ENGINEERING - LESSON PLAN

Grade:	11 years old
Subject:	United in Biodiversity – Invasive Species
Lesson n°:	**6-10**
Topic:	**Biomimicry: Nature-Inspired Solutions**
Lessons focus and goals:	Lesson Focus: ● Understanding invasive species: Students will learn about the impact of invasive species on ecosystems. ○ The threat of invasive species - Jennifer Klos by TED-Ed ○ What Are Invasive Species? by Explore Nature ● Biomimicry principles: Students will explore the concept of biomimicry and how to apply it to solve real-world problems. ○ Biomimicry: definition & examples (explained with drawings) by Sustainability Illustrated ○ Biomimicry 101 - Examples Of How We Copied Nature by Tinyverse ● Design and research skills: Students will practice research, observation, and design thinking processes. Lesson Goals: ● Develop critical thinking and problem-solving skills through analysis of natural systems. ● Foster creativity and innovation by designing nature-inspired solutions. ● Enhance understanding of ecological relationships and the

	importance of biodiversity. ○ Why is biodiversity so important? - Kim Preshoff by TED-Ed ○ Ecological Relationships by Amoeba Sisters ● Cultivate an appreciation for the natural world as a source of inspiration and innovation. ● Develop collaboration and communication skills through group work and presentations.
Learning objectives:	Science ● Identify and describe key characteristics of invasive species. ● Explain the impact of invasive species on ecosystems and biodiversity. ● Understand the concept of ecological balance and how it is disrupted by invasive species. Technology ● Conduct research using digital resources to gather information about organisms. ● Utilize technology tools to design and model potential solutions to ecological problems. ● Develop basic digital presentation skills to communicate findings. Engineering ● Apply the engineering design process to create solutions to real-world problems. ● Develop models or prototypes based on observed natural systems. ● Evaluate the effectiveness of design solutions based on specific criteria. Art ● Visualize and communicate design ideas through sketches, drawings, or digital tools. ● Explore the relationship between art and science in creating innovative solutions. Mathematics ● Collect and analyze data related to invasive species and their impact. ● Use measurement and estimation skills in the design process. ● Apply basic mathematical concepts to evaluate design performance

Materials	The specific materials will depend on the chosen animal or plant model and the desired complexity of the project. Here are some general materials that could be useful: Research Materials

	• Books, magazines, or online resources about animals, plants, and ecosystems • Access to computers or tablets for internet research Design and Prototyping Materials • Various art supplies (markers, crayons, pencils, paints) • Construction paper or cardboard • Recycled materials (boxes, plastic bottles, etc.) • Natural materials (leaves, sticks, feathers) • Modeling clay or playdough • Digital design software (optional) Presentation Materials • Presentation boards or poster paper • Markers or pens Additional Materials (depending on specific projects) • Magnifying glasses • Digital cameras • Gardening supplies (for growing plants) • Small containers for observations
Structure and activities	**Lesson Structure:** **1. Introduction to Invasive Species and Biomimicry (1-2 sessions):** • Introduce the concept of invasive species and their impact on ecosystems. • Explain the concept of biomimicry and provide examples of biomimetic inventions. • Discuss the engineering design process. **2. Research and Selection (1-2 sessions):** • Students research different invasive species and their impacts. • Students select an invasive species to focus on. • Students research animals or plants that have natural defenses against similar threats. **3. Design and Prototyping (2-3 sessions):** • Students brainstorm ideas for biomimetic solutions based on their research. • Students sketch and develop initial designs. • Students create prototypes using available materials. **4. Testing and Refinement (1-2 sessions):** • Students test their prototypes to assess their effectiveness. • Students make improvements based on test results. **5. Presentation and Sharing (1 session):** • Students present their final designs and explain their thought process. • Students share their learning experiences and reflections. **Proposed Activities:** **Session 1: Introduction** • Watch videos about invasive species and biomimicry. • Discuss the impact of invasive species on local ecosystems.

	• Introduce the engineering design process. **Session 2: Research** • Provide students with resources for researching invasive species and natural defenses. • Guide students in selecting an invasive species to focus on. • Encourage students to brainstorm potential biomimetic solutions. **Session 3: Design** • Introduce design thinking tools (e.g., brainstorming, sketching). • Have students sketch initial design ideas. • Discuss the importance of considering materials and constraints. **Session 4: Prototyping** • Provide students with materials to create prototypes. • Encourage collaboration and peer feedback. • Emphasize the importance of testing and iteration. **Session 5: Testing and Refinement** • Conduct prototype testing activities. • Discuss the results and identify areas for improvement. • Allow students to modify their designs based on feedback. **Session 6: Presentation** • Prepare students for presentations. • Provide guidelines for creating visual aids. • Conduct presentations and class discussions.
Examples	**Example 1: Inspired by the Burdock Plant** • **Invasive Species**: Thistle • **Biomimicry Model**: Burdock plant's seed dispersal mechanism (hook-and-loop system) • **Creation**: A reusable fastener system inspired by the burdock's hooks. Students can create prototypes using materials like cardboard, fabric, and velcro. **Example 2: Inspired by the Kingfisher** • **Invasive Species**: Mosquitoes • **Biomimicry Model**: Kingfisher's streamlined body for diving into water • **Creation**: A design for a more efficient water filtration system based on the kingfisher's beak shape. Students can create models using plastic bottles and other materials. **Example 3: Inspired by the Gecko** • **Invasive Species**: Ants • **Biomimicry Model**: Gecko's adhesive feet • **Creation**: A design for a sticky trap to capture ants. Students can experiment with different materials to create an adhesive surface inspired by the gecko's feet.

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Technology Tools for Invasive Species & Biomimicry Learning	**Tracking & Research Tools** 1. iNaturalist • Citizen science platform • Students photograph local flora/fauna • Identify potential invasive species • Contribute to global biodiversity database 2. eBird • Bird migration and species tracking • Understand ecosystem disruptions • Compare native vs invasive bird populations **Design & Simulation Tools** 1. Tinkercad • 3D design software • Create biomimetic prototypes • Low learning curve for young learners 2. Merge Cube • Augmented reality ecosystem simulation • Visualize invasive species interactions • Interactive learning experience **Collaborative Platforms** 1. Padlet • Digital collaboration board • Share research findings • Peer feedback on biomimicry designs 2. Google Jamboard • Real-time brainstorming • Collaborative design thinking • Visual idea development **Implementation Strategy** • Introduce one tool per session • Provide structured digital literacy guidance • Ensure equal access and technological equity

Assessments:

#1 - Alignment with Biomimicry Principles
Objective: Evaluate the extent to which the design is inspired by natural systems
Rubric: Alignment with Biomimicry Principles

Description of performance	Initiating	Developing	Excelling
Understanding of Biomimicry	Limited understanding of biomimicry concepts.	Basic understanding of biomimicry principles.	Demonstrates in-depth knowledge of biomimicry and its

			applications.
Identification of Natural Model	Struggles to identify relevant natural models.	Identifies a basic natural model, but lacks depth in analysis.	Identifies complex natural models and analyzes multiple features.
Application of Biomimicry Principles	Minimal application of biomimicry principles in design.	Some application of biomimicry principles in design.	Demonstrates strong application of biomimicry principles in design, resulting in innovative solutions.
Analysis of Design Choices	Unable to articulate reasons for design choices based on biomimicry.	Provides basic explanations for design choices based on biomimicry.	Offers detailed analysis of design choices, connecting them directly to natural models.
Evaluation of Design Effectiveness	Struggles to assess the effectiveness of the design in relation to biomimicry principles.	Can identify some strengths and weaknesses of the design based on biomimicry.	Provides a comprehensive evaluation of the design's effectiveness, supported by evidence.
Sample student response	**Initiating**	**Developing**	**Excelling**
Understanding of Biomimicry	Limited understanding of biomimicry concepts.	Basic understanding of biomimicry principles.	Demonstrates in-depth knowledge of biomimicry and its applications.
Identification of Natural Model	Struggles to identify relevant natural models.	Identifies a basic natural model, but lacks depth in analysis.	Identifies complex natural models and analyzes multiple features.
Application of Biomimicry Principles	Minimal application of biomimicry principles in design.	Some application of biomimicry principles in design.	Demonstrates strong application of biomimicry principles in design, resulting in innovative solution.
Analysis of Design Choices	Unable to articulate reasons for design choices based on biomimicry.	Provides basic explanations for design choices based on biomimicry.	Offers detailed analysis of design choices, connecting them directly to

			natural models.
Evaluation of Design Effectiveness	Struggles to assess the effectiveness of the design in relation to biomimicry principles.	Can identify some strengths and weaknesses of the design based on biomimicry.	Provides a comprehensive evaluation of the design's effectiveness, supported by evidence.

#2 Functionality
Objective: Assess the effectiveness of the prototype in addressing the problem of invasive species.
Rubric: Functionality

Description of performance	**Initiating**	**Developing**	**Excelling**
Problem Solving	Prototype does not effectively address the identified problem.	Prototype partially addresses the problem, with some limitations.	Prototype effectively addresses the identified problem, demonstrating a strong understanding of the issue.
Design Implementation	Prototype does not effectively implement the design concept.	Prototype partially implements the design concept, with some errors.	Prototype successfully implements the design concept, demonstrating attention to detail.
Testing and Refinement	Limited testing and refinement of the prototype.	Some testing and refinement of the prototype, with minor improvements.	Extensive testing and refinement of the prototype, leading to significant improvements.
Practical Application	Prototype has limited practical application in real-world conditions.	Prototype has some practical application, but with limitations.	Prototype has strong potential for practical application in real-world conditions.
Sample student response	**Initiating**	**Developing**	**Excelling**

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Problem Solving	"My thing doesn't really work."	"It kind of works, but not really."	"My invention really helps to catch the bugs!"
Design Implementation	"I don't think I built it right."	"It looks like what I wanted, but it's not working well."	"My design works exactly as I planned."
Testing and Refinement	"I didn't test it."	"I tried it once and it didn't work."	"I tested it a lot and made it better each time."
Practical Application	"I don't know if it would work outside."	"It might work outside, but I'm not sure."	"This would definitely work to stop the bugs!"

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