Exploring Prosthetics and AI Inspired by Roz the Wild Robot

(12 days)

Authors

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SUBJECT/GRADE LEVEL

Subject Area: Computer Science, ELA, Science

Grade Level: Middle School (5th grade)

Materials

- Book (Wild Robot by Peter Brown)

DAY 1-6

- Chart paper
- Pens/Pencils/Markers
- Sticky notes
- Clipboards
- Yarn
- Toilet paper rolls
- Animal picture cards
- Art supplies (teacher project choice)
- Blank 8 ½ x11 inch copy machine paper

Day 7-12

- Worksheets EDP Worksheet, Problem Statement, Design Map
- Materials to design prosthetics (eg: cardboard, plastic bottles, straw, Lego Prime for programming etc)
- Materials: Printed images of various objects (e.g., animals, fruits, everyday items)
- Stickers or tokens
- A whiteboard or large paper
- Markers
- A simple AI algorithm explanation sheet (age-appropriate language)

STANDARDS

Computer Science Standards (K-12 CSTA)

Impacts of Computing

- 3A-IC-24: Compare tradeoffs associated with computing technologies that affect people's everyday activities and career options.

Algorithms and Programming

- 3A-AP-17: Systematically test and refine programs using a range of test cases

Data and Analysis

- 3A-DA-09: Use data to highlight or propose cause-and-effect relationships, predict outcomes, or communicate an idea.
- 3A-DA-11: Create programs that use variables to store and modify data.

Algorithms and Programming

- 3A-AP-13: Decompose (break down) problems into smaller, manageable subproblems to facilitate the program development process.

Next Generation Science Standards

- 5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- 5-ESS1-1. Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.
- 5-ESS1-2. Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.
- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

English Language Arts Standards | Common Core State

Knowledge of Language:
CCSS.ELA-LITERACY.L.5.3 Use knowledge of language and its conventions when writing, speaking, reading, or listening.
CCSS.ELA-LITERACY.L.5.3.A Expand, combine, and reduce sentences for meaning, reader/listener interest, and style.
CCSS.ELA-LITERACY.L.5.3. Vocabulary Acquisition and Use:
CCSS.ELA-LITERACY.L.5.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 5 reading and content, choosing flexibly from a range of strategies.
CCSS.ELA-LITERACY.L.5.5 Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
CCSS.ELA-LITERACY.L.5.6 Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases, including those that signal contrast, addition, and other logical relationships (e.g., *however, although, nevertheless, similarly, moreover, in addition*).

LESSON OBJECTIVE(S)

- Students will be able to design and create prosthetic hands inspired by the Wild Robot through engineering design process and AI
- Students will be able to retell the story and explain how the story line relates to the ideas presented in the EDP and AI.

CAREER CONNECTION(S)

Mentor Background: Javier Garcia.

Dr. Javier Omar Garcia is a Branch Chief and Neuroscientist with the US DEVCOM Army Research Laboratory currently stationed at the NASA Ames Research Center in Mountain View, CA and Stanford University in Palo Alto, CA. Dr. Garcia received his BA from Rice University (Houston, TX) in

Cognitive Science and Psychology and a PhD in Cognitive Neuroscience from UC Irvine (Irvine, CA) with a predoctoral fellowship from the NIH (NEI), receiving the Ruth L. Kirschstein National Research Service Award. Postdoctoral work in computational multimodal imaging investigating attention and decision making was carried out at UC Irvine (Irvine, CA) and UC San Diego (San Diego, CA), and his relationship with ARL began as a joint postdoctoral fellow with ARL and Syntrogi, Inc. (now Intheon, San Diego, CA) in 2014 while officially joining ARL as a civilian employee in 2015. Using a variety of human neuroscientific techniques (e.g., neuroimaging, neurostimulation, neurophysiology), his expertise and research interests include computational explorations linking physiological measurements to human behavior in several cognitive domains and complex naturalistic environments, providing insight into future teaming neurotechnology that may enhance individual (and team) behavior, and hybrid human-technology systems, investigating novel antidisciplinary approaches to fuse synthetic intelligence with human intelligence to accelerate complex decision making.

Research Interests:

Hybrid Human-Technology Intelligence: The research seeks to revolutionize decision-making by merging human cognition with machine intelligence, aiming for a symbiotic system where human-technology teams can process information and adapt at unprecedented speeds. By integrating advancements in machine learning, neuroscience, and team science, this anti-disciplinary approach intends to enhance the human brain's processing to allow for rapid ideation and adaptation, far exceeding current human capabilities. The goal is to achieve decision-making speeds and complexity that could fundamentally transform US Army operations, while tackling the challenges of coordinating complex multi-domain operations and emerging cognitive capabilities in hybrid systems. The research will explore the extent of cognitive hybridization and its potential to create novel forms of intelligence and radically new thinking paradigms.

Links: Javier Omar Garcia - Google Scholar US DEVCOM Army Research Laboratory

STEM Careers:

1. Robotics Engineer
   - Robotics Engineer Career Information (PDF)
   - Robotics Engineering Degree Programs
2. Artificial Intelligence (AI) Research Scientist
   - AI Research Scientist Career Path
   - Top AI Research Programs
3. Machine Learning Engineer
   - Machine Learning Engineer Career Guide
   - Machine Learning Specializations
4. Data Scientist
   - Data Scientist Career Overview
   - Data Science Degree Programs
5. Cognitive Systems Engineer
   - Cognitive Systems Engineering Explained
   - Cognitive Systems Engineering Programs
6. Human-Robot Interaction Specialist
   - Human-Robot Interaction Career
   - Human-Robot Interaction Programs
7. Ethical AI Consultant
   - Career in Ethical AI
   - Ethics in AI Specializations

NOTES

Days 1-6 will consist of reading **The Wild Robot book, completing comprehension tasks, and various science application activities aligned with the book. These activities will take place in the Engage portion of the unit.

**Days 7-12 will allow the students to engage in an engineering design process of developing a prosthetic hand.

ENGAGEMENT

(90 minutes Day #1 ELA)
Brief Description: Read the story (or excerpts from relevant chapters) of "The Wild Robot" that showcase Roz's adaptation and problem-solving skills.

Procedures: A teacher led introduction to the story “The Wild Robot” and a brief discussion of prior knowledge regarding the topics of AI and the EDP and the reading/listening to the first 20 chapters of the book.
*Gallery Walk with partners and clipboards answering the attached questions for Chapters 1-20. The Wild Robot - 196 QA

Essential Questions: “Do robots have anything in common with wildlife?” & “What type of camouflage did Roz use to disguise herself?”
(clump of seaweed, bramble from mountain, log from riverbank, rock from forest, Chapter 18)

In groups, students will, with a 15 minute time constraint, research the basic characteristics of each of the four landforms, adding their research, in bullet point form , with markers, on chart paper hung around the room.

As a concluding activity, students will research the amount (%) of fresh water available on the Earth and locate these areas on a map provided for them. They will then create a bar graph showing where water is located including these areas: oceans, lakes, rivers, ground water, polar ice caps.

(90 minutes Day #2 ELA/Science)

Brief Description: Read chapters 21-35 together.

*Gallery Walk with partners and clipboards answering the attached questions for Chapters 21-35. The Wild Robot - 196 QA

Character Analysis Activity:

Worksheet Link Character Analysis ROZ.pdf

Procedures: Students will fill out a chart identifying the animal, name of the animal, inner character trait and outer character trait. (Inner traits being personification, traits of the animal that make them people-like and outer being a description of the animal from the outside). Animals that can be identified are:

Owl/Scooper

Weasel/Dart

Buck/Crown Point

Groundhog/Digdown

Fink the Fox

PikeFIsh/RockMouth

Squirrel/ChitChat

Geese, possums, beaver, doe/fawns

Food Web Activity

Students will create a food web and be able to see how the food web is interrelated with this activity that gets them up and moving.

(90 minutes Day #3 ELA/Science)

Procedures: Students will read/listen to Chapters 36-51 together.

*Gallery Walk with partners and clipboards answering the attached questions for Chapters 36-51. The Wild Robot - 196 QA

Vocabulary Chapter 41:

*planet/celestial body/outer space

*Outer Space: “The universe outside the atmosphere of our planet”

*Universe: “Everything and everywhere”

Mini lesson:

* Natural size of objects

*relative distance from the Sun

*seasonal appearance/length of day and direction of shadows day and night

Toilet paper square/ hallway activity

EdPuzzles:

“Amazing Journey from Earth to the End of the Universe” music and pics only 5:45

“The Universe” 6:46

Students should take notes during the video, recommend jotting noticings and wonderings–being prepared to share out at the conclusion of the video.

(90 minutesDay #4 ELA) Read Chapters 52-68 together.

*Gallery Walk with partners and clipboards answering the attached questions for Chapters 52-68. The Wild Robot - 196 QA

(90 minutes Day #5): Read Chapters 69-80 together completing the novel.

Procedures: Multiple activities in a “workshop” like setting

*Gallery Walk with partners and clipboards answering the attached questions for Chapters 69-80. The Wild Robot - 196 QA

*Think/Pair/Share comprehension questions responses on sticky notes stuck on chart paper

1. What are some of Roz's human-like characteristics? (personification)
2. What challenges did Roz face when on the island?

*Vocabulary Activity: choose 8 words from the attached list and fold paper in fourths to make 4 boxes and write the correct definition and appropriate colored illustration in each box.

https://www.storyboardthat.com/lesson-plans/the-wild-robot-by-peter-brown/vocabulary

(90 minutes ELA Day #6): Following are several culminating activities/projects for teacher choice to finish the ELA portion of this novel study.

1. *5 Types of Conflict Graphic Organizer

Conflict	Example (Quote/Page#)	Explain how this quote shows his conflict.	Insert/Draw Image of Conflict.
Character vs Character			
Character vs Society			
Character vs Nature			
Character vs Technology			
Character vs Self			

2. *Disguises for Roz writing activity
   Students will create and describe in a paragraph a disguise to keep Roz safe on the island.
3. *Art project:
   https://www.soulsparklettes.com/wild-robot-art-project/
4. *Projects
   https://obsessedwithlearning.com/5-classroom-activities-for-the-wild-robot/

EXPLORATION

(90 minutes Day#7 EDP)

Brief Description: Students' task is to identify the problem and design a prototype of prosthetic hands incorporating principles of adaptation and innovation inspired by "Roz the Wild Robot."

Procedure: Designing Prosthetic Hands Prototype (Defining and Planning for Solutions) Students' task is to design and create a prototype of prosthetic hands using the engineering design process.

This is a great time to also introduce criteria (what is needed to be successful- i.e. rubric) and constraints (limitations - i.e. cost, materials, time)

1. Introduce the STEM activity and discuss the connection between "Roz the Wild Robot," prosthetic hands, and AI technologies.

> In the story, Roz, a robot initially unfamiliar with the natural world, adapts and learns from her surroundings. After losing a foot in a dangerous encounter, she collaborates with the beavers, who help her create a prosthetic foot. This adaptation parallels the concept of prosthetic limbs, where individuals with limb differences use technological aids to mimic natural abilities.
>
> Roz begins to adapt and learn from her surroundings. She creates tools and finds ways to navigate challenges such as rough terrain and extreme weather.

2. Provide a copy and read the PROBLEM STATEMENT to students.

3. Introduce the EDP process to the students. Divide students into small groups. Provide groups with a copy of the EDP Worksheet and have them answer the " define the problem" on page two.

Optional for students/class: (The teacher may show videos of sample prosthetic hands)

What is ClickUp? VA (youtube.com)

Robotic Hand Science Project | Simple Paper Robot Hand for Kids | STEM Activity (youtube.com)

(5337) Roboland: Robotic Hands - YouTube

4. Provide each group with the worksheet "Four Quadrant" Design Map to brainstorm and sketch their prosthetic hand designs. Groups should be drawing 4 (four) different designs on the map. Then have them choose 1(one) design the group chooses best for their project. Then groups will answer the" design" page of the EDP Worksheet on page 2.

(90 minutes Day#8 EDP- Artificial Intelligence)

Activity 1 (Sketch to Image - 30 minutes)

Brief Description: During the design process, encourage creativity and innovation, prompting students to explore how AI-inspired technologies can be integrated into their designs to enhance performance. Introduce About (openart.ai) to teach about AI. Watch Youtube (5709) OpenArt Tutorial 1 - Beginner's Guide to Create the First AI Image, With a Perfect Prompt Formula - YouTube

Procedure: Use OpenArt AI to upload students' prosthetic hand sketches and convert to realistic and detailed images of their prosthetic hand design. Sketch to image (openart.ai).

Activity 2 (AI Detective Game - 60 minutes)

Brief Description: Learn the basics of AI and how it can be used to solve problems by playing a detective game where they use AI concepts to find clues and solve a mystery.

Procedure:

1. Introduction to AI. Begin with a brief explanation of AI. Question: What does AI stand for? Explain that AI stands for Artificial Intelligence, which means making computers think and learn like humans (collect data, find patterns, and make decisions). Use examples like voice assistants (Siri, Alexa) and image recognition (photo tagging on social media).
2. Explain the Detective Game. Tell students they will be AI detectives who need to solve a mystery by finding clues using AI concepts. Divide the class into small groups.
3. Clue Hunt. Each group receives a set of images and a list of clues related to those images. Clues might include descriptions or characteristics (e.g. Find an animal that can fly, Find a fruit that is yellow). Groups will use the clues to identify the correct images and place a sticker or token on them.
4. Learning AI Concepts.Gather the class and discuss how they used clues (data) to identify images (making decisions). Explain that AI works similarly by learning from data and making decisions based on it.
5. Group Discussion and Reflection. Ask students how they felt being AI detectives.

EXPLANATION

(90 Minutes Day#9 EDP)

Brief Description: Students' task is to construct and build prototypes of prosthetic hands based on their designs. Students will also share and present their prototype to other groups to gather feedback.

Procedure A: Building and Constructing Phase (Making a Model)

1. Introduce the "Building Phase" of the activity. Refer to EDP Worksheet and have them answer the " build page" on page 3.
2. Recap the students' tasks: to construct and build prototypes of prosthetic hands based on their designs, focusing on functionality and adaptability inspired by Roz's problem-solving skills. Then:
    - Introduce a brief discussion or demonstration on how AI concepts could potentially be integrated into prosthetic hand designs.
    - Discuss real-world examples where AI enhances prosthetic functionality, such as adaptive grip control or predictive movement.
3. Instruct students to construct their prototypes based on their sketch on their designs.

4. Instruct students to begin constructing their prototypes using the materials they write from their design.
5. Guide them to follow their design plans and utilize appropriate construction techniques (e.g., cutting, folding, assembling).
6. Encourage students to collaborate within their groups, assigning tasks based on individual strengths and ensuring each part of the prosthetic hand is constructed with attention to detail

(90 Minutes Day#10 EDP)

Procedure Sharing and Presenting Prototypes to Gather Feedback Activity.

1. Each group will present their prototype to the whole class. Give 5 minutes to each group to present their prototypes.
2. Using post it notes, members of other groups will write their feedback of what can be enhanced with each prototype presented. Each group will save the post -it notes and use them as inspiration to enhance their prototypes.

ELABORATE

(90 minutes Day#11 EDP)

Brief Description: Students' task is to review and re-design the constructed prototypes of prosthetics based from the gathered feedback.

Procedure: Review and Re-design the Prototype

1. Groups will choose 4(four) post-it-notes gathered from the activity.
2. Provide again each group with the worksheet "Four Quadrant" Design Map for "round two" to brainstorm and re-sketch their prosthetic hand designs. Groups should be drawing 4 (four) different designs on the map based from the chosen 4 post-it-notes . Then have them choose 1(one) design the group chooses best for redesign their project.
3. Groups will reconstruct and rebuild prototypes of prosthetic hands based on their chosen design.

EVALUATION

(90 minutes Day#12 EDP)

Brief Description: EDPStudents' task is to evaluate and test their prototypes. They will also record their own observations, brainstorm potential solutions or adjustments to enhance prototype performance based on testing feedback.

Procedure A (60 minutes): Evaluating and Testing (Testing the Model)

Students will conduct testing sessions to evaluate the functionality and adaptability of their prosthetic hand prototypes inspired by Roz's problem-solving skills. They will identify strengths and weaknesses, and make iterative improvements based on testing feedback.

1. Explain the purpose of the testing and iterative refinement phase and remind students of today's task: to evaluate how well their prosthetic hand prototypes perform specific tasks and to identify areas for improvement.

2. Instruct each group to begin testing their prosthetic hand prototypes.
3. Provide specific tasks or challenges that simulate real-world use:
    3.1. **Picking up Objects:** Place objects of varying sizes and weights on a table. Instruct students to pick up each object using their prototypes and assess the grip strength and precision or
    3.2. **Typing on a Keyboard:** Provide a keyboard or simulate typing tasks. Ask students to type sentences or words using their prototypes to evaluate dexterity and control.
    3.3. Other tasks or challenges.
4. Prompt students to record their own observations, test results and ideas for improvement on EDP Worksheet on page 3 " test and evaluate" page.
5. Gather students together for a brief discussion on their testing experience. Encourage groups to share their observations and insights:
    5.1. Discuss strengths and successes observed during testing.
    5.2. Identify specific areas where prototypes may need improvement (e.g., grip strength, ease of movement).
    5.3. Brainstorm potential solutions or adjustments to enhance prototype performance based on testing feedback.

Procedure B (30 minutes): Refinement and Final Adjustments (Reflecting and Redesigning the Model)

Students' task is to refine and make final adjustments to their prosthetic hand designs based on testing and recorded observations and feedback

1. Gather students and introduce the *Refinement and Final Adjustments phase* of the activity. Then recap the tasks: to discuss, brainstorm final prosthetic hand designs based on testing observations for optimal performance.
2. Encourage students to brainstorm potential improvements and adjustments to enhance functionality, ergonomics, and adaptability of their prototypes.Groups will answer the "solution" page of the EDP Worksheet on page 4.
3. Encourage students to:
    3.1. Modify materials or components to improve grip strength, flexibility, or control.
    3.2. Adjust size, weight, or shape to enhance ergonomics and user comfort.
    3.3. Experiment with different mechanisms or features to optimize adaptability to various tasks.
    3.4. Facilitate a discussion on how AI-inspired technologies could further optimize their designs.
4. Instruct groups to conduct a final round of testing to evaluate the impact of their refinements.
5. Encourage students to use the same tasks or challenges from earlier testing sessions (e.g., picking up objects, typing) to measure improvements.
6. Prompt students to record observations on how well their prototypes now perform compared to earlier iterations.
7. Encourage groups to share their experiences, successes, and challenges encountered during the iterative refinement phase. Groups will answer " reflect and share" page on the EDP Worksheet,

Grading Rubric

Category	Criteria	Points
Design and Planning	Clearly sketched design, innovative ideas, incorporation of AI concepts	10
Creativity	Originality of design, integration of biomimicry and adaptation principles	10
Teamwork	Effective collaboration, equal participation, clear role assignments	10
Prototype Construction	Adherence to design plan, attention to detail, functionality of prototype	10
Testing and Evaluation	Thorough testing, detailed observations, identification of strengths and weaknesses	10
Refinement and Adjustments	Effective use of feedback, thoughtful improvements, enhanced functionality	10
Final Presentation	Clear communication of process, demonstration of improvements, overall performance	10
Total | | **70**		

Example Scoring

- **Design and Planning**: 8/10
  - Well-detailed sketches but lacked clarity in AI concept integration.
- **Creativity**: 9/10
  - Highly original design with effective biomimicry.
- **Teamwork**: 10/10
  - Excellent collaboration with clear role assignments.
- **Prototype Construction**: 8/10
  - Followed design plan but minor construction flaws.
- **Testing and Evaluation**: 9/10
  - Comprehensive testing with detailed observations.
- **Refinement and Adjustments**: 9/10
  - Significant improvements based on feedback.
- **Final Presentation**: 9/10
  - Clear presentation with effective demonstration of enhancements.

Total Score: 62/70

REFERENCES

- Provide links to resources that you used in the creation of this unit.

Book: The Wild Robot
Brown, Peter. *The Wild Robot.* Little, Brown Books for Young Readers, 2016.
ISBN:978-0316381994

Food Web
https://jeffersfoundation.org/wp-content/uploads/2021/01/Activity-Human-Food-Web.pdf

Dr. Javier O.Garcia
Javier Omar Garcia - Google Scholar
US DEVCOM Army Research Laboratory

Worksheets
EDP Process EDP Worksheet
Four Quadrant Design Map