Mitigate Impacts of Island Development and Deforestation by Increasing Native Plants

High School Biology Guam STEM Design Challenge

Anchor Question: How can we help increase our native species and ecosystem biodiversity that are threatened by island development, deforestation, and invasive species?

Overview

Guam Connection

The number and diversity of our island's native plant and animal species are decreasing for several reasons. Parts of our jungles and mountains have been cleared of plants to create space for development and military operations. The native species once living in these places must find other places to live, which can lead to conflict from sharing space with people in neighborhoods and towns. Nonnative invasive species, most brought to the island by people, are competing with our native species for the limited space when development happens. The survival of native endemic plants, ones found only on Guam, is threatened. These endemic species create the unique biodiversity on our island.

Engineering Design Challenge

Use the iNaturalist and SEEK apps to gather baseline data on the number and diversity of native and invasive plant and animal species on or near school grounds. Based on the data and other expert advice, you can choose a project to try to increase native plant numbers and diversity. Either design a place to plant native plants on or near school grounds, or remove an invasive plant or animal species (chain of love vine or an animal species), or work with a local business, parks department, government, or homeowners to help them increase native species, and/or reduce harm from development or deforesting land.

NGSS Performance Expectation

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. [Examples include finding the average, determining trends, and using graphical comparisons of multiple sets of data.]

STEM Concepts (NGSS Disciplinary Core Ideas)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience. 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 survival of some species.

LS4.D: Biodiversity and Humans. Biodiversity is 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)
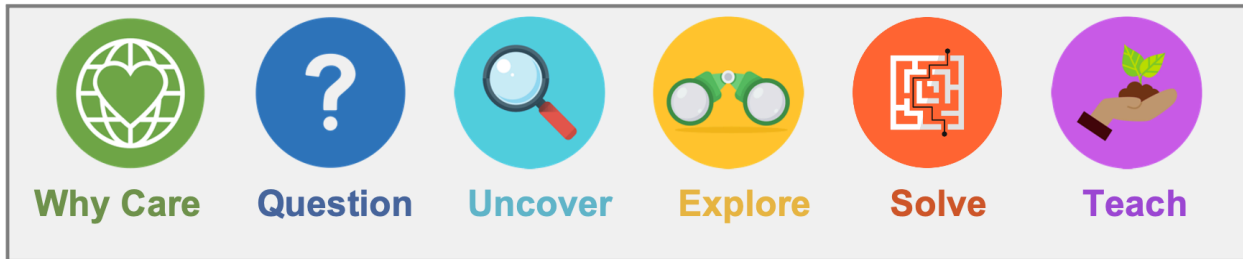
Time: Estimated Number of Classes	Materials for the Design Challenge
4-7 classes (45-minute class)	- Digital devices to access iNaturalist app - Gardening supplies to plant native plants on school grounds, native plant seeds or seedlings (Free at Guam Dept of Agriculture)

The Q-U-E-S-T Experience

Why Care	**Question**	**Uncover**	**Explore**	**Solve**	**Teach**

Why Care?	What is the problem, anchor question, and design challenge? How is this relevant and interesting to us and where we live?
Question	Begin by asking QUESTIONS about the problem and ways to solve it. Figure out what you already know, and brainstorm what you could do.
Uncover	Learn the science ideas needed to understand the problem and design a project to solve the problem.
Explore	Apply what you've learned in Uncover to EXPLORE the problem in your community and consider project ideas to solve the problem.
Solve	Use the engineering design process to design and do a project that helps SOLVE the problem.
Teach	Share your project with others to help others understand the problem and how your project helped solve it.

Why Care?

What is the problem, anchor question, and design challenge? How is this relevant and interesting to us and where we live?

Introduce the Quest

1. **Post and read the anchor question:** How can we help increase our native species and ecosystem biodiversity that are threatened by island development, deforestation, and invasive species?

2. **Read, describe, and post the design challenge:** Use the iNaturalist and SEEK apps to gather baseline data on the number and diversity of native and invasive plant and animal species on or near school grounds. Based on the data and other expert advice, you can choose a project to try to increase native plant numbers and diversity. Either design a place to plant native plants on or near school grounds, or remove an invasive plant or animal species (coral vine/chain of love or an animal species), or work with a local business, parks department, government, or homeowners to help them increase native species, and/or reduce harm from development or deforesting land.

3. **Share and talk about the Driving Question for why we should care:** Why should I care about protecting native species and ecosystem biodiversity on our island?

4. **Do this:** Read, watch videos, and discuss current threats to Guam's native species from development, deforestation, invasive species, and other local issues you are aware of.

a. [Controversy looms over new hospital site](#), (Jan. 2023), The Guam Daily Post
b. [Tropical island forest on Guam being dug up for military firing range,](#) (Feb. 2019), The Independent
c. [Foreshadowing the Marine Corps landing at Guam's Camp Blaz,](#) (March 2023), The Diplomat.
d. [Invasive species on Guam](#), (2020), National Pesticide Safety Education. (Optional to include. There is a separate design challenge specifically on Guam's invasive species, or can wrap in here.)

Guam-STEM Design Notebook for students ([FOLDER with pdf and editable pages](#))

Write or draw your "why I care" and why others on Guam care.

Question

Begin by asking QUESTIONS about the problem and ways to solve it. Figure out what you already know, and brainstorm what you could do.

Ask Questions

1. **Create a KND Chart (Know, Need to know, Do)** with the three driving questions below. Save the questions and responses to look at during the QUEST; writing them on chart paper, butcher paper, in student design notebooks, or use a digital organization chart, like Jamboard. KND Questions:
   a. What do we **KNOW** already about native plant and animal species on Guam, and about the threats to these species?
   b. What do we **NEED TO KNOW** to understand Guam native species are threatened, and why they are important to people and our ecosystems? What do we need to know to help protect the diversity of native species on Guam?
   c. What could we **DO** to learn about native species and threats to them? What are some ideas of what we could DO to help native species and protect the ecosystem biodiversity of our island?
2. **Gather responses from students.** Have students think and write responses: First, silently and individually. Then, in small groups. And finally, with the full class. The result is a class KND chart to refer to, add to, and reorganize throughout the QUEST. Students could sort the responses that are similar. This information will help guide the UNCOVER and EXPLORE.

Guam-STEM Design Notebook for students ([FOLDER with pdf and editable pages](#))

Write the driving question and summarize what you did and learned. (blank page)

Uncover

Learn the science ideas needed to understand the problem and design a project to solve the problem.

Teacher Prep

1. Decide if you want to set the study site boundaries for the iNaturalist project where you want students to gather data about native species or if you want students to help do this? Watch this video with instructions for how to create the project: [Create an iNaturalist Project for Your School & Participate in](#)

the City Nature Challenge! You will need to access GoogleEarth. You can do this with students or before students start.

2. Decide on student requirements: What they are observing (Plants and animals- including small insects), how many observations they need to make and enter, where they will be observing, time frame for gathering data.

3. Consider inviting a UOG scientist to help you get set up, or to get students started and inspired to work with iNaturalist. Both are using iNaturalist projects for their work and have consulted on this design challenge. Aubrey Moore aubreymoore@triton.uog.edu and /or Roland Quitugua quituguarj@triton.uog.edu

Uncover Key Ideas

1. **Share the Driving Question:** What plant and animal species currently live on (or around) school grounds?

    a. Decide on the boundaries of the area where you want to gather observation data on plant and animal species (an area on school grounds, the entire school grounds, an area that extends beyond school grounds into the neighborhood or community. If you have the invasive coral vine (chain of love) around your school-community, you could consider including it in the study area. A project could be removing this plant to see if natives recover.

        i. Have students with phones or tablets download the SEEK app by iNaturalist. Create an observation sheet for them to record observations. (Species, number, location)

        ii. Go outside to have them practice on 1-2 plants all together. Then have them work in pairs to make observations and collect data in the designated area.

        iii. Go back to the classroom to share data. Discuss how the data could help inform decisions we make about what to plant, where to plant, and possibly what invasive species to remove. What does it say about the diversity of plants and animals on or around school grounds, about invasive species on school grounds?

2. **Share the Driving Question:** How can we use the citizen science app iNaturalist to formally collect and organize our observations for us and for scientists on Guam?

    a. Have students go to the iNaturalist website. Give them time on iNaturalist.org to discover and explore. You can have them record "I noticed, I like, I wonder, Questions I have."

    b. Watch How to use iNaturalist. Choose any other video instructions from the iNaturalist YouTube channel that would be helpful.

    c. Give students time to explore the iNaturalist Biodiversity of Guam project site. Click on the top menu links: Overview, Observations, Species, Identifiers, Observers. What information is there and how is it helpful in understanding ecosystem biodiversity on Guam? What information can you find about species in your community?

    d. The first part of this class design challenge is to gather data on any plant and animal species around the school (and possibly neighborhood or community). You have either set up the iNaturalist school biodiversity project already, or you are going to have students help now. Have students go to the project site you (teacher) have set up, or have students set up the project on iNaturalist.

     i. To set up a project, follow the instructions to [Create an iNaturalist Project for Your School & Participate in the City Nature Challenge!](#) You will need to access [GoogleEarth](#). You can do this with students or before students start.

     ii. Decide on and explain student requirements: What they are observing (Plants and animals- including small insects), how many observations they need to make and enter, where they will be observing, time frame for gathering data.

     iii. Aubrey Moore aubreymoore@triton.uog.edu and /or Roland Quitugua quituguarj@triton.uog.edu are advisors to any iNaturalist project you do. They asked that any photos of animals on plants (insects, spiders, and other animals) also include enough of the plant to also be identified. They hope to gather data on the relationships between these animals and plants. Remember you can invite these UOG scientists to help you get set up, or to get students started and inspired to work with iNaturalist. Both are using iNaturalist projects for their work and are consulting on this design challenge.

e. The class is going to collect data on the ecosystem biodiversity in a designated area on school grounds or a larger part of the community. Show students the class iNaturalist project page you have set up. Show how to join the project and add observation data.

f. Watch [How to use iNaturalist. Choose any other video instructions from the iNaturalist YouTube](#) channel that would be helpful.

g. Have students download the iNaturalist [app](#) on phones and tablets.

h. Go outside, demonstrate, and have students practice using the app on any plant or animal. Each student can take 2-3 photos, have the app identify it, and upload in the iNaturalist database. Make sure everyone feels confident using the iNaturalist app and recording observations in your class project.

i. While collecting data on iNaturalist, have students research and gather information about their targeted invasive species. Here are ideas of information that could be researched, organized, and shared. Go to the bottom of this document for a list of native species resources that students can begin with.

     i. Life cycle

     ii. Physical and behavioral adaptations that help it survive and thrive on Guam

     iii. What it eats and what eats it (place in the island food chain)

     iv. Signs of the species being present in an area

     v. Relationships with its native island environment

     vi. Any threats to it surviving and thriving on Guam

j. Take students back out to the study site after doing the research. They will be better able to identify signs of invasive species. If your study site is larger than school grounds, have specific requirements of how many observations, and of what, each student needs to make in a designated number of days.

3. **Share the Driving Question:** Which plants and animals are native and which are invasive? Why does that matter to island biodiversity and the health of ecosystems?

a. Watch [Why Native Plants](#)

b. Discuss this infographic: [Why native plants are better than nonnatives](#)

4. **Share the Driving Question:** What does the data tell us about the diversity of native plants and animals in our study site?

    a. <u>Prep by teacher</u>: Look at this slide deck with video support in i<u>Nat Data in your Classroom</u> to decide if you want students to practice analyzing iNaturalist data as described here. Roland and Aubrey can help with this.

    b. <u>Practice with other data</u>: Students could also look at existing data (stats) for the <u>iNaturalist Biodiversity of Guam citizen science project.</u> How would you summarize it and what does it tell us? What other mathematical representations of data could you create (examples: Make a different graph or a table of the data provided, pull out and organize other data such as the number of a particular species that you found around school or that interest you).

    c. <u>Then analyze your project data</u> gathered in your school-community study site. This is called baseline data and describes the diversity of life before any project you do to help increase biodiversity.

Guam-STEM Design Notebook for students (FOLDER with pdf and editable pages)

Write the driving question and summarize what you did and learned. (blank page)

Students will understand these NGSS Disciplinary Core Ideas:

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 decreased by the loss of species (extinction)

Explore

Apply what you've learned in Uncover to EXPLORE the problem in your community and consider project ideas to solve the problem.

Apply Your Learning

1. **Share the Driving Question with students:** How can we apply what we learned in UNCOVER to figure out how to improve the diversity of native plants and animals around school in our study site?

2. **Revisit the KND lists** you wrote at the beginning of your Quest. Add and edit them to include new understandings and experiences from UNCOVER.

    a. KNOW - What have you confirmed as accurate? Correct any inaccurate information.

    b. NEED to know - Mark any questions that you have answered, and ones you still need and want to answer. Add new questions.

    c. DO - Add any new project ideas you could do to help solve the problem.

3. **Return to the anchor question:** How can we help increase our native species and ecosystem biodiversity that are threatened by island development, deforestation, and invasive species?

4. **Read and talk about the design challenge:** Use the iNaturalist and SEEK apps to gather baseline data on the number and diversity of native and invasive plant and animal species on or near school grounds. Based on the data and other expert advice, you can choose a project to try to increase native plant numbers and diversity. Either design a place to plant native plants on or near school grounds, or remove

an invasive plant or animal species (coral vine/chain of love or an animal species), or work with a local business, parks department, government, or homeowners to help them increase native species, and/or reduce harm from development or deforesting land.

5. **Project ideas:** Research and decide on the project your class wants to do to increase biodiversity of native plants in the study area of your school (community) and to protect any diversity that is currently there. Here are some project ideas:

   a. Invite experts to advise: Guam Green Growth (UOG) and Guam Native Plant Society

   b. Design and plant a native garden:

      i. Getting Started with a Native Garden

      ii. Reference your iNaturalist data for what is growing on your site already.

      iii. Use resources to guide plant choice decisions: Flora and Fauna of Guam (ebook UOG), Field and Garden Plants of Guam, (field guide), Native Plants of the Marianas Islands

   c. Work with a local business, park, government, or homeowners to help them increase native species, reduce invasive species, or reduce harm from development or deforesting.

Guam-STEM Design Notebook for students (*FOLDER with pdf and editable pages*)

- Design Challenge Map- Complete as much as you can. Then add to and edit it throughout SOLVE.
- Design Requirements and Limitations (criteria and constraints)

Students will understand these NGSS Disciplinary Core Ideas:

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)

Solve

Use the engineering design process to design and do a project that helps SOLVE the problem.

Design & Do Your Project

1. At the end of EXPLORE you decided what project you want to do. Now design and complete it! Map out the project: Where, What, How, When, Who. Use pages in the Design Notebook to guide students in this design process.

2. Your steps will follow the steps of the Engineering design process (Poster).

Guam-STEM Design Notebook for students (*FOLDER with pdf and editable pages*)

- Edit and complete the Design Challenge Map.
- Edit and complete the Design Requirements and Limitations (criteria and constraints)
- Action Plan: List steps to complete the project, and who will do what.
- Team Self-Review: Review your project design to make sure it is focused on the design challenge, anchor question, and Guam.
- Gathering Feedback from Others: Get input from others to help strengthen your project.
- Claim-Evidence-Reasoning (CER): Give evidence for the most effective project design.

Teach

Share your project with others to help others understand the problem and how your project helped solve it.

Share & Reflect on What You Learned

1. **Return to the anchor question:** How can we help increase our native species and ecosystem biodiversity that are threatened by island development, deforestation, and invasive species?

2. **Prepare and creatively share your project and how it helped solve the problem.**
   a. Build your presentation around the anchor question. How can we help increase our native species and ecosystem biodiversity that are threatened by island development, deforestation?
   b. Who's your audience? Who will benefit from hearing about and seeing your project?
   c. How will you share this information?
   d. What do you want them to know and understand about the problem, how you collected data on iNaturalists, your project and its impact?
   e. When and where will you share?

3. **Student reflection:** Students can reflect on their experience with this design challenge while preparing their presentation or afterwards. Here is one reflection idea: 4-3-2-1: Looking back, planning forward. Respond to:
   a. FOUR of the most important things I learned doing this design challenge.
   b. THREE of the most important things I learned about myself doing this design challenge.
   c. TWO things I will do differently in my next problem-solving experience.
   d. ONE thing I now want to learn more about.

Guam-STEM Design Notebook for students ([FOLDER with pdf and editable pages](#))

- TEACH. Make a plan for sharing your project with others.
- Looking back, planning forward. Reflect on what you did and what you might do next time.