Design an Invasive Species Game

High School Guam STEM Design Challenge

Anchor Question: How can our Guam residents and tourists learn about the invasive non-native plants and animals who are harming our island ecosystems, and know what to do to help reduce their negative impact?

OVERVIEW

Guam Connection

Throughout history, people have intentionally and unintentionally moved plant and animal species to new environments. Some of these species have proved beneficial, but others invade natural habitats causing environmental, and sometimes economic harm. A few examples of invasive animal species include the brown tree snake, African land snail, coconut rhinoceros beetle, and the recently arrived greater bandit hornet.

Before the accidental release of the brown tree snake in the 1940's, Guam was home to 14 species of terrestrial birds. The loss of these birds is believed to be largely a result of predation by the venomous brown tree snake. Snakes are still a problem with an estimated 2 million still on the island. As many as twelve bird species are believed to have been driven to extinction. Ten species of forest birds have been eliminated by this invasive serpent. Without the birds, agriculture has been affected by the loss of insect control previously provided by birds and lizards. Guam is said to have many more insects and 40 times more spiders than neighboring islands, because bird populations are severely diminished, and the forests are almost completely silent due to lack of birdsongs.

Engineering Design Challenge

Invasive non-native plants and animals can cause severe changes to local environments. This alters the normal balance between the plants and animals. Residents and tourists see the many unique plants and animals on Guam, and may not know if they are native to the island or came here from another place. Many organisms are hitchhikers and travel to the island in planes, on people's shoes and clothes or even on boats.

*Design an interactive game that teaches others about the impacts of one or more invasive species on Guam's environment, plants, people, and other animals. To understand how this has happened on Guam, research invasive species to determine how these species got to their new locations and what characteristics are enabling them to change the natural balance of the native plant and animal populations. Once you have completed your game, teach and facilitate playing the game with younger students, family, or community members. Extension idea: Participate in a project or other solution to reduce the impact of an invasive species.

Challenge: Design a Game https://www.sciencefriday.com/educational-resources/design-a-game/

Design a Game Challenge
http://tgrfoundation.org/wp-content/uploads/sites/14/2020/04/Design_challenge_5day_vertical_WEEK5-1.pdf

NGSS Performance Expectation

LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.]

Science Ideas (NGSS Disciplinary Core Ideas)

To understand the problem and complete the engineering design, students need to understand:

LS2.C: Ecosystem Dynamics, Functioning, and Resilience. Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of *invasive species*, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.

LS4.D: Biodiversity and Humans. Biodiversity is increased by the formation of new species (speciation) and *decreased by the loss of species* (extinction).

ETS1.B: Developing Possible Solutions. When evaluating solutions, it is important to take into account a range of constraints including cost, safety, reliability, and aesthetics and to consider social, cultural and environmental impacts. *(secondary)*

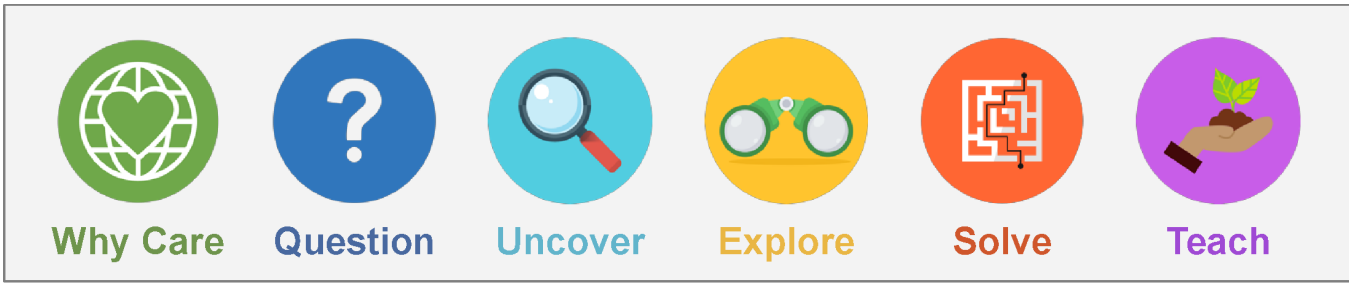
Time: Estimated Number of Classes

3 - 5 classes (45-minute class)

Materials for the Design Challenge

See design challenge for supplies. It will depend on type of game created.

THE Q-U-E-S-T EXPERIENCE



Overview of QUEST sequence

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QUEST TO SOLVE THIS GUAM DESIGN CHALLENGE

Why Students Care

How can you introduce the Quest's anchor question and the engineering design challenge to show its relevance to the students' world, spark their interest, and inspire them to CARE about solving the problem? What stories and phenomena could you include?

Driving Questions	***Concept, skill, issue (Students understand)***	Lesson resources ***(Students could do)***
Why should I care about this anchor question and design challenge? How might it affect my island, my community, my family, and/or me?	Invasive non-native plants and animals can cause severe changes to local environments. This alters the normal balance between the plants and animals.	Guam Design Notebook: Write or draw your "why I care" and why others on Guam care. You could pose any of these questions about invasive species. ● Why does Guam have so many spiders? ● Why do we rarely hear birds singing? ● Where did Guam's fruit bats go? ● Why are so many of our palm trees dying and being cut down? ● Why does the Guam rail only live on Coco Island? Show photos or a video to help introduce the invasive species impact. Share this or other story: Before the accidental release of the brown tree snake in the 1940's, Guam was home to 14 species of terrestrial birds. The loss of these birds is believed to be largely a result of predation by the venomous brown tree snake. Snakes are still a problem with an estimated 2 million still on the island. As many as twelve bird species are believed to have been driven to extinction. Ten species of forest birds have been eliminated by this invasive serpent. Without the birds, agriculture has been affected by the loss of insect control previously provided by birds and lizards. Guam is said to have many more insects and 40 times more spiders than neighboring islands, because bird populations are severely diminished,

Driving Questions	***Concept, skill, issue (Students understand)***	Lesson resources ***(Students could do)***
		and the forests are almost completely silent due to lack of birdsongs.

Question

Engineering design challenges begin with QUESTIONS that guide the path forward. How will you get students to brainstorm and record what they know about the challenge and possible solutions, what they need to know (questions they have), and ideas they have to solve the challenge problem?

Driving Questions	***Concept, skill, issue (Students understand)***	***Lesson resources (Students could do)***
What do we KNOW already about these non-native animals and how they impact our island? What do we NEED TO KNOW about these non-native animals to be able to design a game to teach others about them and their impact? What kind of project could we DO to design and create a game that teaches others about our invasive species, their impact, and actions to reduce harm from them?	NGSS Science & Engineering Practice: Asking questions and defining problems ● These lists help create a map for what we will learn and do on the Quest. ● We already know some things about or have had experiences related to the challenge. ● There are questions we need to answer if we are to understand the problem in the challenge and to design a project to solve the problem. We already have some ideas about possible projects, and we need more information before deciding what we should do.	<u>Guam Design Notebook</u>: Write KND lists, organizing questions from class that are being displayed. <u>Create</u> a KND chart (Know, Need to Know, Do) to go with the three driving questions. ● Brain dump and brainstorm on: ● Chart paper ● Driving question poster/wall ● Personal design notebooks ● Jamboard (google digital tool) <u>Instructional strategy to consider:</u> First, students think and write individually, then share and edit in small groups, and finally share out with the full class and build a class chart to post as an editable reference chart throughout the QUEST. An additional step could be for students to sort the responses. Students could organize them to fit with the page topics in UNCOVER and EXPLORE.

Uncover

How will students UNCOVER answers to the questions they asked? What lessons will help students understand the science-engineering concepts and practices related to the problem and possible solutions? What lessons will help students learn about the issue?

Driving Questions	***Concept, skill, issue (Students understand)***	***Lesson resources (Students could do)***
How do invasive non-native species end up on an island like Guam and why are they so harmful to island ecology?	LS2.C Many invasive species came to Guam from other place by human activities. They can disrupt an ecosystem and threaten the survival of some species. LS4.D Invasive species have caused the extinction of some native species, reducing island biodiversity.	https://www.nwf.org/Educational-Resources/Wildlife-Guide/Threats-to-Wildlife/Invasive-Species Become clear about the language about native, non-native, invasive, exotic species. Introducing Invasive Species into a Native Ecosystem https://www.youtube.com/watch?v=gYNAtw1c7hI
How is a particular invasive species affecting plants, people, the environment, and other animals of Guam? What is the impact of a particular invasive species on ○ the environment? ○ local economy? ○ food web? ○ biodiversity? ○ people?	LS2.C Many invasive species came to Guam from other place by human activities. They can disrupt an ecosystem and threaten the survival of some species. LS4.D Invasive species have caused the extinction of some native species, reducing island biodiversity.	**Guam Design Notebook**: Record what you did and learned Invasive species of Guam (start here) https://www.uog.edu/_resources/files/wptrc/IInvasive_species_GuamSM.pdf Invite experts or knowledgeable community members to talk with students about the species they are studying and are working on ways to reduce their harm. Become familiar with several invasive species that you could include in the game you design. Here are a few to start with. Research and gather information needed to create the game about the impact of the invasive species on native species:

Driving Questions	***Concept, skill, issue (Students understand)***	***Lesson resources (Students could do)***
		• Life cycle • Physical and behavioral adaptations that help it survive and thrive on Guam • What it eats and what eats it (place in the island food chain) • Signs of the species being present in an area (e.g., palm tree leaf patterns made by the coconut rhinoceros beetle) • Harm to native species • Current and past solutions (e.g., traps) to reduce the harm. Include citizen science projects. Go to the bottom of this document for a list of student resources about these invasive species • Brown tree snake • Coconut rhinoceros beetle • Greater banded hornet • African land snail
What interactive games exist that simulate an animal's interactions with its environment and other living things?	Interactive games are an effective way of teaching others about a science concept or issue. s NGSS Science & Engineering Practice: Obtaining, evaluating, and communicating information	Have students look at a variety of interactive games, considering the structure of the game could be adapted to create a simulation of the life and impact of an invasive animal species. Go to the bottom of this document for a list of of board games, physically active games, and cards games that could be considered as models for an invasive species game.

For more lesson resources on these concepts, see Additional Resources (p.).

Explore

How can students apply what they've learned in Uncover to EXPLORE the problem in their community and compare their project ideas to solve the problem?

Driving Questions	***Concept, skill, issue (Students understand)***	***Lesson resources (Students could do)***
How can we apply what we learned in UNCOVER to understand the problem in our community and to come up with project ideas to help solve the problem?	Review and apply concepts from Uncover	Revisit the KND lists you wrote at the beginning of your Quest. Add and edit them to include new understandings and experiences from UNCOVER. KNOW - What have your confirmed as accurate? Correct any inaccurate information. NEED to know - Mark any questions that you have answered, and ones you still need and want to answer. Add new questions. DO - Add any new project ideas you could do to help solve the problem.
How can our Guam residents and tourists learn about the invasive non-native species who are harming our island ecosystems, and know what to do to help reduce their negative impact?	NGSS Science & Engineering Practice ● Defining problems (for engineering) ● Developing and using models ● Designing solutions (for engineering)	Guam Design Notebook: ● Design Challenge Map- Begin this and continue completing throughout the design process. ● Requirements and Limitations (criteria, constraints) ● Action Plan *Design an interactive game that teaches others about the impacts of one or more invasive species on Guam's environment, plants, people, and other animals. ● Design the framework for the game: How the game will tell the story of this invasive species, and what players will do to simulate its life. What will the players do in the game? ● Decide what information about the invasive species is important to include in the game to simulate its story and impact. Research the invasive species to determine how these species got to their new locations and what characteristics are enabling them to change the natural balance of the native plant and animal populations.

Solve

How do you want students to go through the engineering design process to design and do a project to SOLVE the problem? How will they choose one design to create, test and get feedback on, refine, and test again? How do you want them to defend their most effective design?

Driving Questions	***Concept, skill, issue (Students understand)***	***Lesson resources (Students could do)***
How can I create and test a design that is most effective at helping solve the problem?	***NGSS Performance Expectation*** LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.] The project follows a series of design Projects follow a series of design steps to determine the most effective design to solve the problem. 1. Define your design idea you want to create. 2. Create the design idea. 3. Determine how effective the design is by testing it and/or getting feedback from others. 4. Improve the design as many times as needed, based on tests and feedback. 5. Determine and defend your choice of the most effective design. 6. NGSS Science & Engineering Practice ● Defining problems (for engineering) ● Developing and using models ● Designing solutions (for engineering)	<u>Guam Design Notebook:</u> ● Action Plan: Build out ● Design Challenge Map: Continue ● Team Self-Review: Rate the strengths of your design ● Peer/Expert Feedback: Get input from others about your design(s) ● Claim-Evidence-Reasoning (CER): Defend your design of choice. Explain why your design is most effective for catching the animal and reducing the harm it causes our island's native animals and plants. Steps: 1. Build the game with labeled drawings, instructions, any game materials and how they would be used. 2. Play the game to see how it works. 3. Get feedback: Talk with experts to confirm accuracy. 4. Refine: Play again. Get another team to play it and give feedback. 5. Refine and write a CER defense of your game design.

Driving Questions	*Concept, skill, issue (Students understand)*	*Lesson resources (Students could do)*
	• Engaging in argument from evidence	

Teach

TEACH expands the project's impact. How can students share the project they created as an effective solution to the problem or challenge?

Driving Questions	***Concept, skill, issue (Students understand)***	***Lesson resources (Students could do)***
How can you share your project to teach others about the problem and to inspire and empower them to be a part of the solution?	NGSS Science & Engineering Practice: Obtaining, evaluating and communicating information	Guam Design Notebook: ● TEACH: Plan for sharing. Use this as a guide to plan a way to share ● Looking back, planning forward. Reflect on what you did and what you might do in another design challenge. Once you have completed designing and testing your game, teach others (e.g., younger students, another class, family, community group) to play the game. Extension idea: Participate in a project or other solution to reduce the impact of an invasive species.

Additional Resources

Invasive species on Guam

- Brown tree snake
  - Brown tree snake, Invasive species information (several videos here)
  - Brown Treesnake https://youtu.be/SfwffcCeeqA and https://youtu.be/-NTCzIR6awk
  - Article: Invasive Brown Treesnake Present on Cocos Island, Agencies Working to Prevent Further Spread (2020)

- Coconut rhinoceros beetle
  - Coconut rhinoceros beetle (video embedded)
  - The rhinoceros beetle https://youtu.be/3jr3V6kcJzk?t=56
  - A Pacific Battle to Eradicate the Rhinoceros Beetle (Oct 2017)
  - Coconut rhinocero beetle: cnas-re.uog.edu/crb

- Greater banded hornet

- Greater banded hornet, New invasive wasp found on Guam, PNC (video embedded). Video news report on wasp.
- Great banded hornet fact sheet: http://cnas-re.uog.edu/ insect-fact-sheets/

- African land snail
  - Land snails of the Mariana Islands https://www.guampedia.com/land-snails-akaleha-of-the-mariana-islands/
  - Invasive species on Guam https://www.uog.edu/_resources/files/wptrc/IInvasive_species_GuamSM.pdf
  - Giant Africa land snail https://www.invasivespeciesinfo.gov/terrestrial/invertebrates/giant-african-snail
  - Video: Giant African land snail https://www.youtube.com/watch?v=zIEGQo80WTU

Games

- Board games examples:
  - Marae-opoly - (Article) This Maori [New Zealand] community used surprising tactics to avoid killer floods
  - Pandemic: A cooperative board game in which players work as a team to treat infections around the world while gathering resources for cures.

- Physically active game examples:
  - Turtle Hurdles (Project Wild physical activity modeling life of sea turtle) https://seatuddddddfrtleexploration.com/wp-content/uploads/2014/05/Hatching-Turtles-Turtle-Hurdles-Activity.pdf
  - Oh Deer (Project Wild activity based on Red Rover game) https://idrange.org/wp-content/uploads/2020/07/Oh-Deer.pdf
  - Quick Frozen Critters https://kidszoo.org/wp-content/uploads/2014/02/Quick-Frozen-Critters.pdf

- Card game
  - Ecologies. (Read "Description" on right under cost)https://boardgamegeek.com/boardgame/291855/ecologies

Example of an invasive species game:

- Design a physical activity game focused on one invasive species. The game would simulate the changing impact of when the population grows without any ecological controls, and when natural or human-designed solutions are put in place. The game will simulate the interaction the invasive species has with Guam's native species and the environment during different stages of its life cycle. The first part of the game would simulate the effects of the species when there are no controls on its population or behaviors. The second part of the game would introduce any natural or human-designed solutions (e.g., traps) being tried on island to mitigate and reduce the impact of the species on native species and the

island environment. Debriefing and sense-making of the game could include skills practice of graphing any population data collected during the game, summarizing, Claim-Evidence-Reasoning.