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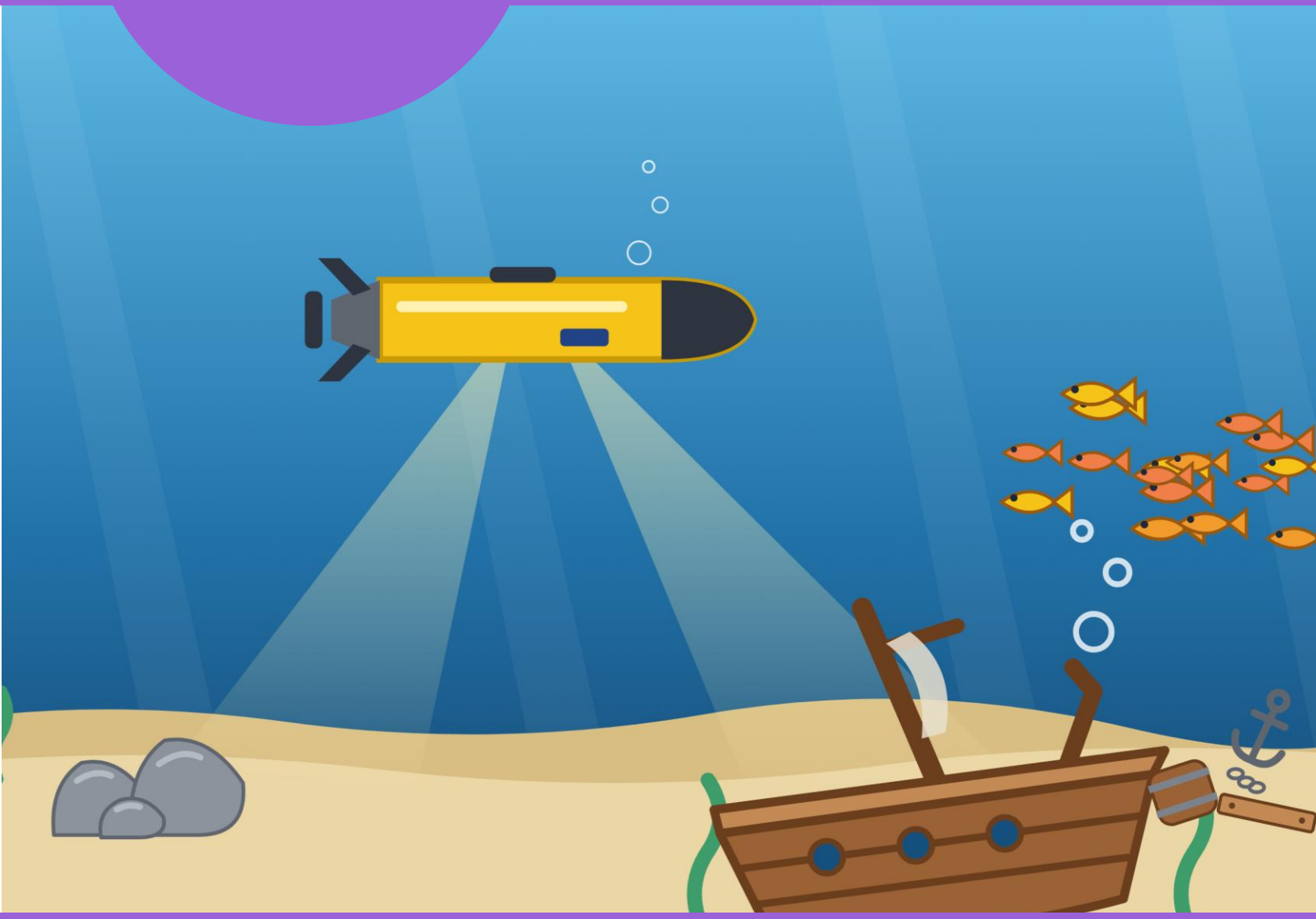
#SeaworthySTEM

Tracking a Shipwreck:

Training an AI Underwater Robot

Ages 6-8

Teacher Guide



Seaworthy STEM™ in a Box Series

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Office of Naval Research
ONR
Science & Technology

Tracking a Shipwreck:
Training an AI Underwater Robot

Teacher Guide: Ages 6-8

#SEAWORTHYSTEM®

SeaworthySTEM™ in a Box Educator Kit description:

Seaworthy STEM™ in a Box activities are a Navy initiative to provide enhanced Naval-relevant, standards aligned, hands-on activities to K-12 teachers and students. Components of this program include, curated sets of classroom activities that aim to build deep conceptual understanding in Naval-relevant content areas. The kits also includes comprehensive lesson plans, material lists, scientific background information, STEM related literacy books, and student activity sheets. The Seaworthy STEM™ in a Box program is designed to support teachers as they select content, acquire materials, and implement more hands-on STEM activities in their classrooms. Increasing student access to hands-on STEM activities, also increases awareness of STEM career paths, engage students in STEM, and support development of student's abilities in STEM content.

The Seaworthy STEM™ in a Box kits were designed to guide students through the scientific inquiry- based theory and the engineering design process. The content and Naval-relevant activities are aligned with the Next Generation Science Standards. The topics and content covered within the lessons are connected and scaffolded based on distinct grade bands (K-2nd, 3rd-5th, 6th-8th, and 9th-12th).

Art on the Cover: An autonomous underwater vehicle (AUV), a robot that explores underwater on its own with no one steering it, searches the seafloor with sonar (original illustration for this lesson).

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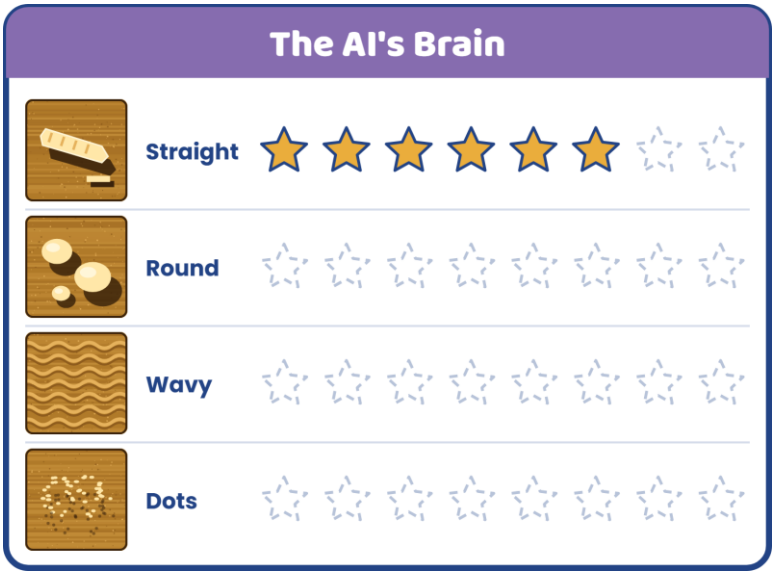
Introduction

Welcome to an unplugged Hour of AI lesson. Teams of young learners train a paper AI to steer an **autonomous underwater vehicle (AUV)**: an underwater robot that drives itself, with no person steering it. The AUV searches for a hidden shipwreck. No computers, no accounts and no internet are needed: the AI is a star chart that the students build together, one reward at a time.

By the end of the hour, students can say in their own words how an AI learns from experience, why people choose its rewards, and why people should check an AI's choices.



A trained AI's Brain: after a few missions, the Straight sonar picture has the most stars.

Parts of the Lesson

Part 1: Mission Briefing. Students meet the AUV, learn that AI is a computer that can learn and make choices, and discover how Navy robots use sonar to search the seafloor.

Part 2: Predict and Learn the Game. Students predict which sonar picture shows a shipwreck, take on team jobs, and learn how the AI chooses (most stars) and how it is rewarded.

Part 3: Train and Test. Teams run three training missions on newly shuffled maps, then a Final Test on a map the AI has never seen, with no new stars allowed.

Part 4: Think Like an AI Engineer. Students graph their data, decide whether the AI improved, discuss the Whale Bones Surprise, and design their own ocean AI.

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Lesson Title:

Tracking a Shipwreck: *Training an AI Underwater Robot*

Time:

One 60-minute lesson (the Hour of AI), plus an optional 15-minute extension activity.

Audience:

Ages 6-8 (about grades 1-3). No experience with computers or AI is needed. Teams of 3 or 4.

Student Objectives:

1. Describe how an AI can learn from experience: it tries, gets a reward, and changes what it does next time.
2. Train a paper AI with star rewards and use its choices to steer an AUV on a hidden map.
3. Collect and graph mission data (battery used) and use the pattern to explain whether the AI improved.
4. Test the trained AI on a new map and judge when people should check an AI's choices.
5. Imagine and draw an AI robot that could help the ocean, and explain what it would learn from.

Lesson Overview:

Students become an AUV team. On a 4 × 4 ocean map of face-down tiles, the AUV can only see sonar pictures. A paper AI (the AI's Brain) chooses where to go by counting stars, and students reward it when it finds debris or the wreck. Each mission uses a newly shuffled map, so the AI has to learn a pattern, not a location. Students graph the battery used, test the trained AI on a brand-new map, and talk about when people should check an AI's choices.

CSTA 2026 Standards (page 14):

E1-ALG-ML-02, E2-ALG-ML-02, E3-ALG-ML-02, E1-DAT-DC-08, E1-SOC-HU-15, E3-SOC-CE-19

AILit Competencies:

Engage with AI 2 and 3; Shape AI 1 and 3



Notes



A fold-over ocean tile: the real thing on one side, its sonar picture on the other.

Materials and Equipment List

For a class of about 24 (6 teams of 4):

- **Game Kit** (free PDF, 8 pages, print in color): one set per team. Cardstock lasts longest.
- **Star tokens:** about 20 per team (or use coins, buttons or counters).
- **Scissors or a paper cutter** to make the kit (one time only). A glue stick is optional.
- **Envelope or zip bag** per team to store the kit.
- Optional: laminator for the Ocean Map and the AI's Brain.

Student Activity Sheets/Handouts:

Tracking a Shipwreck: Training an AI Underwater Robot Student Activity Workbook (4 pages), one per team: the Recorder fills in the two Mission Log pages. Also print page 4, Design Your Own Ocean AI, once for each student. The briefing, rules, results and discussion are on the classroom slides.

Technology/Tools:

None for students. This is an unplugged activity: no devices, accounts or internet. A projector for the optional classroom slides is helpful but not required.

Supplemental Resources:

- Classroom slide deck (PowerPoint) with a model turn and the class results board.
- NOAA Ocean Exploration: Side-scan sonar explainer and images (oceanexplorer.noaa.gov).
- Seaworthy Futures career cards: Sonar Technician, Robotics Engineer, Data Scientist, Naval Historian.

Find Everything Online:

https://shipwrecktracker.vercel.app · Help: shanejwines@gmail.com

How the Lesson Runs (60 Minutes)

Part	Step	What students do	Where	Min
1	Mission Briefing	Meet the AUV; what is AI? Think first.	Slides	5
	Navy connection	How sonar finds shipwrecks	Slides	3
2	Predict	Vote: which sonar picture is a shipwreck?	Slides	2
	Learn the game	Team jobs; model one turn with the class	Slides	7
3	Training missions 1-3	Play, record, fill in the Score Sheet, reshuffle	Workbook pp. 2-3	27
	Final Test	New map, no new stars; last Score Sheet row	Workbook p. 3	6
4	Results	Read the finished graph; check the vote	Team Score Sheet	2
	Think like an AI engineer	Did it improve? Whale Bones Surprise	Slides	5
	Wrap-up	Class results board; careers	Slides	3
Ext.	Design your own ocean AI	Draw and describe an ocean AI robot	Workbook p. 4	+15

Before the Lesson

- Print and assemble one Game Kit per team (about 10 minutes per kit with a paper cutter; reuse every year).
- Print one workbook per team, plus a copy of page 4 for each student.
- Shuffle each team's 15 tiles and bag them with the Start tile, Brain board, stars, arrow cards and AUV.
- Practice one mission yourself so you can model a turn.
- Draw the class results board (see page 10) on chart paper or the board.

Short on Time? More Time?

- **45 minutes:** play 2 training missions and the Final Test; hold the discussion as one quick class talk.
- **Extension (+15 minutes):** Design Your Own Ocean AI (workbook page 4) and a gallery walk.
- Teams that finish early can play a bonus mission with a 10-bar battery.
- Split it over two days: Parts 1-2, then Parts 3-4.

Preparing the Game Kit



Each set has 15 ocean tiles plus 1 Start tile. Top row: the real thing. Bottom row: the sonar picture on the back. Notice that the shipwreck, debris and whale bones share the same sonar picture.

Build it (once)

1. Print the 8-page Game Kit in color, one per team, on cardstock so tiles do not show through.

2. Cut out the 16 tile strips (they touch, so a paper cutter makes quick straight cuts). Fold each strip in half on the dotted line so the sonar picture is on one side and the real thing is on the other. No glue needed; a dab of glue stick keeps a tile from springing open.

3. Cut out the AI's Brain, the 4 arrow cards, the AUV (fold it so it stands) and the star tokens.

4. Laminate the Ocean Map and the AI's Brain if you can. Store each kit in an envelope.

Before each mission (students do this)

The Map Keeper shuffles the 15 ocean tiles and lays them sonar side up, one per square. The Start tile always goes on A1. Stars stay on the AI's Brain from mission to mission; clear them only when a new class starts.

Tip: the map is random every time on purpose. If the shipwreck stayed in one place, the AI could simply memorize the spot. Shuffling forces it to learn a **pattern** that works on any map: real AI has to do the same.

Teaching the Lesson: Parts 1 and 2

1 Mission Briefing

5 min · Slides: Part 1

Say: "Long ago a ship sank. Today you are a Navy robot team. Your robot is an AUV, and it has an AI inside that has never seen a shipwreck. Your job is to teach it."

Show Meet the AUV and Words for Today. Ask: *What does it mean that the AUV is autonomous?* (Nobody steers it.) Turn and talk: what does a robot need to find a shipwreck? (Think first)

1 Navy Connection

3 min · Slides: Part 1

Read the three steps. Have students make a "ping" sound and clap back the echo. Answer the Think about it question aloud: light does not travel far in deep, dark water, but sound does.

2 Predict

2 min · Slides: Read the Sonar

Students hold up 1-4 fingers for the sonar picture they think is a shipwreck and tell a partner why. Tally the votes. Do not give the answer: the game will show it. Many will pick Straight because ships have straight edges.

2 Learn the Game

7 min · Slides: Part 2

Form teams, hand out kits and job cards. Model one full turn under the document camera or with the slides: **See** (sonar pictures next to the AUV), **Choose** (most stars, or flip an arrow card for a tie), **Move & Peek** (cross off a battery bar), **Reward** (add or take away stars), **Record**.

Stress the big rule: **the Pilot follows the AI's choice, not their own idea.**

Teaching Strategy

Post the four steps (See, Choose, Move & Peek, Reward) on the board. Point to each step as teams play.

Ages 6-7: you can act as the AI Trainer for every team during Mission 1.

Why do the stars start empty?

A new AI knows nothing. In Mission 1 it is mostly guessing with the arrow cards. That is why Mission 1 is often slow, and that is the point!

Teaching the Lesson: Parts 3 and 4

3 Training Missions 1-3

27 min (about 9 per mission) · Workbook pages 2-3

Teams play until they find the shipwreck or use all 12 battery bars. **After every mission**, before the next one starts: the Recorder fills in that mission's row on the **Team Score Sheet** (found it? battery bars used, and the stars on each sonar picture) and colors its bar on the graph. Then the Map Keeper reshuffles and deals a new map, **the stars stay on the AI's Brain**, and jobs rotate.

Circulate and ask: *Which sonar picture has the most stars now? Why? Is the AI choosing differently than in Mission 1?*

3 Final Test

6 min · Workbook page 3

New map, same Brain, **no new stars**. **Say:** "Real AI is trained first, then used on new places it has never seen. Let's see what our AI really learned." Teams fill in the Final Test row and bar.

4 Results

2 min · Game Kit Team Score Sheet

The Score Sheet is already filled in, mission by mission. Teams read their graph: which bar is shortest? Compare with the class vote from the Predict step. Most teams see shorter bars after Mission 1.

4 Think Like an AI Engineer

5 min · Slides: Part 4

Discuss together: Did the AI improve? How do you know? Did whale bones fool it? Who should check the AI's work? What would happen if we rewarded rocks by mistake?

4 Wrap-up

3 min · Slides: Part 4

Each team adds its Mission 1 and Final Test battery bars to the class results board. Share the career cards and the Keep Exploring ideas.

Team Jobs

Pilot: moves the AUV

Map Keeper: shuffles, flips, hides

AI Trainer: reads and changes stars

Recorder: fills in the log

Teams of 3: the Pilot also crosses off battery.

Class Results Board

Draw on the board:

Team · Mission 1 bars · Final Test bars · Most stars on

Ask: How many teams used fewer bars in the Final Test? Which sonar picture won everywhere?

Extension (+15 min)

Design Your Own Ocean AI (workbook page 4; one copy per student). Students draw a robot and finish the sentence frames. Hang the designs for a gallery walk.

Teacher Background Information

What is AI?

Artificial intelligence (AI) is computer technology that does tasks that usually need human thinking, like recognizing patterns or making choices. Many AI systems are not given every rule. Instead they **learn from data**.

How does this game model AI learning?

The paper AI learns by **reinforcement learning**: it tries something, gets a reward signal (stars), and becomes more likely to repeat what earned the reward (learning from experience).

- **What the AI senses:** the sonar picture of each nearby square.
- **Its choice:** which square to visit next.
- **The reward:** +3 stars for the wreck, +1 for debris, a star taken away for rocks.
- **Its memory:** the stars on the AI's Brain. That is all it knows.
- **Guessing to explore:** ties are broken with arrow cards, so a new AI tries many things.
- **Training vs. testing:** the map is reshuffled each mission, so the AI must learn a pattern (Straight sonar pictures are worth visiting) that works on a new map in the Final Test.

We tested the rules

In 5,000 computer-simulated games, an untrained AI found the wreck within 12 battery bars about 55% of the time. After three training missions it found it about 81% of the time on brand-new maps, and the typical battery used dropped from about 11 bars to about 6. A real class will be bumpier: one lucky Mission 1 can beat Mission 2. That is a great conversation about why AI needs lots of practice data.

Common Misconceptions

"The AI knows what a shipwreck is." It only counts stars next to pictures. It has no idea what a ship is.

"AI is always right." Whale bones fool it, just like sea life fools real sonar AI.

"AI learns all by itself." People choose the rewards. Wrong rewards teach wrong behavior.

"The AI is the robot." The AUV is the body. The AI is the part that chooses.

Vocabulary

AI · AUV · autonomous · data · debris · echo · learn from experience · mission · pattern · reward · robot · shipwreck · sonar · test · training

Student-friendly definitions are on the Words for Today slide.

Answer Guide and Troubleshooting

Think first Answers vary: sonar or sound, lights, a camera, a battery, a map, a way to learn or remember.

Why sound? Light does not travel far in deep, dark water. Sound travels far, and its echoes make a picture.

Predict Straight. Ship parts have long, straight edges and cast straight shadows. Round = rocks, Wavy = sand, Dots = fish.

Results Straight should have the most stars. Round usually has 0 (stars get taken away). Wavy and Dots stay at 0. Bars on the Team Score Sheet usually get shorter after Mission 1.

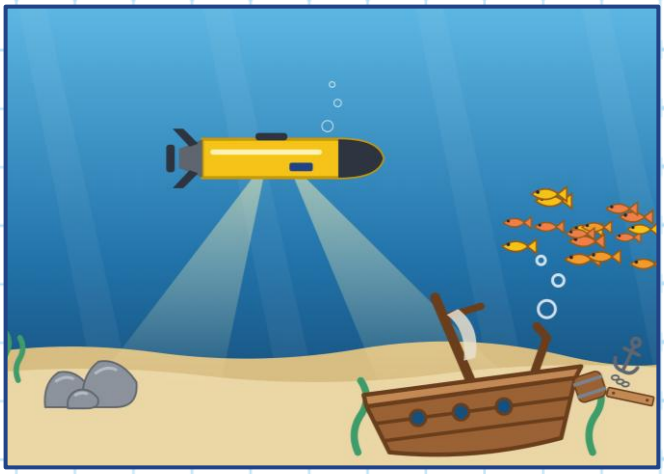
Discussion Did it get better? Yes, it used fewer battery bars or found the wreck more often. Whale bones? Yes, they look Straight, so people should check its work. Stars for rocks? It would learn to visit rocks, bump into them and waste battery: the AI learns whatever we reward.

Troubleshooting

If...	Try this
Stars are tied a lot in Mission 1	That is normal: the AI is exploring. Flip arrow cards to break ties.
Every square next to the AUV was visited	Any touching square counts. Flip an arrow card.
The battery runs out in Mission 1	Celebrate the data! A new AI is slow. Compare with Mission 3.
Students steer toward tiles they remember	Remind them the Pilot follows the AI. Tiles are reshuffled anyway.
Tiles show through or spring open	Print on cardstock; add a dab of glue stick inside the fold.
A team runs out of star tokens	Use coins, counters or tally marks on the Brain board.

Navy Connection

The U.S. Navy uses autonomous underwater vehicles to map the seafloor, find hazards and study shipwrecks. The **Naval History and Heritage Command's Underwater Archaeology Branch** manages more than 3,000 Navy shipwrecks and 17,000 aircraft wrecks around the world, and it lists AUVs with side-scan sonar as a tool for searching large areas.



An AUV searches with side-scan sonar (illustration).

REMUS

The REMUS 6000 AUV was designed by Woods Hole Oceanographic Institution in a program with the U.S. Naval Oceanographic Office and the Office of Naval Research.

2011

Three REMUS 6000 AUVs "mowed the lawn" with side-scan sonar and found the wreck of Air France 447, almost 4,000 meters deep.

2015

A REMUS 6000 found the San José, a Spanish galleon lost in 1708, more than 600 meters down off Colombia.

2021

Engineers at NSWC Carderock used wreck-site data and sonar from a 2018 discovery to study damage to the sunken carrier USS Lexington.

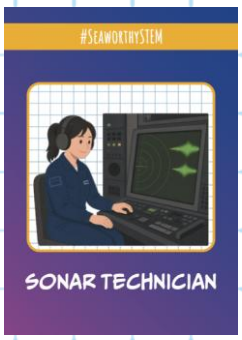
Today

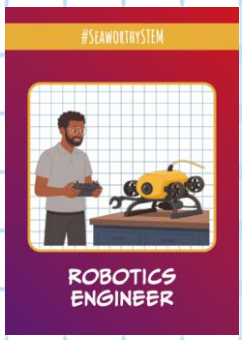
The Navy is funding AI that recognizes objects in sonar pictures, including AI that can learn from less data and tell real targets from "clutter" such as sea life.

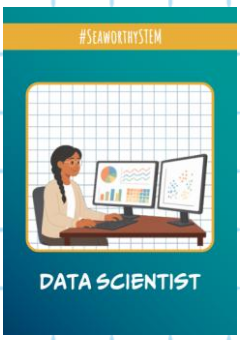
Talk About It

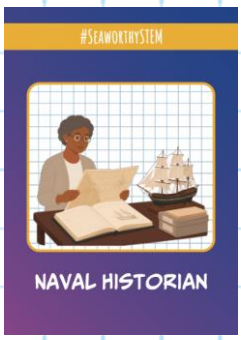
- Why would the Navy send a robot instead of a diver to search deep water?
- Sea life can fool real sonar AI, like whale bones fooled ours. How could people help?
- What other jobs could an underwater robot do?

Careers in this lesson (Seaworthy Futures cards)









Standards and AI Literacy

Standards are from the **2026 CSTA PK-12 Computer Science Standards** (grades 1-3).

E1-ALG-ML-02: Recognize that AI systems are technologies that use patterns in data to make decisions or generate new things.
In this lesson: The AI chooses squares by the pattern in its stars.

E2-ALG-ML-02: Examine how data is used to train a machine learning model.
In this lesson: Rewards from each move train the AI's Brain; whale bones show how it can make mistakes.

E3-ALG-ML-02: Investigate how a machine learning model can change when new data is added to a training set.
In this lesson: Each mission adds data; students see the AI's choices change from Mission 1 to the Final Test.

E1-DAT-DC-08: Use multiple methods to collect both numeric and non-numeric data to help answer questions.
In this lesson: Mission Logs record what was found (words and symbols) and battery bars used (numbers).

E1-SOC-HU-15: Differentiate between activities that humans do well and activities that computing technologies do well.
In this lesson: The AI counts stars tirelessly; people notice the whale bones and check its work.

E3-SOC-CE-19: Explain how people in different industries use computing technologies and skills to accomplish their work.
In this lesson: Navy sonar technicians, robotics engineers, data scientists and historians use AUVs and AI.

AI Literacy (AILit)

Hour of AI competencies from the AILit Framework:

Engage 2: Describe how AI systems perform tasks using language that addresses and clarifies common misconceptions.
In this lesson: Slides: how the AI chooses; it only counts stars and does not know what a ship is.

Engage 3: Evaluate whether AI outputs should be accepted, revised, or rejected.
In this lesson: The Whale Bones Surprise: should we trust the AI or check its work?

Shape 1: Investigate how an AI system is intended to work, whom it is designed for and what its limitations are.
In this lesson: The Final Test on a new map; what the AI can and cannot do.

Shape 3: Design AI systems with attention to how data sources, selection, and information flow influence behavior and outputs.
In this lesson: Rewards shape behavior (stars for rocks?); Design Your Own Ocean AI (workbook p. 4).

Fits Into

Science: ocean exploration, sound and echoes, animals and habitats.

Math: bar graphs, comparing numbers, counting on and back.

Social studies: history of ships and the Navy; careers.

Writing and art: Design Your Own Ocean AI.

Accommodations, Adapting and Support

Instructional Accommodations

- Every tile has a picture **and** a word; sonar pictures differ by shape, not only color.
- Read the rules aloud; post the four steps with pictures.
- Picture job cards give every child a clear role. Pair a reader with a non-reader.
- Fine-motor needs: pre-cut the kit; use large counters or coins as stars.
- Low vision: enlarge the kit to 11 × 17 and the workbook to 129%. Add texture (sandpaper on rocks, yarn on Straight tiles) for a tactile version.
- English learners: vocabulary page with pictures; sentence frames on workbook page 4; let students answer by drawing.
- Movement breaks: rotate jobs after each mission; the Pilot stands.
- Extra challenge: change the reward values and predict what the AI will learn; find the average battery used.

Technical Requirements

- No computers, apps, accounts or internet for students. Nothing to download for play.
- Teachers need a PDF reader and a color printer. The slides open in PowerPoint, Keynote or Google Slides.
- No student data is collected (COPPA). The website follows WCAG 2.1 AA practices.

Adapting for Other Ages

Ages 5 and under: play one class game on the floor with big tiles. The teacher is the AI Trainer; children vote on the move and place stars.

Ages 9–12: add a 4th sonar type, record all four missions in a table, find the average, and change the rewards to see what the AI learns. Discuss false alarms (whale bones) and how to fix them with more data.

Ages 13–18: connect the stars to Q-values in reinforcement learning, compare with supervised learning (labeled sonar pictures), and code the game in a block or text language.

Language

English. All text is in editable files so it can be translated.

Need Help?

Everything for this lesson is free at **shipwrecktracker.vercel.app**.

Questions or problems with the materials: **shanejwines@gmail.com**

Expertise needed: none. If you can play a board game, you can teach this lesson.

Sources

Every fact, date and number in this lesson was checked against these sources.

AUVs that found famous wrecks

- WHOI (2018): New details on discovery of the San José shipwreck (REMUS 6000, Nov. 27, 2015, more than 600 m deep) https://www.whoi.edu/press-room/news-release/new-details-on-discovery-of-the...
- WHOI (2011): REMUS 6000 AUVs locate Air France 447 wreckage; side-scan sonar "mowing the lawn" https://www.whoi.edu/press-room/news-release/whoi-conducts-latest-search-for...

Navy shipwrecks and AI

- Naval History and Heritage Command: Underwater Archaeology Branch (more than 3,000 Navy shipwrecks) https://www.history.navy.mil/research/underwater-archaeology.html
- NHHC: Underwater archaeology field guidelines (AUVs and side-scan sonar for surveys) https://www.history.navy.mil/research/underwater-archaeology/sites-and-proje...
- NAVSEA (2021): Carderock helps assess damage to the sunken USS Lexington https://www.navsea.navy.mil/Media/News/Article-View/Article/2490603/carderoc...
- Navy SBIR N231-035 (2023): AI/machine learning target recognition for AUVs https://www.navysbir.com/n23_1/N231-035.htm
- Navy SBIR N241-025 (2024): AI that learns from smaller sonar data sets https://www.navysbir.com/n24_1/N241-025.htm

Sonar and the seafloor

- NOAA Ocean Exploration: Side-scan sonar https://oceanexplorer.noaa.gov/technology/sonar-side-scan/
- NOAA Ocean Exploration: Maritime archaeology (wrecks as artificial reefs) https://oceanexplorer.noaa.gov/explainers/archaeology/
- NOAA Ocean Service: What is a whale fall? https://oceanservice.noaa.gov/facts/whale-fall.html

Standards

- Computer Science Teachers Association (2026): 2026 CSTA PK-12 Computer Science Standards https://csteachers.org/wp-content/uploads/2026/07/2026-CSTA-PK%E2%80%9312-Co...

Original art

- Illustrations, tiles and sonar pictures were drawn for this lesson. Characters are from the Seaworthy STEM™ in a Box series.

Notes

The Seaworthy STEM™ in a Box curricula was developed through collaborative efforts of a team of individuals at the Naval Surface Warfare Center Carderock Division and Albert Einstein Distinguished Educator Fellows via an inter-agency agreement with the U.S. Department of Energy for the Albert Einstein Distinguished Educator Fellowship (AEF) Program. We are grateful to the following Content Specialists who contributed their knowledge and expertise by researching and writing on selected topics: Suzanne Otto, Stephanie Klixbull, Thomas Jenkins, Melissa Thompson, Nathan Diehl and Shane Wines. We'd also like to acknowledge the contributions of AEF participant Ms. Deborah Reynolds, the inaugural AEF Educator at Carderock that helped inspire the design of Seaworthy STEM™ in a Box content.

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It is the goal of the Seaworthy STEM™ Curriculum to embrace NAVSEA technologies from sites nationwide to empower the youth of our nation to pursue STEM-centric career pathways. The views and opinions of the Content Specialists expressed herein do not necessarily state or reflect those of the AEF Program, the U.S. Department of Energy, or the U.S. Government. Reference herein to any specific commercial product, process, or service by trade name, trademark, service mark, manufacturer, or otherwise does not constitute or imply endorsement, recommendation, or favoring by the AEF Program, the U.S. Department of Energy, or the U.S. Government.

#SeaworthySTEM

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