Ages 10 - 14 | Design Thinking | Empathize | AI & Machine Learning| Computer Vision

Science | 120 min | Educator's Guide

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Summary: Students will explore the importance of coral reefs, their threats, and how technology aids conservation. Through the Reef Census, they will learn how citizens contribute to monitoring coral health and gain hands-on experience training an AI model in Google Colab to predict coral health from images. They will reflect on their learnings and propose tangible actions to protect reefs.

Key Concepts

Importance of Coral reefs, AI & ML

Software

Google Colab

Instructional Objectives

Learners will be able to:

1. Understand the ecological significance of coral reefs and their threats.
2. Explore the role of technology in coral reef conservation through the Reef Census.
3. Use Google Colab to train an AI model to predict coral health from coral images.
4. Reflect on the importance of coral reefs and design actionable solutions for reef protection.

Learning Outcomes

Students will understand coral reefs' ecological importance, use AI tools to assess coral health, and propose tangible actions to conserve them.

Real World Application

Students will learn how AI technology is used to monitor coral health and support reef conservation efforts. They will gain hands-on experience in applying AI tools to analyze coral images and understand how data-driven solutions are used to address real-world environmental challenges.

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1. Lesson Overview

	Activity	Innovation Skill
Introduction (20 min) **Slides 1 – 7**	Explore the ecological importance of coral reefs through discussion and video analysis.	
Development (95 min) **Slides 8 – 23**	Comprehensive exploration of coral reef ecosystems, environmental threats, and conservation technologies	
	Identify potential threats to coral reefs and consider their impacts.	Design Thinking (Empathize)
	Label coral images as healthy or bleached, upload them to Google Colab, and train the AI model to classify images, adjusting variables to improve accuracy.	AI & Machine Learning (Computer Vision)
Conclusion (05 min) **Slides 24 – 28**	Summarize key learnings, discuss challenges, and propose personal and community action plans for coral reef protection.	

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2. Session Preparation

Logistics

Items
Laptop or Desktop, Chromebook (Recommended: 2 learners per laptop)
Worksheets

Installation

1. To work in the Google Colab, refer to Worksheet-2 provided in the working folder and follow the instructions provided.
2. Download and extract files in the "Working Files" folder.
3. Other things to note:
    - For hardware requirements, please refer to the minimum hardware requirements from the software provider.

Working files contain:

- Coral images, Test images.
- Dataset (For teacher reference)
- Google Colab (.ipynb file)
- Worksheets – 1 & 2, Answer Key

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3. Activity Guide

Introduction (slides 1 – 6)		
Duration	**Slide**	**Activity**
20 mins	1	Introduction to the lesson
	2	The Educator begins by providing an overview of the lesson • Understand the ecological significance of coral reefs and their interconnected ecosystem. • Understand how threats like coral bleaching can impact reef health. • Explore the Great Reef Census to understand how citizen science and technology contribute to reef monitoring. • Create and use a Google Colab notebook to classify coral images as healthy or bleached. • Reflect on learnings and design personal and community pledges for coral reef protection.
	3	Play the first video showcasing vibrant coral reefs. Pause after the video and ask questions like, "What caught your attention?" or "How do you feel watching these thriving ecosystems?"
	4	Encourage students to reflect on what they've learned about coral reefs by guiding them to think about their role in the environment. Prompt them to identify the organisms they noticed in the video.
	5	Play the video showing bleached and dying corals. Encourage them to think critically about the stark contrast between healthy and bleached reefs.
	6	Guide students to observe the videos and describe what stands out. Encourage them to think critically about the changes they see in the corals, asking them to consider possible reasons. Allow space for curiosity by asking open-ended questions to prompt further thinking. It will help students develop a deeper understanding of corals.
	7	Once students share their views, transition by saying, Let's deep-dive into corals to understand their ecosystem, how they contribute to the marine ecosystem, and what has been happening to them.

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3. Activity Guide

Development (slides 7 – 10)

Duration	Slide	Activity
15 mins	8	Highlight that People often call coral reefs the "rainforests of the sea" because they support various life forms. Explain that corals provide shelter and protection for many marine species, making them vital to ocean biodiversity. Highlight that millions depend on coral reefs for their livelihoods, whether through fishing or tourism. Emphasize how reefs protect coastal communities by absorbing wave energy, preventing erosion, and reducing the impact of storms and floods.
	9	Corals and algae work together to build coral reefs. Algae provide food to corals through photosynthesis, and corals give algae a home. This relationship supports the reef's structure. Herbivores, like parrotfish, help keep algae growth in check, preventing overgrowth that could harm corals. Secondary consumers, such as groupers, control herbivore populations and help maintain the balance. At the top, tuna and sharks regulate smaller predator populations. The entire ecosystem's health depends on this balance—removing one species can affect the whole food web. Overfishing of apex predators like sharks can disrupt this balance, causing long-term harm to the reef.
	10	Remind students that the food web shown earlier is simplified. In reality, many more species interconnect in the coral ecosystem. Explain that if one part of the system is disturbed, it can cause a chain reaction that affects the entire ecosystem. Ask students to think about what might harm this balance. Encourage them to brainstorm factors such as pollution, climate change, or overfishing that could upset the delicate relationships in the ecosystem. Mindset: Design Thinking | Empathize Learners analyze and understand problems from perspectives that are different from their own, which is critical to identifying problems from other people's points of view.
	11	Connect this slide to the question in Slide 9. Explain that rising ocean temperatures caused by human actions like burning coal, oil, and gas disrupt the coral ecosystem. Warmer waters stress corals, forcing them to expel algae, which leads to coral bleaching. Without algae, corals lose their primary energy source and weaken, harming all species that depend on them.

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3. Activity Guide

Development (slides 11 – 17)		
Duration	**Slide**	**Activity**
35 mins	12	Explain that Human activities like overfishing and pollution harm coral reefs. Overfishing can disrupt the delicate balance of the reef ecosystem by removing key species, leading to algal overgrowth. Pollution, such as plastic and chemical runoff, can damage corals and reduce their survival ability.
	13	Highlight that coral death leads to the collapse of the ecosystem, and human activities are at the core of this problem. Ask what actions people can take to protect coral reefs, leading to the next slide, where you will introduce conservation efforts as the solution.
	14	Explain that Dell Technologies has teamed up with the Citizens of the Reef to use technology for coral conservation. The Reef Census is a global project where people help marine scientists identify and label coral species. Emphasize that their work is vital in collecting data for coral conservation. Dell provided special rugged devices to capture high-quality coral images in harsh ocean environments, and the devices automatically uploaded the pictures to the website for analysis.
	15	Discuss how Dell's AI technology helps analyze coral images faster and more accurately. The AI divides photos into segments, making it easier for citizen scientists to label. It reduces the time spent on analysis from hours to minutes, enabling marine scientists to focus on timely conservation actions and better protect coral reefs.
	16	Introduce the concept of becoming citizen scientists and explain how students will help marine scientists by identifying and labeling different types of corals. Provide a brief overview of the types of corals they need to identify, ensuring students understand the various forms and structures they will encounter.
	17	Explain to students that they will use the Reef Census website to identify corals, emphasizing the importance of following the detailed instructions provided in the worksheet-1.
	18	Ask students to think about how identifying different corals can help scientists understand the health of a reef.

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3. Activity Guide

Development (slides 18 – 23)

Duration	Slide	Activity
45 mins	19	Labeling corals like branching and plating corals, which are vulnerable to stress and bleaching, making them essential for early detection of reef health changes. Identifying these types and reef structure elements paints a comprehensive picture of reef health. This labeled data is crucial for AI to analyze.
	20	Explain that AI helps automate the process of analyzing coral images, which would be too time-consuming manually. Emphasize that the computer learns from labeled images, improving its ability to identify coral species and detect bleaching signs. Highlight the role of computer vision (CV) in AI: it breaks down images into smaller parts like shapes and colors, allowing the computer to "see" and understand the images. This technology makes the process faster and more efficient, helping scientists monitor coral health more effectively.
	21	Explain that we've learned how AI and computer vision can automate the process of analyzing coral images. It's time to apply this knowledge in a hands-on mission. In this activity, you will get the chance to train an AI model to detect whether the corals are healthy or bleached.
	22	Explain that In this mission, you'll: • Label Images & Prepare Dataset: Label the images as 'healthy' or 'bleached' and organize them into a dataset. • Train the Model: Upload the dataset to Google Colab and train the AI model. • Test & Improve: Test the model with new images and make improvements to enhance its accuracy.
	23	Guide students to Activity 2 in the worksheet for detailed, step-by-step instructions on completing the labeling and training process. Highlight that the worksheet will help them test the model's accuracy and analyze their findings. Encourage them to follow the instructions carefully to gain a clear understanding of how the AI works. Skillset: AI & Machine Learning | Computer Vision Learners employ machine learning methods to train computers in the classification of patterns to be able to interpret, understand and react to the visual world.

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3. Activity Guide

Development (slides 24– 26)		
Duration	**Slide**	**Activity**
05 mins	24&25	Encourage students to reflect on how their labeled data contributed to training the AI model and its predictions about coral health. Prompt them to think about challenges they noticed during the activity, such as variability in coral images, etc. Ask them to brainstorm ways to use similar models in real-world conservation scenarios.
	26	Facilitate the discussion by revisiting the causes of coral bleaching—rising ocean temperatures, pollution, runoff from land, and increased UV radiation from sunlight. Encourage students to suggest personal actions like reducing carbon footprints or avoiding harmful chemicals. For community actions, guide them to think about initiatives that tackle these causes, such as advocating for better waste management or supporting policies that reduce industrial pollution. This approach connects the real-world causes of reef decline to tangible actions students can take.
	27	Conclude the lesson by summarizing the key takeaways from our project: • Explored the significance of coral reefs and the impact of threats like bleaching on their ecosystems. • Contributed to the Reef Census by labeling coral images, learning how this data helps scientists monitor reef health. • Used Google Colab to train a model that analyzes coral images using machine learning and computer vision to assess coral health. • Reflected on actions individuals and communities can take to support coral reef conservation.
	28	End of the lesson.

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4. Troubleshooting Tips

Common Mistakes & Issues :

	Issue	Possible Reasons	Resolution
1	Code cell taking too long to execute.	Colab may have lost connection to the runtime.	Interrupt the execution, click the "Stop" button, or reset the runtime.
2	Invalid image path errors (File Not Found Error).	The image paths need to be corrected.	Verify and correct the image paths.
3.	Label mismatches in predictions.	Incorrectly labeled training data.	Verify the labels by displaying sample images and their labels.
		Preprocessing steps not followed correctly.	Check and correct preprocessing steps.

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5. Assessment Rubric

Focus	Learning Outcome	Approaching Expectation	Meeting Expectation	Exceeding Expectation
Design Thinking (Empathize)	Analyze and understand threats to the coral ecosystem from multiple perspectives.	Identifies a few threats to the ecosystem but offers limited or general analysis, showing a basic understanding of the ecosystem's balance.	Clearly identifies multiple threats to the ecosystem and explains how these threats impact its balance. Considers perspectives of different ecosystem components.	Provides a detailed and insightful analysis of multiple threats, examining their interconnections, and demonstrates an empathetic understanding of the ecosystem's fragility.
AI & Machine Learning (Computer Vision)	Train a machine learning model to classify coral images by effectively labeling and developing an accurate classification system.	Labels images with minimal accuracy or consistency, leading to a basic model with limited accuracy and exploration.	Accurately labels images, effectively prepares the dataset, and develops a moderately accurate functional model. Systematically explores parameters.	Demonstrates excellent labeling accuracy, prepares a high-quality dataset, and builds an accurate model. Analyzes results deeply and reflects on dataset quality.