STEMS^2 Unit Plan Template

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BACKGROUND:

My overall goal is to redefine the culture of robotics education in Hawaii. Although robotic competitions encourage teamwork and high-pressure situations, in the end, what does it all mean for the students? By promoting a civic-minded and project-based pedagogy in robotics education, robotics can be relevant and meaningful for every individual participant. Robotics is an interdisciplinary field comprised of mechanical engineering, electrical engineering, and computer science, and those fields are blended as well, integrating math, technology, and science. Robotics should also include social science, humanities and arts, and community-based learning. Robotics can be a driving solution to problems in the community, whether it be helping the elderly or monitoring transportation issues. By introducing a supportive culture in robotics, every student is able to experience a level of project "completeness" and the satisfaction of achieving his or her own goals without the added pressure of winning.

A report by Stager, "A Constructionist Approach to Teaching with Robotics," gives a thorough introduction to developing a robotics curriculum for use in the classroom. The author explains five approaches to the use of robotics education: robotics as a discipline, teaching STEM-specific concepts, thematic units, curricular themes, and freestyle. The report also identified four critical factors in implementing robotics in the classroom: a good prompt, appropriate materials, sufficient time, and supportive culture. These four factors are important when developing my Unit Plan. The last factor, a supportive culture, is one that I stand firm with. The author states that a supportive culture is "non-coercive, collaborative, non-competitive environment..." One point that I want to try to address is the non-competitive side of robotics. In competition, reward comes with a top-scoring robot. However, in this type of culture, we reward creativity. Therefore, with the four critical factors mentioned, I want to be able to develop a well-rounded robotics curriculum that gives students the tools they need to make well-informed decisions on their project.

The book, *Interdisciplinary curriculum: Design and implementation* written by Jacobs explained the growing need for interdisciplinary curriculum content, design options for an integrated curriculum, and intellectual and practical criteria for curriculum integration. The author states that effective interdisciplinary programs must meet two criteria: have carefully conceived design features including a scope and sequence, a cognitive taxonomy to encourage thinking skills, behavioral indicators of attitudinal change, and a solid evaluation scheme, and use both discipline-field-based and interdisciplinary experiences for students in the curriculum. I believe that Robotics is truly an interdisciplinary field as it not only includes the fields of mechanical, electrical, and computer engineering, but also

math, the humanities and arts, and social science. Some examples described in the book are ones that are similar to the type of curriculum that I want to eventually develop, one that is very engaging to all participants: students, educators, and parents. One school completed a unit on dinosaurs and another completed a grades 1-6 unit on space. It was evident that the school was able to take a single theme and transcend grade levels.

Unit Overview:

Designed for grades 7 & 8, this unit integrates engineering, math, science, technology, humanities and arts, social science, and sense of place. Students design innovation and creativity solutions to the challenge that in 2030, a third of Hawaii's population will be over the age of 60. With the demand for healthcare rising, assistive robot can perform physical tasks and/or provide social interaction to improve health and psychological wellbeing of elderly.

STAGE 1:

Unit Plan Title: Assistive Care Robots

Essential Question: What role can robotic technologies play in assistive care for seniors in my home and in my community?

Enduring Understanding(s):

The engineering design process is a series of steps engineers use to come up with a solution to a problem and involves a cycle of background research, setting limits, brainstorm and design, and testing.

- Engineers work cooperatively in teams to accomplish a task.
- Robot systems require troubleshooting and maintenance to ensure safe and proper operation.
- Sensors allow robots to interact with the physical world.
- Robots are designed to perform dull and repetitive jobs.
- Robotic technologies can provide an improvement to health and psychological wellbeing to people.

STEMS²

Standard Benchmarks and Values

Science	Technology	Engineering	Mathematics	Social Science

Standards Addressed

Common Core – Math

7.RP.1 Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units.
7.RP.2 Recognize and represent proportional relationships between quantities.
7.RP.3 Use proportional relationships to solve multistep ratio and percent problems.
7.NS.1 Apply and extend previous understandings of addition and subtraction to add and subtract rational numbers.
7.NS.2 Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers.
7.NS.3 Solve real-world and mathematical problems involving the four operations with rational numbers.
7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically.
7.G.2 Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions.
8.EE.5 Graph proportional relationships, interpreting the unit rate as the slope of the Graph.

NGSS (Middle School)

MS-PS3-1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
MS-ETS1-4 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

C3 Social Studies

D2.His.3.6-8. Use questions generated about individuals and groups to analyze why they, and the developments they shaped, are seen as historically significant.
D3.1.6-8. Gather relevant information from multiple sources while using the origin, authority, structure, context, and corroborative value of the sources to guide the

selection.
D3.3.6-8. Identify evidence that draws information from multiple sources to support claims, noting evidentiary limitations.
D3.4.6-8. Develop claims and counterclaims while pointing out the strengths and limitations of both.
D4.2.6-8. Construct explanations using reasoning, correct sequence, examples, and details with relevant information and data, while acknowledging the strengths and weaknesses of the explanations.
D4.3.6-8. Present adaptations of arguments and explanations on topics of interest to others to reach audiences and venues outside the classroom using print and oral technologies (e.g., posters, essays, letters, debates, speeches, reports, and maps) and digital technologies (e.g., Internet, social media, and digital documentary).

Common Core - Language Arts (Grade 7-8)
RI.1 Cite several pieces of textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
W.1 Write arguments to support claims with clear reasons and relevant evidence.
W.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
W.7 Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.
W.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.
SL.1 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.

Standards Assessed
Common Core - Language Arts (Grade 7-8)
SL.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.
SL.6 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.
SL.6 Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.

Common Core – Math
7.G.1 Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

NGSS (Middle School) MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
Sense of Place (Nā Hopena Aʻo and beyond)
Nā Hopena Aʻo 1. Strengthened Sense of Belonging 2. Strengthened Sense of Responsibility 3. Strengthened Sense of Excellence 4. Strengthened Sense of Aloha 5. Strengthened Sense of Total Well-Being

Critical Skills and Concepts:

- Interview your senior partner at a local nursing home
- Identify and learn a problem faced by seniors
- Develop a robot or robotic machine to solve the chosen problem
- Develop a working schedule
- Utilize the engineering notebook to document research, observation, and design process
- Work in teams of 2-3 to design, build, and test
- Prepare a 5-10 minute Critical Design Review for feedback
- Undergo the engineering design process again to solve any issues
- Prepare a final presentation showcasing your solution
- Present your solution in a Assistive Care Robots Expo at the nursing home

STAGE 2:

Authentic Performance Tasks:

- In teams of two or three, identify a problem faced by the elderly. o Research, design, build, program, and test your Assistive Robot.
- Prepare a Critical Design Review.
- Prepare a final presentation describing your Assistive Robot.
- Present your robot in the Exhibition at a local assisted-living home.

Authentic Audience:

Adults from your school and community, and seniors from the local nursing home.

Assessment Plan:
Rubric (to be expanded with comments from the students)

	Needs Improvement	**Satisfactory**	**Excellent**
Engineering Notebook	The engineering notebook is difficult to read. Research and/or design ideas are not included.	The engineering notebook is somewhat organized. Includes research and sketches of robot designs.	The engineering notebook is clearly organized and robot design process is easy to follow.
Visual	Visual is hard to follow. Does not complement or add to the presentation.	Visual is somewhat easy to follow. Includes what was said in the presentation.	Visual is easy to follow and complements the presentation. Very organized.
Presentation	Presentation had minimal to no preparation. Not professional	Students can explain the design process. Some preparation for the presentation. Presentation had some inconsistencies but overall can follow along.	Students understand and can explain how they worked together to develop their robot. Professional presentation. Evident there was a lot of preparation

Other Evidence:

- Engineering notebook including sketches
- Observations
- Research and methodology
- Programming notes
- Flowchart

STAGE 3:

Learning Plan:

Objectives

- Students will learn about current assistive and social robots.
- Students will interview their senior partner and determine a list of problems that will help with robotic technology.
- In their teams of two to three, they will discuss interview notes and identify a problem they will want to solve using robots.
- Each will come up with two to three design solutions and record them in their engineering notebook.
- The team will determine a pre-final solution and figure out a plan of action.
- The team will design, build, program, and test their robot
- Teams will go through a Critical Design Review with a panel of educators and professionals for feedback
- From that feedback, teams will go back to re-design and tweak any issues. o Students should be recording everything in their engineering notebook.
- Teams will prepare and practice for their final presentation and their expo.

Challenge Presented to Students:

By the year 2030, the number of people over the age of 60 will account for about 27% of Hawaii's population. Service robots are becoming more and more popular in the household with the introduction of robotic vacuums and pool cleaning robots. A particular interest service robot developers are taking is assisting elderly people. The use of technical assistive robots or robotic technology will support and improve their independence and quality of life.

Sequence of Lessons (50 minutes – 1 hour each)

- **Class 1:** Intro to assistive robots and service robots
- **Class 2:** Spend a day at the nursing home interviewing your senior partner
- **Class 3:** Intro to project scheduling, continuing developing your work schedule, and identify a problem for your robot design
- **Class 4:** Work day to develop schedule and robot design
- **Class 5:** One-on-one teacher meeting with group to determine feasibility of work schedule and robot design
- **Class 6:** Intro to Critical Design Review
- **Class 7:** Programming and Sensors
- **Class 8-12:** Continue to design, build, and test your robot
- **Class 13:** Critical Design Review
- **Class 14:** Finalize rubric for assessment as a class
- **Class 15-18:** Continue to re-design and test your robot. Prepare for your final presentation
- **Class 19:** Final presentation to class and guests
- **Class 20:** Assisted robot exhibition at the nursing home

Adaptability:

This unit is designed not only for grades 7 and 8, but can also be modified to meet the standards of elementary and high school students. For example, the unit can be expanded for students to undergo the engineering design process multiple times until they reach a point of "completeness." This unit can also incorporate business ideals as well. A business plan including budget, feasibility, and market, can also be added to the assessment. Students may present their business plan to investors as part of the authentic audience. Therefore, this thematic unit can be applied to different grade levels and different classrooms in order to fit the needs of the students and the community.

If the class is not able to partner with a local nursing home, students may interview a family member or someone they know who is over the age of 60. The exhibition may occur in the classroom extending the invitation to students' families and other classes.