn or ruptured ligaments.

Symptoms of a sprain may include:

Pain immediately after the sprain
A popping sound
Local swelling, often within minutes
Bruising
Trouble moving the joint

Information from:
http://www.wisegeek.com/what-are-hand-ligaments.htm
http://www.bidmc.org/YourHealth/ConditionsAZ/LigamentSprain.aspx

Muscles in the Hand

The hand and forearm, connected by the wrist, make up a functional unit. There are over 30 muscles in the hand and forearm, working together in a highly complex way.

Long forearm muscles
Movements of the hand are mostly started by muscles in the forearm. Only the thin tendons of these muscles are directly a part of the hand: the extensor tendons used for extending the hand run through the back of the hand to the tips of the fingers, and the flexor tendons run through the palms to the fingers.

Short hand muscles
The short muscles of the hand lie between the individual metacarpal bones. They allow us to spread our fingers (abduction) and then press them back together (adduction). They also help us to flex the metacarpophalangeal joints and extend our fingers.

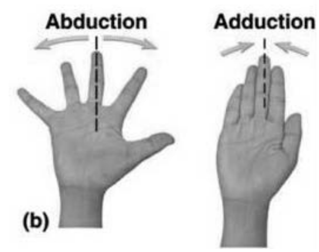


Figure 1 Found at http://anatomystudybuddy.files.wordpress.com/2012/09/abduction-adduction2.jpg?w=470&h=353

The thenar eminence and the hypothenar eminence muscles
Two groups of more powerful muscles in the hand itself make up the thenar eminence (at the base of the thumb) and the hypothenar eminence (controlling the little finger). The thenar eminence helps the thumb to move. This includes the essential movement of opposition, allowing the thumb and the tips of the remaining four fingers to touch. A separate muscle for flexing (adductor) can help move the thumb towards the palm. The muscles of the hypothenar eminence are mainly used for extending and bending the little finger, as well as for tightening the skin that covers the hypothenar eminence.

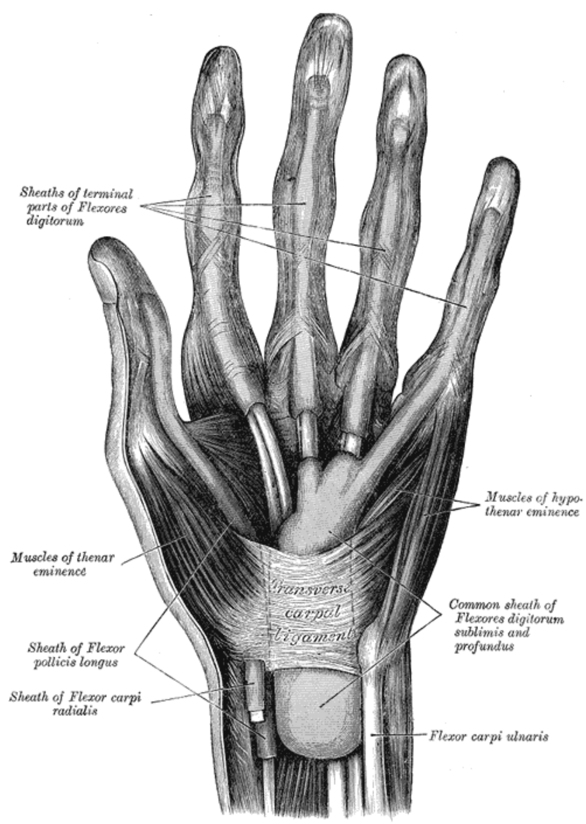


Figure 2"The mucous sheaths of the tendons on the front of the wrist and digits." Henry Gray's Anatomy of the Human Body, 1918.

Lumbricals
The lumbricals of the hand are four thin, worm-shaped muscles that help bend the metacarpophalangeal joints and extend the fingers.

Adapted from: Informed Health Online [Internet]. Cologne, Germany: Institute for Quality and Efficiency in Health Care (IQWiG); 2006-. How does the hand work? 2010 Aug 31 [Updated 2012 Jan 12]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK83668/

Tendons in the Hand

The hand and forearm, connected by the wrist, make up a functional unit. There are over 30 muscles here, working together in a highly complex way. Each muscle is connected to a bone by a tendon.

Tendons that Control the Hand

One example of how tendons work in the forearm and hand are found in the extensor muscles.

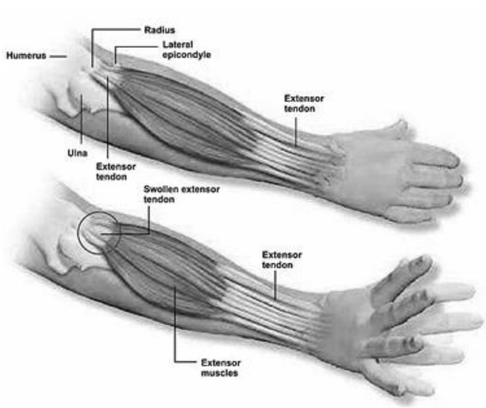


Figure 1
http://www.orthoneuro.com/sites/default/files/tennis-elbow.jpg

Inside the Elbow

The muscles that pull the wrist back are called extensor muscles. These muscles joint together and attach to a single tendon at the elbow. This tendon, called the common extensor tendon, attaches to the lateral epicondyle, the bony bumb on the outer side of the elbow.

Tennis Elbow This condition is a degeneration of the tendons that attach to the lateral epicondyle. This condition is caused by repetitive trauma or aging. Common symptoms include tenderness and pain at the lateral epicondyle, and this pain can be made worse by bending the wrist.

Tendons of the long forearm muscles

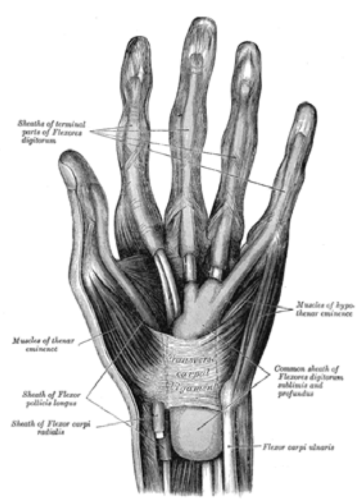


Figure 2"The mucous sheaths of the tendons on the front of the wrist and digits." Henry Gray's Anatomy of the Human Body, 1918.

Movements of the hand are mostly started by muscles in the forearm. Only the thin tendons of these muscles are directly a part of the hand: the extensor tendons used for extending the hand run through the back of the hand to the tips of the fingers, and the flexor tendons run through the palms to the fingers.

The long flexor and extensor tendons of the forearm muscles are partially surrounded by protective layers, called tendon sheaths. They produce a fluid that acts as a joint lubricant to lessen the friction caused by any movement. The tendon sheaths can become inflamed, which may be caused by injuries or by overuse resulting from repetitive uniform motions.

Muscle tendons, nerves and blood vessels run from the forearm to the hand through a passageway, which is level with the wrist on the inside of the hand. This passageway is called the carpal tunnel and is made up of connective tissue and carpal bones. If the tissue around the carpal tunnel swells up as a result of an inflammation or an injury, the nerves may be compressed, causing pain and distortions in sensation.

Informed Health Online [Internet]. Cologne, Germany: Institute for Quality and Efficiency in Health Care (IQWiG); 2006-. How does the hand work? 2010 Aug 31 [Updated 2012 Jan 12]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK83668/

Sample Language to use to Discuss the Structures of the Hand

Student A = Student 1, *Student B = Student 2*, Student C = Student 1, *Student D = Student 2*

Student 1 – What part of the hand connects bone to bone?
Student 2 – The part of the hand that connects bone to bone is . . . .

Student 2 – What is the function of one of the muscles in the hand?
Student 1 – The function of one muscle in the hand is . . . .

Student 1 – What is one effect or limitation when a ligament is torn?
Student 2 – One effect of a torn ligament is . . . .

Student 2 – What is an interesting fact about bones in the hand?
Student 1 – An interesting fact about the bones in the hand is . . . .

Student 1 – What is the function of a tendon in the hand?
Student 2 – The function of a tendon in the hand is . . . .

Student 2 – What parts of the hand are the rigid structures that the tendons and ligaments are connected to?
Student 1 – The parts of the hand that are the rigid structures that tendons and ligaments are connected to are the . . . .

Or create your own sentence starter and response below!
Student 1 - ____

____

Student 2 - ____

____

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Lesson Planner **Teacher:**

Unit: The Human Hand Lesson: #4 *Department of Defense*	**Grade Level/Course:** Intermediate 7/ Life Science	**Duration:** 2 class periods **Date:**
Common Core and Content Standards	**Big Idea: Systems have parts that work together to complete a task.** **Essential Questions:** **What tasks can be completed by the human hand?** **How can engineers develop an artificial hand that mimics the hand?** **Content Standards:** **MS-LS1-3.** In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions**.** **MS-LS1-8.** Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. **MS-LS1-d.** Design and conduct an investigation to gather evidence to support explanations that the body is a system of interacting subsystems composed of groups of cells working to form tissues and organs specialized for particular body functions, and that scientific advances in understanding of those systems have led to improvements in nutrition, health, and medicine. **Developing and Using Models** Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to support explanations, describe, test, and predict more abstract phenomena and design systems. (MS-ETS1-4) **Influence of Engineering, Technology, and Science on Society and the Natural World** Technologies can have deep impacts on society and the environment, including some that were not anticipated. (MS-LS1-a),(MS-LS1-d) **Science is a Human Endeavor** Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (MS-LS1-d) **Common Core Anchor Standards:** **CCSS Speaking and Listening Grade 7:** Students engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly. **CCSS Writing Grades 6-8:** Students produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience	
Materials/ Resources/ Lesson Preparation	Teacher Resource 4.0a Video Clip Bionic Hand on Man Student Resource 4.1: Text Dependent Questions from Video Student Resource 4.2: Extended Anticipatory Guide for Bionic Hand Student Resource 4.3: Agree/Disagree Sentence Frames Student Resource 4.4: DOD Article Student Resource 4.5: DO/SAY Chart for DOD Article	
Objectives	**Content:** Students will bridge their personal experiences and knowledge to the	**Language:** Students will gain a deeper understanding of informational text structures.

<table>
<tr><td colspan="2"></td><td>concept of prosthetics.
Students will use a video clip and text to develop content knowledge (structure and function of bionic hands)</td><td>Students will read and comprehend informational texts.
Students will participate in collaborative conservations using academic language.</td></tr>
<tr><td colspan="2">Depth of Knowledge Level</td><td colspan="2">☒ Level 1: Recall ☒ Level 2: Skill/Concept
☒ Level 3: Strategic Thinking ☒ Level 4: Extended Thinking</td></tr>
<tr><td colspan="2">College and Career Ready Skills</td><td colspan="2">☐ Demonstrating independence
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<tr><td colspan="2">Common Core Instructional Shifts</td><td colspan="2">☒ Building knowledge through content-rich nonfiction texts
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<tr><td rowspan="3">Academic Vocabulary (Tier II & Tier III)</td><td rowspan="2">TEACHER PROVIDES SIMPLE EXPLANATION</td><td>KEY WORDS ESSENTIAL TO UNDERSTANDING</td><td>WORDS WORTH KNOWING</td></tr>
<tr><td>Bionic
electric motors
controllers
sensory</td><td>Root word=Bio=life
extremity</td></tr>
<tr><td>STUDENTS FIGURE OUT THE MEANING</td><td>Prosthetic
artificial
robotic
mechanical
grip</td><td>Amputee/amputation
clinical studies</td></tr>
<tr><td colspan="2">/Pre-teaching Considerations</td><td colspan="2">Be sure to see if the video for this lesson works on your computer.</td></tr>
<tr><td colspan="4">Lesson Delivery Comprehension</td></tr>
<tr><td colspan="2">Instructional Methods</td><td colspan="2">Check method(s) used in the lesson:
☒Modeling ☒Guided Practice ☒Collaboration ☒ Independent Practice
☐Guided Inquiry ☐ Reflection</td></tr>
</table>

Lesson Opening

Preparing the Learner

Extended Anticipatory Guide-Bionic Hand (in Student Workbook)

- Read the statements in the Extended Anticipatory Guide to the students.

Anticipatory Guide Statements
1. Prosthetic limbs, which are man-made devices used to replace missing body parts, function, or work, exactly like human hands.
2. Artificial arms and legs can be bought at the pharmacy, like knee braces or ace bandages.
3. Cosmetic prostheses, which look like natural body parts, do not function, or work, they are just for looks.
4. It is very expensive and difficult to get a prosthetic limb because they must be custom built for each patient.
5. Prosthetic limbs help military veterans who were injured in war.

- Students independently place a checkmark under the column that best represents their opinion for each statement.
- In dyads, Student A reads Statement #1 and then shares his/her opinion and reason while student B listens attentively (no discussion at this point in the process).
- Next, Student B acknowledges Student A's response and then shares his/her opinion.
- Partners continue alternating as such until they reach the last statement.
- After all statements and responses are shared in partnerships, students may then discuss and comment on each other's responses.

Note: Teacher may choose to provide language supports for students so that they can practice using academic language. There is a page of sentence starters for Agree/Disagree Statements in the student workbook.

Some other examples are:

<u>Language Supports for Agreeing</u>
I agree with the statement that …because…
I agree with my classmate that …because…
I share a similar belief to ___________. (Explanation)
<u>Language Supports for Disagreeing</u>
I disagree with the statement…because…
I disagree with ______. I believe that … because…
Although ________makes a valid point, I still feel that … because…

Reflect on the Anticipatory Guide with a group discussion:

- On which statement(s) did you all agree? What were the reasons for these responses?
- On which statement(s) did you all disagree? What were the reasons for the differing responses?

Lesson Continuum			
	Body of the Lesson: Activities/ Questioning/ Tasks/ Strategies/ Technology/ Engagement	**<u>Interacting With the Text</u>** **Video Clip –Unencumbered view** The teacher will show the Bionic Hand video clip. (1st viewing unencumbered, allow the students to view without any guiding questions) **Preparing for the Second View** **1.** Teacher reads the "Viewing with a focus Questions" printed in the Student Workbook. (Another option is to have students write the questions "Cornell Note Style" on the left 1/3 of their paper then fill in the right hand "answer/details" side with their responses to the questions. Lastly have students craft a "big idea" statement to summarize the focus of each note-taking section.)While watching the video clip, students will focus and take notes on the following text dependent questions: • What is a bionic hand or prosthetic hand? • How does it function or work? • What is a bionic hand capable of or able to do? • What are the limitations of a bionic hand? • Who are bionic or prosthetic limbs arms and legs, designed for? **NOTE**: Since all of the questions ask about robotic/prosthetic hands/arms, a Circle Map would be one useful graphic organizer to use as a note-taking guide. A Circle Map could be drawn at the bottom of the student page. 2. Instruct students to write "Robotic Hand" in the middle circle, and then draw lines to write their responses to the focus questions. 3. When they are done, ask them to draw a large box around all of their notes and answer a deeper understanding question such as or -How do you think you would feel if you needed a bionic hand and why? -How would you feel if a friend or sibling had an accident and needed a prosthetic limb and why? <u>DOD Article Close Read and DO/SAY Chart</u> ****NOTE**: The text of this article (in the Student Workbook) has been chunked appropriately, allowing students to concentrate on the details/ideas in the text. The paragraphs have also been numbered. Lexile level is 1237. Remember to amplify the difficult portions rather than simplify.	**Differentiated Instruction:** **Students Who Need Additional Support:** • Provide language supports for students using sentence starters for Agree/Disagree Statements in the student workbook. • Pair share for immediate feedback. • Teacher proximity is reduced, but present to provide immediate feedback. • Multiple viewings to support different EL levels and reading speed • Contextualize activities with video clips. **Accelerated Learners:** • Produce a digital Thinking Map or graphic organizer to map out the Robotic Hand question. • Research the story behind the design and testing of a bionic hand. • Have students look into other medical devices or prosthetics that are use. • Have students research alternatives to bionic limbs, such as animal assistance or rehabilitation programs.

Lesson Continuum			
	Body of the Lesson: Activities/ Questioning/ Tasks/ Strategies/ Technology/ Engagement	4. The teacher will model/guide students in identifying the function (DO) and the content (SAY) of each section. Since this task may be new to your students it may be difficult for them to understand the first time around. We have provided the DO (function) for some of the sections and have them read the text to find the SAY (content). Be sure to model/guide first before you have them work collaboratively or independently on this chart! 5. As students become familiar and experience with this task, they will determine the DO/SAY of each section on their own. This may take a few attempts before they really understand the chart. 6. When students have completed the DO/SAY chart they will revisit the Extended Anticipatory Guide and fill in the Evidence From Text column. **Extended Learning** 1. Have students reflect on what they learned about prosthetic hands. 2. Students then fill in the "Now What Have You Learned" column on the Extended Anticipatory Guide. At this point students will confirm and/or adjust their thinking now that they know more about prosthetic arms, citing evidence to support their claims.	

Teacher Reflection Evidenced by Student Learning/ Outcomes	

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Video Clip - Prosthetic Hands: Range of Motion

From: DiscoveryStreaming - A Segment of: Dean of Invention: Building the Bionic Body
Time: 5 minutes, 12 seconds
Link: http://player.discoveryeducation.com/index.cfm?guidAssetId=6343EDCD-20E8-46A3-A6F5-D0141212DE71

Segment Description
Inventor Dean Kamen worked with the U.S. Department of Defense to develop the Luke Arm, a prosthetic hand that can complete tasks requiring precise motor skills, like making a sandwich or picking up small objects. Controlled by the user's foot, the device includes a tactile sensor that tells the user the tightness of the hand's grip.

Text-dependent (video-dependent) Questions:

While watching the video clip, focus and take notes on the following questions:

1. What is a bionic hand or prosthetic hand?

2. How does it function or work?

3. What is a bionic hand capable of or able to do?

4. What are the limitations of a bionic hand?

5. Who are bionic or prosthetic limbs arms and legs designed for?

The Bionic Hand Extended Anticipatory Guide

Statements	Agree	Disagree	NOW WHAT DO YOU THINK?			
			Agree	Disagree	EVIDENCE FROM VIDEO to support your argument	EVIDENCE FROM TEXT to support your argument
1. Prosthetic limbs, which are man-made devices used to replace missing body parts, function, or work, exactly like human hands.						
2. Artificial arms and legs can be bought at the pharmacy, like knee braces or ace bandages.						
3. Cosmetic prostheses, which look like natural body parts, do not function, or work. They are just for looks.						
4. It is very expensive and difficult to get a prosthetic limb because they must be custom built for each patient.						
5. Prosthetic limbs help military veterans who were injured in war.						

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Discussion Sentence Frames

To Disagree
(Remember, you disagree with an idea, not the person)

☐Another way to look at it is ________.

☐I understand what you said about ____________, but I think _________.

☐I have a different answer. I wrote down that _______________.

To Agree

☐You made a good point when you said _________.

☐I see what you're saying. I agree because ______________.

☐My idea builds on _______'s idea. I think _________.

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DOD working toward fully functional prosthetic arms

February 1, 2012 By Rob McIlvaine (http://www.army.mil/article/72958/)

NATIONAL HARBOR, Md. (Army News Service, Feb. 1, 2012)

1. A robotic arm, dubbed "Luke," after the Jedi with the mechanical hand, served as the centerpiece for a Jan. 31 discussion here regarding advancements in prosthetics. The robotic arm is a Defense Advanced Research Projects Agency-funded project, in partnership with the Department of Veterans Affairs. The goal of the project is to restore functionality for individuals with upper extremity amputations. The project is still in development.

2. "The original goal for the program, back when we got started in 2005, was to create, within this decade, a fully functional motor and sensory upper limb that responds to direct neural control," said Dr. Stewart Coulter, during the 2012 Military Health System Conference at the Gaylord National Hotel and Convention Center, from Jan. 30 to Feb. 2. Coulter, who serves as the general manager at DEKA Research and Development Corporation in Manchester, N.H., also has the role of product manager for the revolutionizing prosthetic arm system to provide improvements in functionality and usability for wounded warriors and others.

3. The DEKA arm has 10 degrees of movement, and features moving fingers, wrist, elbow and shoulder. All those parts move with electric motors, which are controlled by the user with signals from a foot-based controller.

4. But Coulter said it's easy to confuse the advances being made in prosthetics with science fiction. "A lot of people have seen, for instance, the Terminator movies, and sometimes forget that those aren't actually real," Coulter said.

5. The standard for prosthetic arms up until now has been "two to three degrees of freedom," Coulter said, which is not much different than a prosthetic arm that features a hook. "You see the hand open and close, you're seeing elbow flex, you might see a wrist rotate but not much more than that," Coulter said. "You're seeing low torque, but you're not seeing any feedback to the user."

6. In addition to degrees of freedom in prosthetic movement, Coulter said work being done to combine multiple individual prosthetic movements into single, more fluid movements. He also said there is work being done to find better ways to attach prosthetics to the user's body. "These are the three areas that need to be resolved," he said. "If you can't address making the arm have the capability, if you can't address the control seam part, if you can't address how you attach it to them, it won't do any good to address two of the three."

7. The various grips are also important. "If you want to be able to use a drill, there's a whole different grip," Coulter said. "So now we have a grip that will let you close the index finger independently like that. And you ought to see somebody's face light up who hasn't used a drill in 20 or 30 years."

8. One of the hard parts about this, he said, is finding a way to control a system, given the fact there's now 10 degrees of freedom in the arm. "Current ones are done with myoelectric controls, so they'll use residual muscles and it's very difficult to do that," he said. With the DEKA arm, they are using foot-based controls. "This provides a pretty good level of control, without relying on someone else to do it, relying on a joy stick, or relying on using their other arm to control it," he said.

9. Coulter said his team works very closely with a number of people who have used the arm system, and he says they've let the team know what works, and what needs to be fixed. "We've done clinical studies over the life of the program to improve design and to confirm we got it right," he said. They now have more than 4,000 hours of use time on versions of the arm system. "This has really given us the experience with the people who'll have to use it," he said.

10. Coulter said it's fun to have a group of engineers sit and design something but even more fun to have people use it. "It's been tremendous to work with them and give them the chance to say what activities they want to do," he said. "We've let five people take it home for two weeks, see what they think of it, come back and tell us what's going on."

11. The feedback, he said, has been very positive. "They want to do the things that are important to them, such as, going out to a restaurant and eating with chopsticks or a fork, playing golf, holding a trumpet and playing it, leaning up on a lamppost with an outstretched arm, holding a baseball, or reaching up to the top shelf and picking up a glass of water and holding it level as it's brought down to drink," he said. "To hear them say, 'Yes, I can use this for things I couldn't get done before,' is exactly what we're pushing for here," Coulter said.

DO/SAY Chart to use with DOD Article

Section	DO (function of this section)	SAY (content of this section) *You can paraphrase (restate in your own words) the information from the text.*
1	States the goal of the project.	
2	Provides background information on this project.	
3	Provides details about the DEKA arm.	
4	States a misconception of prosthetics that some people have.	
5	Tells what prosthetic arms were able to do before the DEKA arm.	

Section	DO (function of this section)	SAY (content of this section) *You can paraphrase (restate in your own words) the information from the text.*
6	Describes further improvements of the DEKA arm.	
7	Describes how the grips are important.	
8	Describes how the arm is controlled.	
9	Describes how the arm has been tested by amputees.	
10	Further describes who has tested the arm.	
11	Describes the results of having amputees test the prosthetic arm.	

SAUSD Common Core Lesson Planner **Teacher:**

Unit: The Human Hand **Lesson #5** *Engineering Design Process*	**Grade Level/Course:** Grade 7/ Life Science	**Duration:** Five Class Periods
Common Core and Content Standards	**Big Idea:** Systems have parts that work together to complete a task. **Essential Question**: How can engineers modify their designs to choose a best/better solution? **MS-LS1-3.** In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions**.** **MS-LS1-8.** Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. **MS-LS1-d.** Design and conduct an investigation to gather evidence to support explanations that the body is a system of interacting subsystems composed of groups of cells working to form tissues and organs specialized for particular body functions, and that scientific advances in understanding of those systems have led to improvements in nutrition, health, and medicine. **Developing and Using Models** Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to support explanations, describe, test, and predict more abstract phenomena and design systems. (MS-ETS1-4) **Influence of Engineering, Technology, and Science on Society and the Natural World** Technologies can have deep impacts on society and the environment, including some that were not anticipated. (MS-LS1-a),(MS-LS1-d) **Science is a Human Endeavor** Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (MS-LS1-d) **CCSS Reading for Literacy in Science Grade 6-8**: 3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. **CCSS Speaking and Listening Grade 7:** Students engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly. **CSS Writing Grades 6-8:** Students produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	

<table>
<tr><td colspan="2">Materials/ Resources/ Lesson Preparation</td><td colspan="2">Teacher Resource 5.0a: I-Limb Controlled by App video (see lesson plan for information)
Student Resource 5.1: EDP (Engineering Design Process) Design Challenge Scenario
Student Resource 5.2: EDP (Engineering Design Process) Close Reading
Student Resource 5.2a: EDP (Engineering Design Process) Pulled Quotes and Cornell Notes
Student Resource 5.2b: EDP (Engineering Design Process) Vocabulary Notebook and TE
Student Resource 5.3: EDP (Engineering Design Process) Defining the Problem
Student Resource 5.3a: EDP (Engineering Design Process) Idea Web
Student Resource 5.4: EDP (Engineering Design Process) Brainstorming Guide
Student Resource 5.5: EDP (Engineering Design Process) Visual Aid of Design Loop
Student Resource 5.6: Engineering Design Packet (8 pages includes the Rubric)
Student Resource 5.7: EDP (Engineering Design Process) Test and Improve
Additional construction materials: cardboard, tape, nylon cord, things from home to build bionic hand</td></tr>
<tr><td colspan="2">Objectives</td><td>Content:
Students will be able modify and improve a model hand using the engineering design process.</td><td>Language:
Students will share and communicate their experiences using the engineering design process to modify and improve their model hand devices.</td></tr>
<tr><td colspan="2">Depth of Knowledge Level</td><td colspan="2">☒ Level 1: Recall ☒ Level 2: Skill/Concept
☐ Level 3: Strategic Thinking ☐ Level 4: Extended Thinking</td></tr>
<tr><td colspan="2">College and Career Ready Skills</td><td colspan="2">☐ Demonstrating independence ☒ Building strong content knowledge
☒ Responding to varying demands of audience, task, purpose, and discipline ☐ Valuing evidence</td></tr>
<tr><td colspan="2">Common Core Instructional Shifts</td><td colspan="2">☒ Building knowledge through content-rich nonfiction texts
☒ Reading and writing grounded from text
☒ Regular practice with complex text and its academic vocabulary</td></tr>
<tr><td rowspan="3">Academic Vocabulary
General Academic Words & Domain Specific</td><td></td><td>KEY WORDS ESSENTIAL TO UNDERSTANDING</td><td>WORDS WORTH KNOWING</td></tr>
<tr><td>TEACHER PROVIDES SIMPLE EXPLANATION</td><td>Constraints
Problem/Solution
Modify
Factors
Prototype
Improve
Iteration</td><td>Flexor
Precision
Extend
Complex
Open-ended design</td></tr>
<tr><td>STUDENTS FIGURE OUT THE MEANING</td><td>Bone
Muscle
Tendon
Ligament
Joint</td><td>Palm
Wrist
Forearm</td></tr>
</table>

<table>
<tr><td>Pre-teaching Considerations</td><td colspan="2">Model hands constructed during lesson two, week one of the unit should have been stored in gallon size plastic bags labeled by period # and table/group # or with student names for use during this week's lessons. Students will need additional construction supplies such as cardboard, tape, nylon cord in order to add thumbs or more fingers. Students should also be told they may bring in materials from home for their modifications if possible.</td></tr>
<tr><td colspan="3">Lesson Delivery Comprehension</td></tr>
<tr><td>Instructional Methods</td><td colspan="2">Check method(s) used in the lesson:
☒Modeling ☒Guided Practice ☒Collaboration ☒ Independent Practice
☐Guided Inquiry ☒ Reflection</td></tr>
<tr><td>Lesson Opening</td><td colspan="2"><u>Preparing the Learner: Viewing with a Focus (~5 minutes)</u>
1. Have students complete an unencumbered read of "Engineering Design Challenge-Prosthetic Hand" (resource 5.1 handout).
2. Then have them watch the "I-limb controlled by App" video clip while <u>viewing with a focus</u> on the Essential Question: How can engineers modify their designs to choose the best solution? Tell students to be prepared to share their ideas.
3. Ask students to share with their elbow partner one example of how they saw an engineer modify the design to improve function or how an engineer might further modify the I-limb to improve its functionality.
4. Restate the Unit Big Idea: Systems have parts that work together to complete a task.</td></tr>
<tr><td>Body of the Lesson:
Activities/ Questioning/ Tasks/ Strategies/ Technology/ Engagement</td><td><u>Interacting with the Concept/Text: (~15-20 minutes)</u>
Close Reading of "Engineering Design Process" article
1. Students are asked to complete an unencumbered 1st reading of the Engineering Design Process article. Remind students they are reading to understand and it is okay if they do not finish the article.
2. Next, students are instructed to number the paragraphs. Teacher may wish to model "numbering" the paragraphs under the document camera or projector depending on the students' experience with this task.
3. Then students are asked to consider the main ideas in the reading as they complete a second reading with their table groups, this time Reading with a Focus (QTEL) to "Pull a Quote". (Close Reading Strategy)
NOTE: To "Pull a Quote" teacher may have a newspaper or magazine available to display and point out the "pulled quotes" in the body of the reading.
4. Then instruct students that as they read "Engineering Design Process" they are to read with the focus of searching for one single statement that could express the most important or main ideas of the text.
5. Once students select their "pulled quote" they should highlight or underline the sentence in the text of the article. Encourage students to pull quotes from the beginning steps of the process "Brainstorm," the middle steps "Design" and the final steps of engineering design process "Review."</td><td>Differentiated Instruction:
Students Who Need more Support:
• Viewing with a focus to help focus students
• Hands-on Construction to contextualize
• Multiple opportunities to speak and practice language skills
• Teacher proximity for immediate support and feedback
• Copy of their article to take home to pre-read or follow up on
• Cooperative groups for immediate support</td></tr>
</table>

Body of the Lesson: Activities/ Questioning/ Tasks/ Strategies/ Technology/ Engagement	6. Each group member should underline or highlight their own "pulled quote" then share their quote/quotes aloud with their groups. **NOTE**: Do not allow "duplicated" quotes. If another group member had already quoted a statement, other members cannot repeat, and they must find another statement to quote. 7. Students should refer group members to where they found their quote in the text while the other members highlight or underline all group members' quotes. For example, "My pulled quote is found at the beginning of paragraph 3." 8. Students should pause to allow time for all members to find the paragraph in the text. 9. Student then reads the statement aloud. 10. Students should highlight or underline all shared pulled quotes from the article. 11. The student sharing then explains WHY this quote was selected before any other student shares. **NOTE**: Sharing WHY a quote was pulled requires students to think about their thinking (metacognition) and helps them practice explaining their reasoning. 12. Teacher should circulate around the room as students take turns reading aloud to their groups and assist students who need more clarification on "pulled quotes". 13. Students should record the pulled quotes shared in their groups, including their own Cornell Note Style on the right hand side of the page on resource Lesson 5.2a 14. Students should then create a question about each note on the left hand side of the page and write a summary of the information found in the notes at the bottom of the page. **NOTE**: *If short on time the summary paragraph can be written as homework.* **<u>Interacting with the Concept/Text: (~10 minutes)</u>** **Vocabulary Notebook 5.2b** 1. Students focus on the vocabulary in bold read in 5.2 article 2. Teacher reads aloud each of the vocabulary words and asks students to repeat aloud in "choral response" style. 3. Teacher then pairs up students or asks them to work with elbow partners (take into account language ability) **NOTE**: Teacher may want to model the first term paraphrasing and discussion for students depending on their familiarity and comfort level with the process.	**Accelerated Readers** • Students create podcasts or YouTube tutorials of the engineering design process articles for other students to listen to. • Students work in groups with other accelerated students to promote more in-depth critical thinking.

<table>
<tr>
<td>Body of the Lesson:
Activities/ Questioning/ Tasks/ Strategies/ Technology/ Engagement</td>
<td>
4. Students complete the Vocabulary Notebook activity by reading the definition for each term and rewriting the definition in their own words. NOTE: Students should have the “Engineering Design Process” article handy to reread to see how the terms are used in conversation. Students will discuss in pairs what the definition means until they agree upon its meaning. They then paraphrasing the definition and write their version below.
5. Teacher should actively circulate during this process and help guide students in their discussion and paraphrasing.
6. Once students understand the term, they should sketch an image or graphic to help them remember the term in the vocabulary notebook middle column.
7. Additional Vocabulary Building Support:
-Write the words on sentence strips and display on bulletin board.
-Move the vocabulary words to the “word wall” weekly.
-Words may move back and forth from the word wall to the bulletin board daily to match the exact vocabulary being focused on each day.
-Charting the Vocabulary Notebook and posting as a class reference (GLAD) could be another method of displaying “word walls”.

While paraphrasing the definition needs to be completed in class with a partner, the graphic drawing can be completed at home.

<u>Transferring/Extending the Learning (15 minutes)</u>
1. In teams of four, have students read do a Round Robin and read through “Defining the Problem” Resource 5.3.
2. Have groups number off 1-4 and each student takes a turn reading aloud to the group. Each student should read the main problem and the two or three bullet point questions below.
3. When done, have each student select one of the bulleted questions and ask it to the group. After each question is asked, student teams should brainstorm an answer or make a prediction as it relates to the Design Challenge Scenario. Then proceed to the next question.
NOTE: It is not necessary to answer every single question, the resource is more meant to engage students in the process of using questioning to define problems and identify constraints.

NOTE: If time allows go over the Idea Web resource Lesson 5.3a for closure to the lesson. If short on time the Idea Web can serve as the opening activity for day 11. (see next page for details)

REMIND students that they may bring materials from home that may be used to improve their designs.
Possible ideas: stronger cardboard, stronger tape, thicker string, small plastic/PVC tubes for fingers, etc.
</td>
<td>
Differentiated Instruction:

English Learners:

Multiple opportunities to speak
Cooperative groups

Special Needs:
Hands-on construction
Multiple opportunities to speak
Copy of their article to take home
Cooperative groups

Accelerated Readers
Students could create podcasts of the EDP articles for other students to listen to.
</td>
</tr>
</table>

<u>Transferring</u><u>/Extending the Learning (Days 11-14)</u>
NOTE: If the Idea Web (resource 6.3a) was discussed on Day 10 then, begin day 11 with the Brainstorming Guidelines (6.4) if not, please go over the Idea Web first.

1. Give students 1-2 minutes to look at the Idea Web for an Amputee and ask them to determine what kind of person this Idea Web was created for. (13 year old girl-see "Target Audience")
2. After students determine this, tell students this is a model of an engineering teams' thought process written down as they problem solve how to meet the needs of this amputee.
3. Give them another 1-2 minutes to examine all of the information and see the layout.
4. Ask students to think of another target amputee they could design for. If they can't think of someone, suggest they use themselves as the target. Have them add additional bubbles to the Idea Web for 1-2 minutes.
5. Students can share their ideas with their elbow partner.
6. Before students get into their designing groups, ask them to look at The Brainstorming Guidelines (6.4) together. These are a good way to "set the tone" for acceptable interactions between students as they work collaboratively to improve and modify their designs.
7. Display the visual aid of the "Engineering Design Process" 5.7 shown as a loop and review the steps that were read about in the prior lesson's article.
8. Go over the Engineering Design Packet with the students and have them work on the packet over the course of the next two days as they work on modifying their designs.
9. Explain the Evaluation Rubric found at the end of the Engineering Design Packet and tell students they should use the rubric as a self-assessment as it will be used during days 13 or 14 for their final evaluation of their model hand device.
10. Have students work on modifying, testing and improving their model hands as they work on the Engineering Design Packet. If students get stuck they should review the text on 5. "Engineering Design Process: Test and Improve" 5.7
11. Continually circulate to ask questions and observe student work. Remind students to have the Evaluation Rubric hand to self-assess as they work.

NOTE: Point out that the final evaluation includes an oral "communicating" of the design process used to construct and modify their model hand device.

	Extension Continued: **Student Self-Assessment with Rubric** **Scaffolding: Metacognitive Development, Schema Building** • Explain to students the purpose of self-assessment is help them know exactly how well one is doing on a task or what one does not understand and needs help with is essential to the success of all students. • For English learners, who may times miss part of oral explanations, written rubrics are powerful scaffolds. They specify the requirements for the task, different levels of completion, commentaries or grades students will receive for their work, and how to improve on an assignment. • Initially, rubrics need to be discussed with the whole class and their individual and group implementation has to be practiced and reflected on together. • Eventually, students will appropriate the process of self-evaluation, becoming increasingly autonomous and intrinsically motivated to monitor their own production.	
Lesson Reflection		
Teacher Reflection Evidenced by Student Learning/ Outcomes		

Video Clip – I-Limb: Hands Controlled by App

From: youtube

Time: 5 min 2 sec

Engineering Design Challenge – Prosthetic Hand

Scenario
You are working with a team of engineers from a biomedical engineering company that specializes in the design and manufacturing of prosthetic devices. Your team's challenge is to design a prosthetic hand that can perform ONE specific function to help improve the quality of life of the amputee who uses the prosthesis.

Example functions to design for:

- holding a pen or pencil
- clasping
- using sign language
- throwing
- brushing teeth
- picking up and relocating an object
- holding a utensil
- eating spaghetti

Design Constraints
- **Time**: You will be expected to complete this design challenge from start to finish in a matter of days! Therefore, it is important to agree on a design that is functional, yet not overly complex.

Functionality Goals:

Identify and describe the function you have chosen to design for and explain why you chose that particular functionality goal.

Bee creative! ~~~  ~~~~~~

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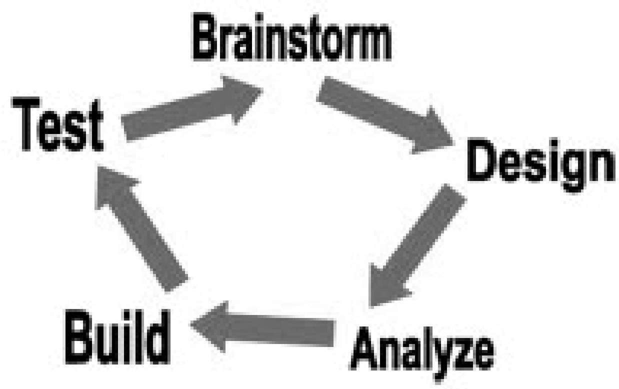
Engineering Design Process

The **engineering design process** is a series of steps that engineering teams use to guide them as they solve problems. Anyone can do it! To determine how to build something (skyscraper, amusement park ride, bicycle, music player), engineers gather information and conduct research to understand the needs of the challenge to be addressed. Then they brainstorm many imaginative possible solutions. They select the most promising idea and embark upon a design that includes drawings and analytical decisions on the materials, construction, manufacturing, and fabrication technologies to use. They create and test many prototypes, making improvements until the product design is good enough to meet their needs.

Engineers design and build all types of structures, systems, and products that are important in our everyday lives. The engineering design process is a series of **steps** that engineering teams use to guide them as they solve problems:

- **Understand the Need:** What is the problem? What do we want to accomplish? What are the project requirements? What are the limitations? Who is the customer? What is our goal? Gather information and conduct research - talking to people from many different backgrounds.
- **Brainstorm Different Designs:** Imagine and brainstorm ideas. Be creative; build upon the wild and crazy ideas of others. Investigate existing technologies and methods to use. Explore, compare and analyze many possible solutions.
- **Select a Design:** Based on the needs identified, select the most promising idea.



- **Plan & Analyze:** Draw a diagram of your idea. How will it work? What environmental and cultural considerations will you evaluate? What materials and tools are needed? What analyses must you do? How will you test it to make sure it works?
- **Build:** Assign team tasks. Build a prototype and test it against your design objectives. Push yourself for creativity, imagination and excellence in design. Does it work? Analyze and talk about what works, what doesn't and what could be improved.
- **Test & Improve:** Discuss how you could improve your product. Make revisions. Draw new designs. Iterate your design to make your product the best it can be.

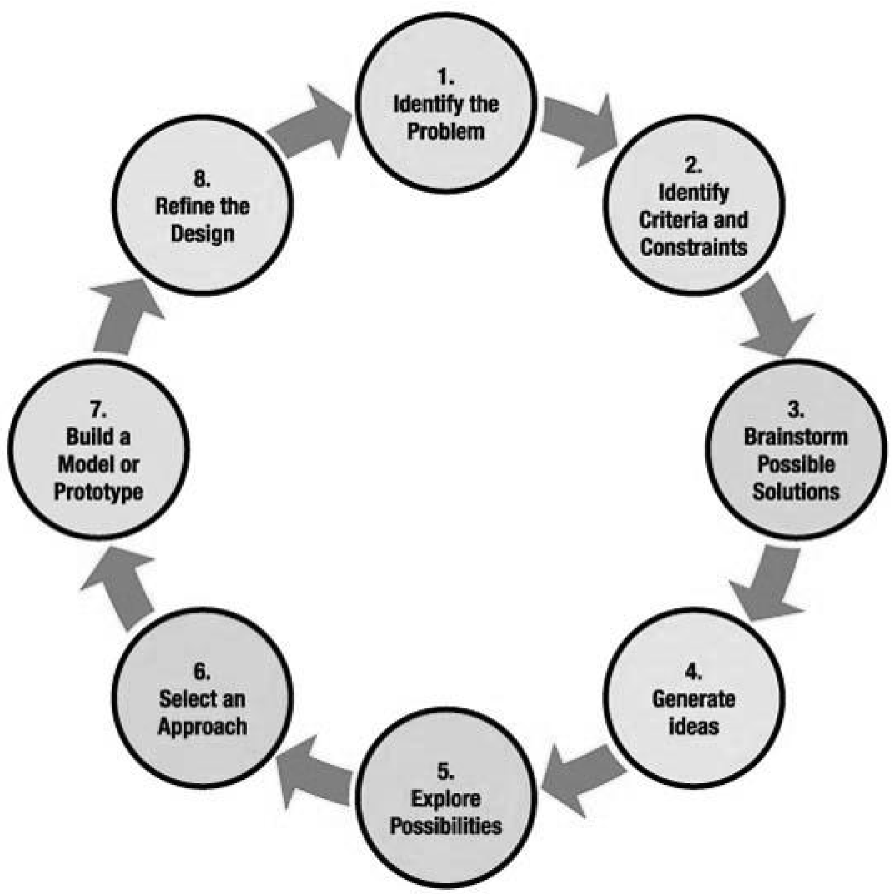
Engineering Design Process *continued*

Engineers use their science and math knowledge to explore all possible options and compare many design ideas. This is called **open-ended design** because when you start to solve a problem, you don't know what the best solution will be to meet the requirements. The process is **cyclical** and may begin at, and return to, any step.

The use of **prototypes,** or early versions of the design (or a model or mock-up) helps move the design process forward by improving your team's understanding of the problem, identifying missing requirements, evaluating design objectives and product features, and getting feedback from others. These **iterations** help the team look at how the prototypes change and improve with each repetition of the design cycle.

Engineers select the **solution** that best utilizes the available **resources** and best meets the project's requirements. They consider many **factors** before they implement a design: Quality, reliability, environmental consideration, safety, functionality, ease of use, aesthetics, ethics, social and cultural impact, maintainability, testability, ease/cost of construction and manufacturability. They also consider **sustainability** - how the development, use and ultimate disposal of the product might impact people and our planet.

For a more detailed Look at the Engineering Process:
http://www.sciencebuddies.org/engineering-design-process



Engineering Design Process: Test & Improve

Practice modifying a device:
After completing a design cycle (designing, building, and testing) your designs should be modified for improvement. How can it work better? As you work on improving your model hand device, think about how to fix specific parts of the device. To help you engineer better working hand models you must consider the tasks that are to be completed with the hand. Is the hand strong enough? Does the hand model have any parts that may cause harm to the person using it and how will the user deal with this? How big will it need to be? Engineers must always be resourceful and use at little materials as possible. Consider the cost. Will it be too expensive to build?

Consider the following:
- How can adding a thumb or more fingers improve your device's functions?
- Is the hand easy to use?
- Are there ways to improve parts of the hand?
- Can using different materials on parts of the device help the hand work better?

Engineering is an **iterative process, a series of improvements**. You built your **1st iteration** of your model hand during the first week of this unit. Each time you build or change parts on the hand it is considered another **"iteration."** Now review these questions again while thinking about your model hand device and try to modify and improve your device for your 2nd and possibly 3rd iterations of the robotic hand prototype.

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Engineering Design Process Cornell Notes

Questions/Main Ideas	Details/Answers
(**After** taking notes write questions that could "test" your understanding of the information in your notes)	(**While you watch and listen** to the power point, write down important facts, details and examples from the presentation)
1.	PULLED QUOTES from BRAINSTORM section
2.	PULLED QUOTES from DESIGN section
3.	PULLED QUOTES from REVIEW (ANALYZE-BUILD-TEST) section

Summary: 1st **Review and Recite** your notes. Then **write a paragraph** summarizing the information in your notes

(use T-P-C, t-topic sentence, p-paraphrase, c-conclusion statement)

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Vocabulary Notebook

Word	Graphic/Image	Definition /Application
		Below: Rewrite the definition in your OWN words.
Prototype		The original or <u>model</u> on <u>which</u> something is based or formed
Factors		One of the elements contributing to a particular result or situation
Solution		The act of solving a problem, question
Iteration		The act of repeating; a repetition
Open-ended Design		Not restrained by definite limits, restrictions, or structure. Allowing for or adaptable to change

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Defining the Problem

A. Description of Problem, Need or Value

- What are the problems and/or needs that justify the project?
- Describe the target population — who specifically experiences this problem or need?

B. Overview of the Design Team

- What is the mission of the design team?
- What are the team member's qualifications to accomplish this project?

C. Overview of Proposed Project

- What is the basic purpose of the project?
- Who will benefit from it? Describe the geographic area and population to be served.
- How does this project help fulfill the team's mission?
- How is this project unique? For example, is it similar to other projects but designed for a different target population? Does it employ a new approach?

D. Project Requirements and Constraints

- What are the project requirements?
- What constraints have been placed on your team?

E. Project Activities and Timeline

- What exactly must be done in order to achieve the desired outcomes?
- When, and in what order, must these activities be done to achieve the desired outcomes?
- Who will carry out project activities? Who is responsible?

F. Outcomes

- What immediate and long-range results are expected?
- Will these results change people's lives, the educational community and/or the world?

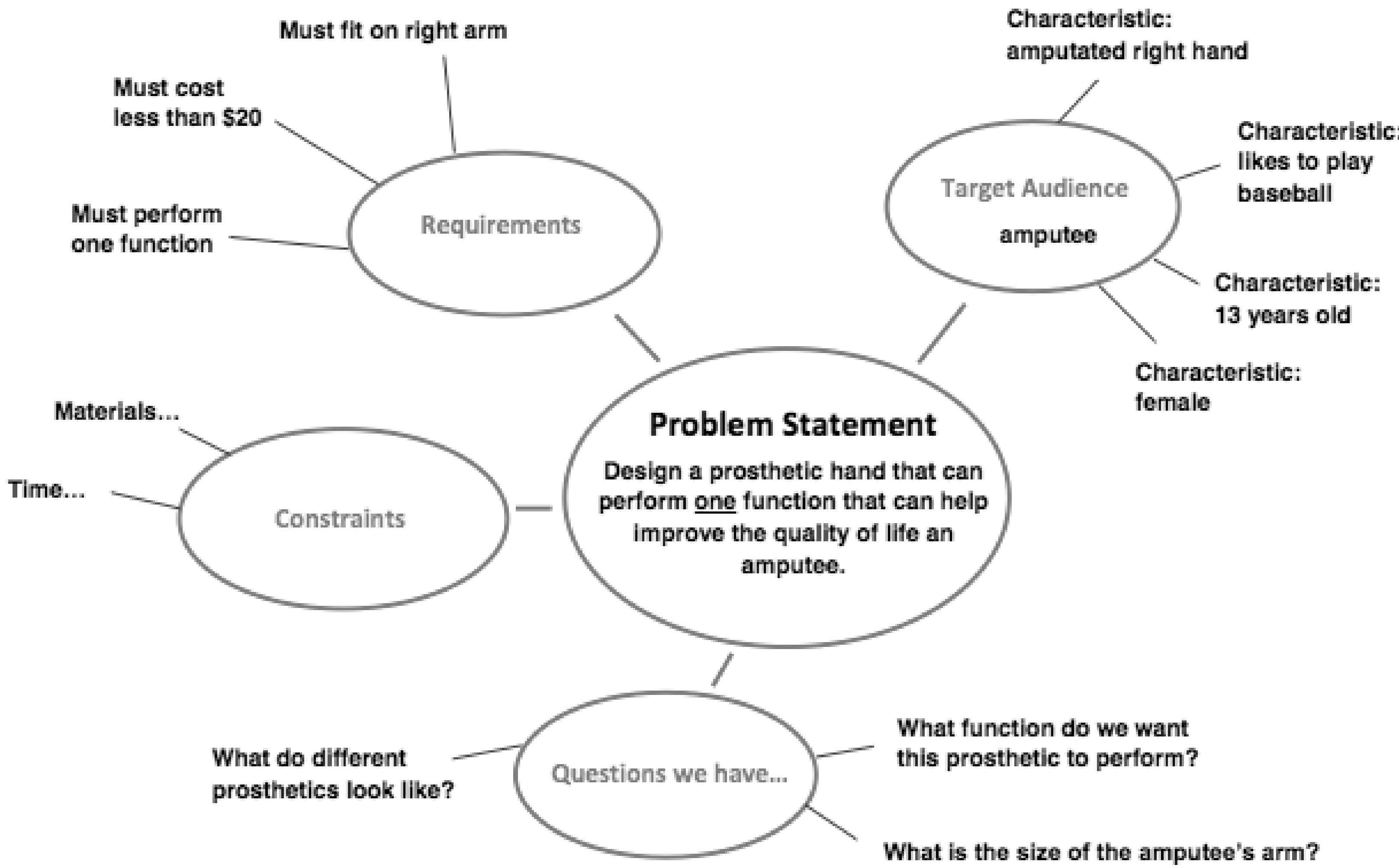
G. Evaluation

- By what criteria will the success or failure of this project be measured?
- What techniques or tools will be used to evaluate?
- Who will do the evaluation? When and how often will they do it?
- How will evaluation results be used? Who will see evaluations?

H. Funding

- What is the anticipated total budget for this project? Give a complete budget breakdown.
- What is the anticipated source(s) of funding?

Idea Web Example



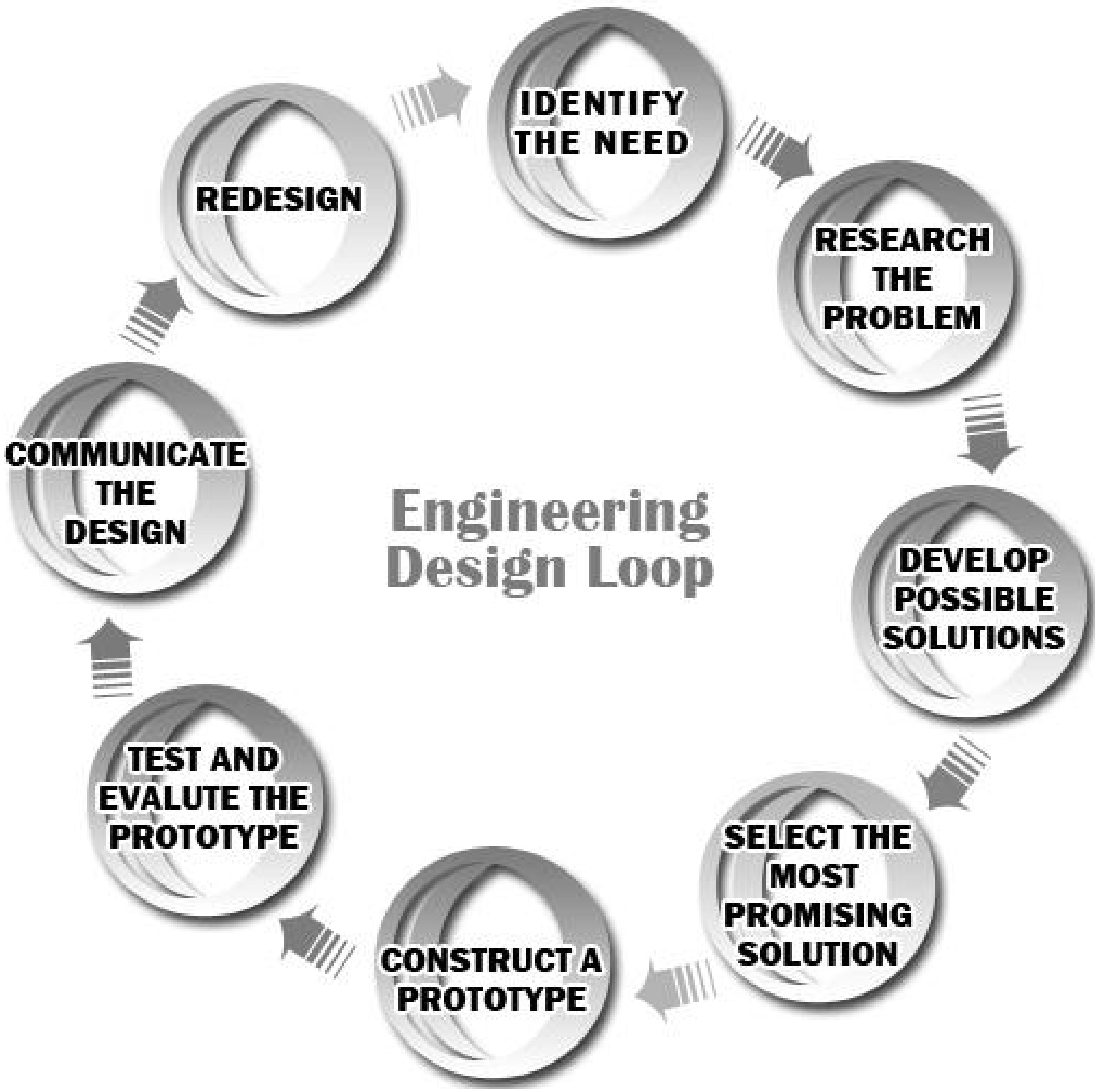
Design Step 2: Research the Problem Activity — Idea Web Example

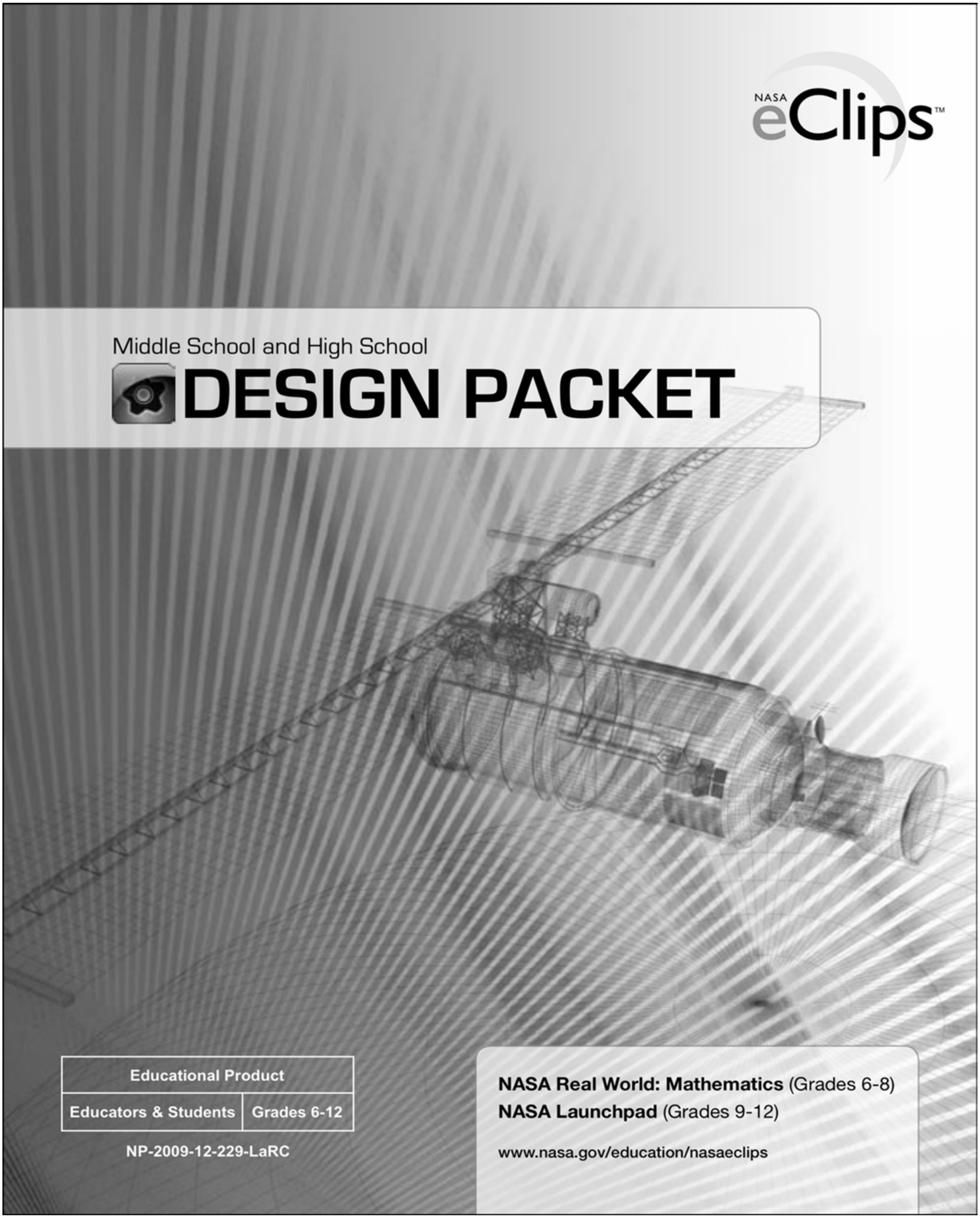
Brainstorming Guidelines

Focus on quantity	**Capture as many ideas as you can!**
Withhold criticism	**No put downs!**
Encourage wild ideas	**Wild ideas lead to innovative designs!**
Record all ideas	**Write everything down as it comes out!**
Combine ideas	**Build upon the ideas of others!**
Stay focused	**Focus your ideas on the topic at hand!**

Engineering Design Loop

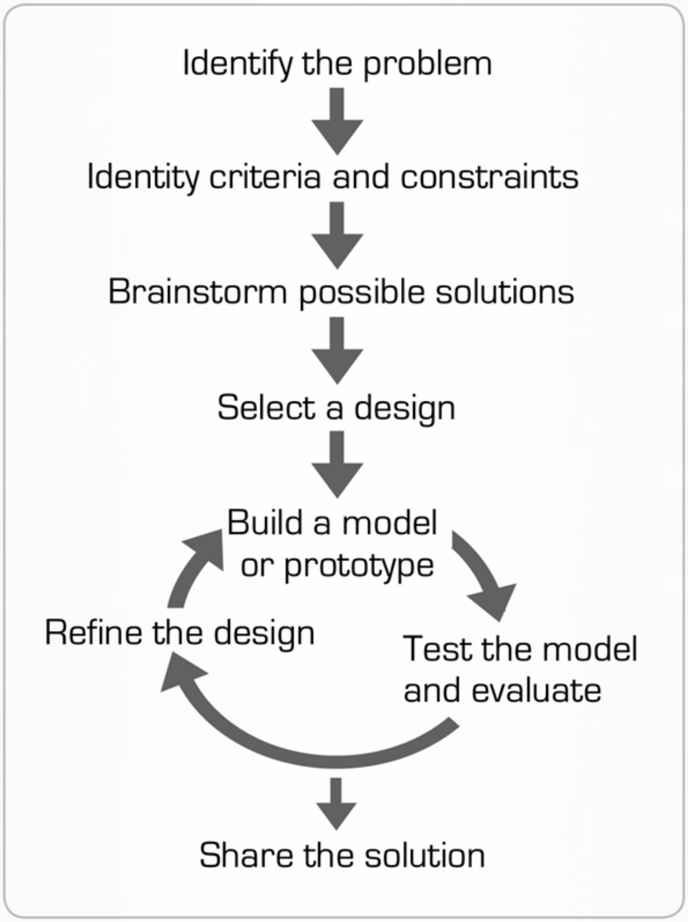
A specific and iterative set of steps engineers use to organize their ideas and refine potential solutions to engineering challenges.




NASA eClips™
Middle School and High School
DESIGN PACKET
Educational Product
Educators & Students
Grades 6-12
NP-2009-12-229-LaRC
NASA Real World: Mathematics (Grades 6-8)
NASA Launchpad (Grades 9-12)
www.nasa.gov/education/nasaeclips

Design Process

Middle School and High School Design Packet



Graphic of Design Process

Steps of the Design Process

1. Identify the problem.
2. Identify criteria and constraints.
3. Brainstorm possible solutions.
4. Select a design.
5. Build a model or prototype.
6. Test the model and evaluate.
7. Refine the design.
8. Share the solution.

Design Sheets

Steps 1 - 2

Middle School and High School Design Packet

Step 1: Identify the Problem

- State the problem clearly.

Step 2: Identify Criteria and Constraints

- Identify the conditions that must be met to solve the problem.

- Identify anything that might limit a solution, such as cost, availability of materials, safety.

- Be specific.

3

Design Sheets

Steps 3 - 4

Middle School and High School Design Packet

Step 3: Brainstorm Possible Solutions

- Consider what others have done to solve this problem and include prior research.
- Generate new ideas for solutions.

Step 4: Select a Design

- Choose two or three of the best ideas from the brainstormed list.
- Make a detailed sketch of each design.
- Label each sketch with dimensions and include the materials needed to build a model.
- Select one design to construct.
- Justify your choice by listing the reasons you selected this design.

Design Sheets

Step 5

Middle School and High School Design Packet

Step 5: Build a Model or Prototype

- Write a detailed procedure for building the model or prototype.

- List the materials actually used to construct the model.

- Follow your procedure and build the model.

Design Sheets

Step 6

Middle School and High School Design Packet

Step 6: Test the Model and Evaluate

Test

- Write a hypothesis about your design's performance during testing.

- Use an "If. . . then . . ." format. For example, "If the redesigned model has increased in size (change in the independent variable), then it will fall at a faster speed, (change seen in the dependent variable).

- Decide on a test for the model and try it out.

- Record the results of your tests.

Evaluate

- List the strengths of your design.

- List the weaknesses of your design.

- Discuss what changes, or compromises, in your design (if any) had to be made due to constraints.

- Decide if your design solved the problem identified in Step 1.

Design Sheets

Steps 7 - 8

Middle School and High School Design Packet

Step 7: Refine the Design

- Based on the results of your tests, make improvements on your design.
- Identify the changes that you would make.
- Give reasons for the changes.

Step 8: Share the Design

- Organize your findings. For example, you could make a poster, digital collage, PowerPoint presentation, or short video documentary.
- Present your findings to your teammates for feedback.
- Compare your design to those of your teammates.
- If you were to build this model again, what would you do differently and why?

Design Challenge Evaluation Rubric

Middle School and High School Design Packet

Group Members: ______________________________

____

Rubric Category	*Score*
Brainstorm to Identify the Problem and Constraints • The problem is identified and explained in detail. • All criteria and constraints are listed and clarified. • Possible solutions are listed from the brainstorming session. • The work others have done to solve the problem is included.	
Generate Ideas, Possibilities, and Design Choice • Two or three ideas are selected from brainstormed list. • Detailed sketches are created for the selected ideas. • Sketches are labeled with dimensions and materials for each component. • One design is selected to construct with reasons for the choice.	
Build the Model or Prototype • Detailed list of materials is included. • Detailed procedures are included and followed. • Materials are handled and stored appropriately. • Safety rules are followed.	
Test the Model and Evaluate • Hypothesis following an "if.., then…" format is developed for the design. • Strengths of the design are listed. • Weaknesses of the design or compromises of the design are listed. • Results are accurately recorded. • Data tables are complete and well organized. • The chosen design effectively addresses the identified problem.	
Refine the Design • Modifications to improve the design are based on test results. • Modifications to the design are documented. • Additional trials are conducted. • Reflections show great insight and understanding of process and goals of project.	
Share the Design • Presentation is well-organized. • Presentation covers all areas of the design process. • Presentation is clearly communicated (verbally or visually) with appropriate data, sketches, graphs or pictures. • Presentation includes contributions from all team members.	
TOTAL (out of 24 pts possible)	

4 (Excellent) = All criteria (procedures, steps, and details) are met or followed with rare mistakes.
3 (Good) = Most criteria are met with only a few mistakes.
2 (Fair) = Many criteria are not met and/or there are many mistakes.
1 (Poor) = Most criteria are not met.
0 (No effort) = No effort to meet criteria.

Engineering Design Process: Test & Improve

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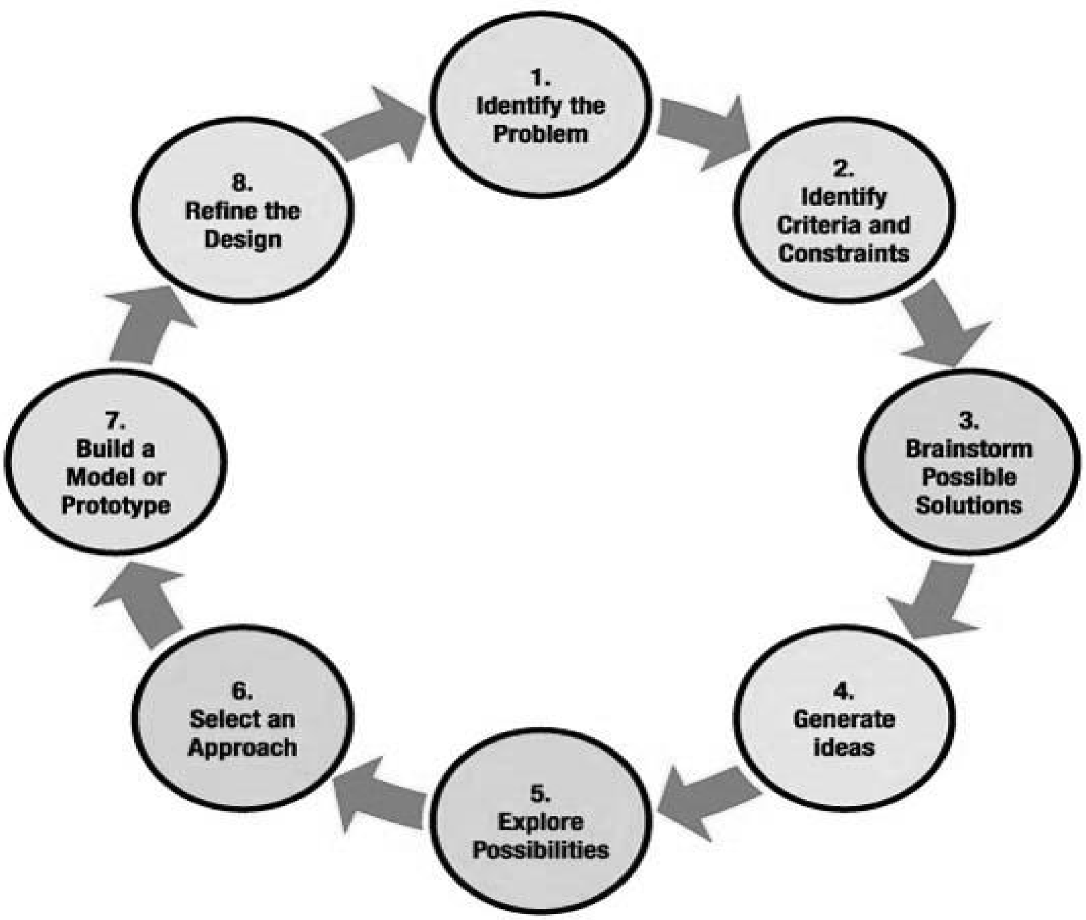

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Lesson Planner **Teacher:**

Unit: The Hand **Lesson : 6** *Summative Assessment*	**Grade Level/Course:** Intermediate 7/ Life Science	**Duration:** 1 class period **Date:**
Common Core and Content Standards	**Big Idea: Systems have parts that work together to complete a task.** **Essential Question: What tasks and movements can be done by the human hand?** **Content Standards:** **MS-LS1-3.** In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions**.** **MS-LS1-8.** Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. **MS-LS1-d.** Design and conduct an investigation to gather evidence to support explanations that the body is a system of interacting subsystems composed of groups of cells working to form tissues and organs specialized for particular body functions, and that scientific advances in understanding of those systems have led to improvements in nutrition, health, and medicine. **Developing and Using Models** Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to support explanations, describe, test, and predict more abstract phenomena and design systems. (MS-ETS1-4) **Influence of Engineering, Technology, and Science on Society and the Natural World** Technologies can have deep impacts on society and the environment, including some that were not anticipated. (MS-LS1-a),(MS-LS1-d) **Science is a Human Endeavor** Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (MS-LS1-d) **Common Core Anchor Standards:** **CCSS Speaking and Listening Grade 7:** Students engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly. **CCSS Writing Grades 6-8**: Students produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	

<table>
<tr><td>Materials/ Resources/ Lesson Preparation</td><td colspan="2">Teacher Resource 6.0a: Video of Thomas Viloteau playing Fuga
Student Resource 6.1: R.A.F.T. and Rubric
Teacher Resource 6.1a: Professional Response Letter for Overhead
Student Resource 6.2 : Professional Response Letter Directions and Sample
Teacher Resource 6.3: NEXT GENERATION SCIENCE STANDARDS QUOTE

What is RAFT?
The RAFTs Technique is a system to help students understand their role as a writer, the audience they will address, the varied formats for writing, and the expected content. It is an acronym that stands for:
Role of the Writer - Who are you as the writer? Are you Sir John A. Macdonald? A warrior? A homeless person? An auto mechanic? The endangered snail darter?
Audience - To whom are you writing? Is your audience the Canadian people? A friend? Your teacher? Readers of a newspaper? A local bank?
Format - What form will the writing take? Is it a letter? A classified ad? A speech? A poem? A text message?
Topic + Strong Verb - What's the subject or the point of this piece? Is it to persuade a goddess to spare your life? To plead for a re-test? To call for stricter regulations on logging?
Almost all RAFTs writing assignments are written from a viewpoint different from the student's, to another audience rather than the teacher, and in a form different from the ordinary writing assignment. Therefore, students are encouraged to use creative thinking and respond as they connect their imagination to newly learned information. RAFT is used in the SAUSD 7th grade ELA Common Core Unit.</td></tr>
<tr><td>Objectives</td><td>Content: Students will be able to describe how the parts of a robotic hand can mimic the movements of a human hand.</td><td>Writing: Student assume the role of a scientist and will write a response letter to a parent concerned about getting a robotic hand for her son who’s hands were both amputated.</td></tr>
<tr><td>Depth of Knowledge Level</td><td colspan="2">☒ Level 1: Recall ☐ Level 2: Skill/Concept
☒ Level 3: Strategic Thinking ☒ Level 4: Extended Thinking</td></tr>
<tr><td>College and Career Ready Skills</td><td colspan="2">☐ Demonstrating independence ☐ Building strong content knowledge
☒ Responding to varying demands of audience, task, purpose, and discipline ☐ Valuing evidence
☐ Comprehending as well as critiquing
☐ Using technology and digital media strategically and capably
☐ Coming to understand other perspectives and cultures</td></tr>
<tr><td>Common Core Instructiona l Shifts</td><td colspan="2">☒ Building knowledge through content-rich nonfiction texts
☒ Reading and writing grounded from text
☒ Regular practice with complex text and its academic vocabulary</td></tr>
</table>

<table>
<tr><td rowspan="3">Academic Vocabulary (Tier II & Tier III)</td><td></td><td>KEY WORDS ESSENTIAL TO UNDERSTANDING</td><td>WORDS WORTH KNOWING</td></tr>
<tr><td>TEACHER PROVIDES SIMPLE EXPLANATION</td><td>amputee
DARPA (Defense Advanced Research Projects Agency—part of the Department of Defense)</td><td></td></tr>
<tr><td>STUDENTS FIGURE OUT THE MEANING</td><td></td><td></td></tr>
<tr><td colspan="2">Pre-teaching Considerations</td><td colspan="2">Preview the video of Thomas Viloteau playing the guitar
Instructions for letter (in Student Workbook)
Writing Rubric for letter (in Student Workbook)
Notebook paper is required</td></tr>
</table>

Lesson Delivery Comprehension

Instructional Methods	**Check method(s) used in the lesson:** ☐**Modeling** ☐**Guided Practice** ☒**Collaboration** ☒ **Independent Practice** ☐**Guided Inquiry** ☒ **Reflection**
Lesson Opening	**Prior Knowledge, Context, and Motivation:** **Lesson opening and engagement:** 1. Show the students the video of Thomas Viloteau plays Fuga by M. Ponce. 2. Have the students work in pairs to discuss the hand movements needed to play the guitar. They should then share with their groups. Ask them to be specific and demonstrate the motions to their teams to clarify the movements.

<table>
<tr><td>Body of the Lesson:
Activities/ Questioning/ Tasks/ Strategies/ Technology/ Engagement</td>
<td>Interacting with the Text:

RAFT activity:
1. Display a completed RAFT prompt on the overhead (resource 6.1)
2. Ask students to help you identify each of the following terms in the RAFT prompt: role of the Writer (Ms. Meyers is a concerned mother), audience (Ms. Meyers is writing to a doctor who is also a member of the government and a high ranking individual), format (formal letter), and topic (thank you and follow up inquiry about expectations for her son).

NOTE: It may be helpful to write the elements on chart paper or a bulletin board for future reference).Clarify where needed to help students understand what each term means.

3. Model how to write responses to the prompts, and discuss the key elements (role, audience, format, topic) as a class.</td>
<td>Differentiated Instruction: Students Who Need More Support:
• RAFT is great for differentiation; teachers (and students) can develop any number of possible RAFTs based on the same text that can be adjusted for skill level and rigor.
• High-low level grouping for immediate support
• Teacher proximity for feedback and guidance.</td></tr>
</table>

Lesson Continuum

	4. Have students work in pairs to fill in the Role, Audience, Format, and Topic for when they RESPOND to the letter.	
Body of the Lesson: Activities/ Questioning/ Tasks/ Strategies/ Technology/ Engagement	5. Each student then writes rough draft response letter individually. 6. Students exchange letters and critique. 7. For homework, students take their rough draft home and copy it in final form.	• The RAFTs strategy can be used as a prewriting strategy and/or as a strategy for helping students prepare for a small or large group discussion. **Accelerated Learners:** • Have students select from a list of tasks that the mother would like the son to be able to accomplish such as: Driving a car Writing his name Batting a ball Sewing on a button And have them write a paragraph about how they would need to modify their bionic hand to accomplish one of these tasks. If time and resources permit, have student work to make these adjustments. • High-High level grouping to keep students challenging each other.

Lesson Reflection

Teacher Reflection Evidenced by Student Learning/ Outcomes	

Video Clip - Thomas Viloteau plays Fuga by M. Ponce

From: You Tube
Time: 3 minutes, 28 seconds
Link: http://www.youtube.com/watch?v=bQnsCIjYmNI

French Guitarist Thomas Viloteau plays Fuga on la Folia by Manuel María Ponce (8 december 1882 -- 24 april 1948) a Mexican composer.

Name ___________________________________ Period _______

Professional Response Letter

Writing Rubric

- **R**ole of the Writer: Who are you as the writer? A movie star? The President? A scientist?
- **A**udience: To whom are you writing? A senator? Yourself? A company?
- **F**ormat: In what format are you writing? A diary entry? A newspaper? A letter?
- **T**opic: What are you writing about?

R Role____

A Audience____

F Form____

T Topic____

RAFT Rubric

Points	**10**	**5**	**0**	**Points Earned**
RAFT	Satisfies all 4 RAFT components.	Satisfies 3 of 4 RAFT components.	Satisfies 2 or less of the RAFT components.	
Content	Exhibits knowledge of the bionic hand, includes important facts and information.	Exhibits some knowledge of the material.	No scientific facts included or major scientific inaccuracies.	
Writing Technique	Uses proper punctuation, spelling, grammar, and sentence structure.	Some mistakes.	Displays a lack of attention for rules of formal writing.	
Creativity	Displays originality, creativity and thoughtfulness.	Some attempts at creativity.	Predictable, little creativity.	
Presentation	Neat, easy to read, interesting graphics.	Neat, but lacks illustration.	Messy and hard to read.	
			Total	

To: Dr. Geoffrey Ling, Program Manager
DARPA Revolutionizing Prosthetics Program
United States Department of Defense
http://www.darpa.mil/Our_Work/DSO/Programs/Revolutionizing_Prosthetics.aspx

From: Ms. Joanne Meyers
c/o Brad Meyers, Gen-3 Arm System Recipient
Houston, Texas

Dr. Ling,

Thank you for accepting my son Brad into your Robotic Arm Prosthetic Program. As you know from our application, Brad was involved in an industrial accident and subsequently had both his hands amputated. Prior to losing his hands my son was an avid musician playing the piano and guitar since he was a young child. What kind of hope can you give me that your Gen-3 Arm System will enable Brad to once again play the music that he so dearly loves? We want to be optimistic without getting our hopes too high. Thank you in advance for your thoughts on this matter. Brad and I are looking forward to meeting you and your team soon.

Cordially,

Ms. Meyers

Professional Response Letter Directions

Directions

1) You are the lead scientist on the DARPA Revolutionizing Prosthetics Team.

2) You and your fellow scientist have been building robotic hands for amputees as part of a United States Department of Defense Project for the past ten years.

3) You have received the letter below from the mother of one of your future patients who is to receive two of your latest robotic hands.

4) Read the letter then write a 'Professional Response' to the mother addressing her concerns while giving evidence of how your team has the expertise to help her son. You can include diagrams about how the hand will be attached or what the hand will look like.

5) Use the RAFT processes to help you focus your writing and be sure to include academic language related to the mechanics of hand movement in the development of the robotic hand. See the Rubric on the next page for specifics.

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Cordially,

Ms. Meyers

Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (MS-LS1)

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