

# Robot Sharks: An AI and STEM Adventure for 5th Grade Students

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## OVERVIEW

This five-lesson artificial intelligence (AI) and STEM integrated unit was designed for 5th graders in an informal learning context. Each lesson featured 45 minutes of instruction following the 5E model, which centered on the topic of sharks. Students explored sharks from multiple disciplinary perspectives, including computational thinking (CT), math, statistics, and science. They then employed educational robots (Sphero Bolt) to design and program their own robot sharks through inquiry-based activities oriented in the engineering design process. This course concluded by having the students design and code their robots to represent and explain the knowledge they gained about sharks.

Topics: Artificial Intelligence, Computational Thinking, Computer Science, Integration, K-12, STEM

Time: 45- 60 minutes per lesson, five lessons in total

## SETUP

Each lesson plan and accompanying material should be reviewed carefully before teaching. The teacher should be familiar with the student's background knowledge, skills, capabilities, and grouping preferences. The teacher should plan for at least 30 minutes for preparation, such as printing the worksheets, preparing the game cards, charging the robots and iPads, and filling the storage bins/baby pool with water. This lesson was designed for a small group of students in an informal learning context. The learning environment should include internet access, tables and chairs, flat-open areas for students' movements, and accessible water faucets and drain areas.

## CONTEXT-AT-A-GLANCE

### Setting

Twelve groups of two preservice teachers collaborated with 4-5, fifth-grade learners. They offered an informal learning experience to elementary students in afterschool programs in a suburban area of the southeastern United States.

### Modality

In-person

### Class Structure

Five 45-minute lessons across five weeks.

### Organizational Norms

This unit addressed Florida CPalms standards and AI4K12 big ideas, introducing AI concepts, developing AI literacy, integrating AI with STEM disciplines, and developing knowledge of AI, CT, CS, and STEM through hands-on designing and programming experiences.

### Learner Characteristics

Although this unit can support K-5 learners, this article focuses on 5th graders.

### Teacher Characteristics

The teachers were novice preservice teachers with strong math or science backgrounds but less CS/CT pedagogical knowledge.

### Development Rationale

This lesson aimed to develop elementary students' AI literacy, CS/CT knowledge, and shark knowledge through inquiry-based activities. Meanwhile, it provided math, science, and computer science preservice teachers with opportunities to teach AI, CT, and CS-integrated STEM content.

### Design Framework

5E Model of Instruction

## MATERIALS

Lesson One - AI Meets Sharks:

- [Lesson One Packet](#) (Guo et al., n.d.-a)
- Printed materials in the lesson plan
- Paper and pencils

Lesson Two - Shark Statistics:

- [Lesson Two Packet](#) (Guo et al., n.d.-b)
- Printed materials in the lesson plan
- iPads with an internet connection
- [Ocearch Tracker Website](#) (OCEARCH, n.d.)
- Tape measures
- Masking tape
- Paper and pencils

Lesson Three - Shark Adaptations:

- [Lesson Three Packet](#) (Guo et al., n.d.-c)
- iPads with an Internet connection
- Shark teeth
- Magnifying glass
- A large bowl of water
- Balloons
- 40ml vegetable oil
- Paper and pencils

Lesson Four - Robot Sharks:

- [Lesson Four Packet](#) (Guo et al., n.d.-d)
- Printed materials in the lesson plan
- iPads with an Internet connection
- Sphero robots with Nubby covers
- Storage bins/baby pool with water
- Rubber bands
- Plastic folders
- Aluminum foil
- Gaff tape
- EVA foam sheets
- Bubble wrappers
- Paper and pencils

Lesson Five - Design Your Own Shark:

- [Lesson Five Packet](#) (Guo et al., n.d.-e)
- The rest of the materials are the same as those in Lesson Four

## STANDARDS

AI4K12 AI Guidelines Big Idea #3 (AI4K12.org, n.d.):

- Definition of machine learning
- The role of training data
- Learning phase vs. application phase

Florida CPalms Math Standards (Florida State University, n.d.):

- MA.5.DP.1.1 Collect and represent numerical data, including fractional and decimal values, using tables, line graphs, or line plots.
- MA.5.DP.1.2 Interpret numerical data, with whole-number values, represented with tables or line plots by determining the mean, mode, median, or range.

Florida CPalms Science Standards (Florida State University, n.d.):

- SC.5.N.2.1 Recognize and explain that science is grounded in observations that are testable, explanation must be linked to evidence.
- SC.5.L.17.1 Compare and contrast adaptations displayed by animals and plants that enable them to survive in different environments, such as life cycle variations, animal behaviors, and physical characteristics.

Florida CPalms Computer Science Standards (Florida State University, n.d.):

- SC.5.PE.2.3 Analyze the data from a given scenario.
- SC.5.PE.1.3 Create a program using arithmetic operators, conditionals, and repetition in programs.

## CONTEXT AND SETTING

To support a group of math, science, engineering, and computer science preservice teachers in teaching K-5 students in afterschool programs, the team designed a five-lesson AI and STEM-integrated unit on sharks, titled “Robot Sharks: An AI & STEM Adventure.” This unit created a locally relevant and engaging learning experience for K-5 students in Florida, U.S. The team members included researchers and experts from Mathematics Education, Science Education, and Computer Science Education at the University of Florida. The original lesson plans and materials were designed and pilot-tested in one local elementary school. The team revised the lesson plan, activities, and materials based on preservice teachers’ practice. Finally, refined lesson plans and

materials were implemented in another elementary school. The whole unit included detailed lesson plans and customized teaching materials tailored to different grade levels. The lesson designers intentionally aligned the content with academic standards from Florida CPalms and incorporated AI guidelines from AI4K12.org (n.d.).

During the Fall 2024 semester practice, 23 preservice teachers (organized into 12 teaching groups) delivered this lesson to 53 elementary students across various grade levels. Each teaching pair worked with 4-5 students for 45 minutes per week over five weeks. This learning representation uses the 5th-grade lesson plans, teaching materials, and activities as examples to illustrate how AI, CT, and CS were integrated into STEM lessons.

This five-lesson AI and STEM-integrated unit followed the 5E model of instruction (Bybee, 2014). The teaching activities in each lesson were aligned with the phases of Engage, Explore, Explain, Elaborate, and Evaluate. Although this lesson addressed Florida CPalms academic standards, the Evaluation phase utilized formative assessment due to the informal learning context.

This unit centered on the topic of sharks to create a locally relevant real-world context (Figure 1). The lessons aimed to enhance students' understanding of AI literacy, statistics, animal adaptations, algorithmic thinking, robot coding, and engineering design processes via a multidisciplinary integration approach (Vasquez et al., 2013). The students explored sharks from various disciplinary lenses,

such as AI, CS, math, and science, and then used educational robots to simulate and represent their knowledge through engineering design. In addition, the students had CT and CS backgrounds, such as algorithmic thinking and block coding, but it was their first time experiencing the educational robot Sphero Bolt.

The educational robot Sphero Bolt (Sphero Central, n.d.) was selected for this unit because it is waterproof and equipped with sensors. However, the teacher could use alternative educational robots to tailor students' backgrounds in Lesson Four and Five. For example, the team also incorporated Ozobots (Ozobots, n.d.) as "land sharks" for lower elementary grades to accommodate younger learners' small hands. The activities related to using robots to collect and analyze data in Lesson Four were adjusted accordingly. Please contact us for detailed lesson plans and materials tailored to different grade levels.

### LESSON ONE: AI MEETS SHARKS

Lesson One, AI Meets Sharks, introduces the fundamentals of machine learning and data features through unplugged activities within the context of sharks. The real-world connection focuses on machine learning applications in image and facial recognition. The guiding questions for this lesson are "What makes a shark a shark?" and "How do computers identify an image as a shark?" Before teaching, the teachers should review the Lesson One Packet for printable materials (PDF; Guo et al., n.d.-a).

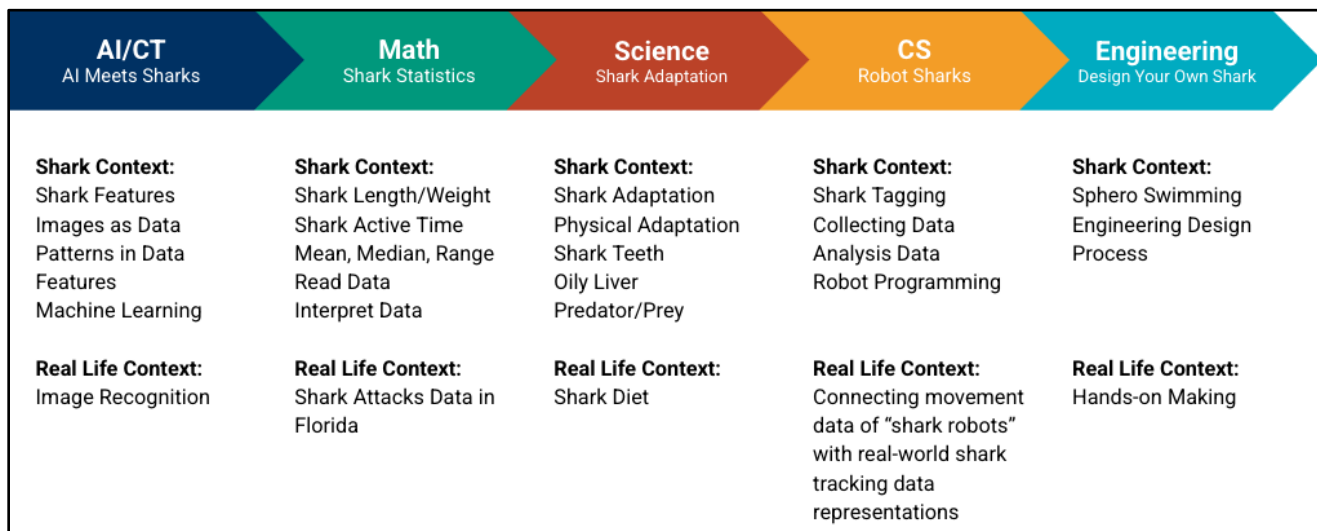


Figure 1. Unit Structure of Robot Sharks: An AI and STEM Adventure.

## MATERIALS

- Lesson One Packet (PDF; Guo et al., n.d.-a)
- Printed materials in the lesson plan
- Paper and pencils

## 5E LESSON ONE

### ENGAGE

To capture students' interest, the teacher begins with an activity called "Circling the Dogs" (Guo et al., n.d.-a), which utilizes a widely recognized internet meme (Shenkman et al., 2021) to illustrate the differences between human and machine learning. In this activity, students observe, analyze, and differentiate between images of Chihuahua dogs and blueberry muffins, which share similar visual features. Following this, the teacher introduces the concept of machine learning, explaining how computers process and classify images based on extracted patterns and features. Next, the teacher introduces the ocean animal scenarios, promoting discussions with questions such as "How can we distinguish shark images from those of other ocean animals?" and "What makes a shark a shark?" Finally, the teacher connects these ideas to real-world applications, such as Australian scientists using AI image recognition to monitor coral reefs (González-Rivero et al., 2020) to spark students' interest in machine learning principles.

### EXPLORE

In the explore phase, students randomly draw 12 ocean creature cards in the Lesson One Packet (PDF; Guo et al., n.d.-a) and sort them into 3-5 groups based on common features. They then describe the features they used for classification. This activity serves as a practice of observing and recognizing patterns in images.

To simulate the principle of machine learning, students use the same 12 cards as training data and classify them into the "shark group" and the "non-shark group." They record the features they use to identify sharks. Next, students apply these features to classify the remaining six cards as test data. The

class then discusses whether the identified features need to be refined.

### EXPLAIN

In the explain phase, the teacher further presents machine learning and its process, emphasizing how models identify features in training data and use them to make predictions about new data. However, students may initially rely on their personal experience rather than extracted features when identifying sharks. To address this, the teacher can use the Shark Anatomy poster (Guo et al., n.d.-a) to clarify key shark features. Additionally, to reinforce algorithmic thinking, the teacher can use the Decision Trees worksheet in the Lesson One Packet (PDF; Guo et al., n.d.-a) to guide students through a step-by-step decision-making process based on shark features (Figure 2).



Figure 2. Using decision trees worksheet to guide the step-by-step decision making.

### ELABORATE

In the elaboration phase, the teacher revisits the students' prior knowledge of the binary system, which computers use to process information. Students then practice converting extracted features into binary questions that can only be answered with

“Yes” or “No.” Using the Construct Binary Questions worksheet in the Lesson One Packet (PDF; Guo et al., n.d.-a), the teacher provides images of turtles, dolphins, whales, rays, and sharks. Students write binary questions to describe and differentiate these ocean animal images based on observation features.

## EVALUATE

Since this lesson takes place in an informal learning setting, the teacher assesses the students’ learning through open-ended discussion, collaboration, and active participation in the activities.

## LESSON TWO: SHARK STATISTICS

Lesson Two, Shark Statistics, focuses on mathematical and statistical concepts, especially mean, median, range, and how to calculate these values within a dataset. Through this lesson, students will be able to develop an understanding of shark size. The guiding question of this lesson is, “How big is a shark?” Prior to teaching, the teacher should review the lesson package (Guo et al., n.d.-b), prepare the worksheets, and, if needed, install the OCEARCH app in advance.

## MATERIALS

- Lesson Two Packet (PDF; Guo et al., n.d.-b)
- Printed materials in the lesson plan
- iPads with an internet connection
- [Ocearch Tracker Website](#) (OCEARCH, n.d.)
- Tape measures
- Masking tape
- Paper and pencils

## 5E LESSON TWO

### ENGAGE

At the beginning of the class, the teacher and the students read a news article about a shark scientist tagged and named “Breton” from USA Today together (Lesson Two Packet PDF; Guo et al., n.d.-b). Following this, students work in groups to measure their heights with tape measures and record the results on Worksheet #1 found in Lesson Two Packet

(Guo et al., n.d.-b). They then compare their measurements with Breton. Alternatively, students may use tape measures and masking tape to mark Breton’s length on the ground, according to the information in the article. After this, students can attempt to jump the measured distance, incorporating a physical activity component that provides an intuitive grasp of shark size.

### EXPLORE

Next, students explore the [OCEARCH shark tracker website](#) or app (OCEARCH, n.d.). To familiarize them with the website’s interface, the teacher demonstrates how to use the filter in the toolbar to track Breton’s movement and guide them in answering the questions in Part A of Worksheet #2 found in the Lesson Two Packet (Guo et al., n.d.-b). Once they become comfortable navigating the website or app, let them complete Part B of worksheet #2, which focuses on data collection and recording. Then, they proceed to Part C of worksheet #2, which involves graphing the collected data.

### EXPLAIN

Upon completing the worksheet, students pair up with elbow partners to discuss their findings. The teacher then introduces the concepts of mean, median, and range, guiding students through the calculation process using the data from Part A of worksheet #2. Based on their calculations, students respond to questions in Part D of worksheet #3 (Guo et al., n.d.-b). Through these activities, students practice interpreting numerical data and formulating analytical statements. To further develop their data interpretation skills, the teacher may utilize the travel logs of sharks tagged by scientists and called Mary Lee and Luna as additional examples to discuss how data can be analyzed for meaningful insights.

### ELABORATE

To establish a real-world connection, students visit the Shark Attack Data on the [Florida Museum of Natural History Website](#) (University of Florida, n.d.) and discuss the following questions:

- Which county in Florida has the highest number of confirmed unprovoked shark attacks?

- How many fatal attacks have happened in this county since 2012?
- When do shark attacks most commonly occur?

The teacher should emphasize that only about a dozen of 530 known shark species are involved in attacks on humans. The three species most commonly associated with shark attacks, often referred to as “the big three,” are the great white shark, the tiger shark, and the bull shark.

## EVALUATE

Finally, student learning is assessed through students’ collaborative discussions, worksheet completion, participation in activities, and open-ended reflections.

## LESSON THREE: SHARK ADAPTATIONS

Lesson Three, Shark Adaptation, explores concepts in life sciences, focusing on predators, prey, and animal adaptation. In this lesson, students will be able to explain the shark’s adaptations and apply their knowledge by designing their own shark that illustrates these adaptations. The guiding question for this lesson is, “What makes a shark special?” Before the class, the teacher should review the lesson package (Guo et al., n.d.-c) and prepare the necessary teaching materials.

## MATERIALS

- Lesson Three Packet (PDF; Guo et al., n.d.-c)
- iPads with an Internet connection
- Shark teeth
- Magnifying glass
- A large bowl of water
- Balloons
- 40ml vegetable oil
- Paper and pencils

## 5E LESSON THREE

### ENGAGE

To engage students at the start of the lesson, the teacher guides students to the [27 Animals That Don’t](#)

[Think You Can See Them](#) webpage (Baldwin, 2015) and lets them identify the hidden animals in images. This activity fosters students’ curiosity and introduces the concept of camouflage as a physical adaptation. Following this, students use magnifying glasses to observe shark teeth and compare them to human teeth, describing the differences. The teacher introduces the fact that shark teeth are arranged in rows, allowing continuous replacement when a tooth is damaged or lost. When a front tooth is worn down, it falls out and is replaced by a new tooth from the row behind it, with additional teeth forming at the back to maintain this cycle.

### EXPLORE

After exploring shark teeth, students engage in another hands-on activity to investigate the buoyancy of sharks. Students place two balloons, one filled with oil and the other with water, in a large bowl of water. Students observe the position of the two balloons. Meanwhile, the teacher explains that sharks do not have swim bladders; instead, they rely on their large, oil-filled livers, which contain substances called squalene, to help them maintain buoyancy.

### EXPLAIN

Following these observation activities, the teacher introduces the concepts of predators and prey. The discussion extends to shark diets, reinforcing the idea that sharks do not perceive humans as prey. By revisiting the Shark Attack Data from Unit Two, students critically discuss the ecological importance of protecting these apex predators. The teacher can also facilitate an open discussion about how predators can also be prey to other species, highlighting the interconnectedness of marine ecosystems.

### ELABORATE

Next, students apply what they have learned by designing their own shark on paper. Each student names their shark, specifies its length and weight, and illustrates its color, teeth, fins, and unique adaptations that aid in survival. Additionally, students describe their shark’s habitat, diet, and daily behaviors.

## EVALUATE

The teacher assesses students' learning by participating in activities, engaging in open discussion, and completing their shark design.

## LESSON FOUR: ROBOT SHARKS

Lesson Four, Robot Sharks, provides students with the opportunity to simulate the data collection process in shark tagging through the use of Sphero, an educational robot. In this lesson, the student will be able to program Sphero to move in water and record the data collected by the robots. The guiding question for this lesson is, "How does shark tagging work?" The teacher should review the Lesson Four Packet and data examples (Guo et al., n.d.-d), pre-charge the Sphero robots, prepare materials for students to construct their own sharks, and set up a water pool for testing the robots' movement.

## MATERIALS

- Lesson Four Packet (PDF; Guo et al., n.d.-d)
- Printed materials in the lesson plan
- iPads with an Internet connection
- Sphero robots with Nubby covers
- Storage bins/baby pool with water
- Rubber bands
- Plastic folders
- Aluminum foil
- Gaff tape
- EVA foam sheets
- Bubble wrappers
- Paper and pencils

## 5E LESSON FOUR

### ENGAGE

To introduce the lesson, students participate in an [animal track match game](#) (ESLVault.com, n.d.). The teacher places the cards face down, and students take turns flipping over two cards at a time, attempting to find matching pairs. If a student finds a match, they keep the cards and continue playing until no further matches remain. If working with a large group, the teacher may instead distribute cards

randomly and have students search for peers with matching cards.

### EXPLORE

Following this activity, the teacher prompts students to consider how scientists observe ocean creatures that live beyond the range of human vision. This discussion leads to an introduction to shark tagging, where scientists collect and record data on sharks' location, size, sex, growth, and movement patterns to track their behavior over time.

### EXPLAIN

Building on this concept, the teacher introduces Sphero as a model for a tagged shark in this lesson. The teacher showcases how to drive the Sphero robot in water and then explains how to program it for data collection. This lesson connects to Lesson Two, reinforcing how the data collected through shark tagging contributes to the OCEARCH (n.d.) track website and app. Additionally, the instructor explains the real-world process of shark tagging, detailing how scientists attach tracking devices to sharks and utilize the collected data for research.

### ELABORATE

Students then start hands-on exploration by driving and programming the Sphero robots. The teacher facilitates discussions by allowing students to compare Sphero's movement with and without Nubby covers, which leads to an optional extension on shark skin adaptations (Figure 3). To further encourage creativity and problem-solving, students are given various craft materials and challenged to design different "swimsuits" for their Sphero robots, optimizing their movement in the water.

### EVALUATE

Lesson Four serves to deepen students' understanding of data collection, which was introduced in Lesson Two, expand their knowledge of shark tagging and skin adaptations in Lesson Three, and enhance their programming skills through hands-on application. The teacher can assess students' learning via collaborative activities, participation, and open-ended discussions.



Figure 3. Preservice teachers introducing Sphero's movement with and without Nubby Cover.

## 5E LESSON FIVE

### ENGAGE

The class begins with a headband game to review the key concepts in previous lessons. The teacher prepares cards featuring terms students have learned in prior lessons. Each student randomly draws a card, holds it in front of their forehead, and takes turns asking binary (yes/no) questions (as introduced in Lesson One) to peers to determine the words on their card (Figure 4).



Figure 4. Preservice teachers play the headband game with students.

## LESSON FIVE: DESIGN YOUR OWN SHARK

Lesson Five, Design Your Own Shark, offers students an opportunity to review and apply the knowledge acquired in the previous four lessons. This lesson is designed to give students hands-on experience in designing and constructing their own sharks using limited craft materials. The guiding question for this lesson is, "Who will win the Shark Olympics Game?" As this lesson builds upon Lesson Four, the preparation process and required craft materials remain the same. However, the teacher still needs to review the Lesson Five Packet and prepare the engineering design process poster before the class (Guo et al., n.d.-e).

### MATERIALS

- Lesson Five Packet (PDF; Guo et al., n.d.-e)
- The rest of the materials are the same as those in Lesson Four

### EXPLORE

After the activity, the teacher introduces the rules of the Shark Olympics Game and divides students into pairs. Each group is given 5-8 minutes to design a prototype of their robot shark and 8-10 minutes to construct their design using the provided craft materials. Next, groups test their prototypes in a water pool, adjusting and revising their prototypes as needed.

### EXPLAIN

Throughout the design process, the teacher actively engages with students, encouraging them to verbalize their thought processes, explain their design choices, and describe the debugging and revision process (Figure 5).

## ELABORATE

Once all groups have completed their design, the teacher gets them together to participate in the Shark Olympics Games. Each group places its robot shark at the starting line, and all sharks begin “swimming” simultaneously. The shark that completes the full path in the shortest time is declared the winner. If time allows, the teachers may facilitate multiple rounds of competition.

## EVALUATE

To conclude the lesson, the teacher refers to the [engineering design process poster](#) (PBS LearningMedia, n.d.) and discusses the nine steps. Students then reflect on their design strategies, problem-solving techniques, and iterative improvement. Although this final lesson does not include a formal assessment, students’ learning can be evaluated based on their improvement in collaboration, active participation, and engagement in discussions.

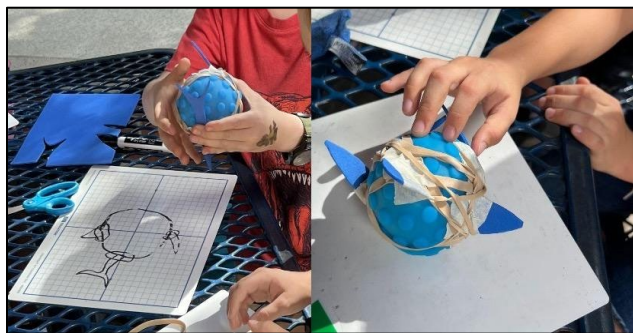


Figure 5. Student's design and prototype.

## CRITICAL REFLECTION

Robot Shark: An AI & STEM Adventure was an AI and STEM disciplines integrated unit implemented by 23 preservice teachers (in 12 teaching groups) for 53 elementary students across grades K to 5 during an afterschool STEM club in the fall semester of 2024. The preservice teachers were enrolled in an undergraduate level teacher preparation program and participated in their first teaching exploration course. In this course, the preservice teachers were divided into teaching groups based on their preferred grade levels, prepared the lessons together, and practiced teaching once a week. To prepare each lesson of this

unit, the preservice teachers spent 60 minutes studying the weekly lesson packages, selecting suitable activities for their students from the package, and developing their customized lesson plans. Next, each group spent 30 minutes preparing their weekly teaching materials, sharing effective teaching strategies they utilized in the last week, and did a last-minute check-in before their practice. The preservice teachers then moved to a local elementary school together and prepared their teaching before the students arrived. The preservice teachers conducted the teaching practice with their students for 45-50 minutes. Finally, all preservice teachers individually completed a teaching reflection before the subsequent lesson preparation.

The unit consists of two distinct versions: one for K-2nd graders and another for 3rd-5th graders. Both versions focus on the topic of AI and sharks but utilize different academic standards, teaching activities, and robotic devices in each lesson. Each version is tailored with suitable activities for students’ grade levels. This article uses the 5th-grade lesson package and authorized teaching images as examples to illustrate how to teach these five lessons of the unit.

The course designers aligned each lesson with the K12 AI guideline (AI4K12.org, n.d.) and the state’s academic standards in Math, Science, and Computer Science (CPalms.org, n.d.) for 5th grade. For example, Lesson One, AI Meets Sharks, focused on the K12 AI Guideline Big Idea #3 (the definition of machine learning, the role of training data, and the learning phase vs the application phase in machine learning). Lesson Two, Shark Statistics, targeted the Math standards MA.5.DP.1.1 and MA.5.DP.1.2. Lesson Three, Shark Adaptations, aims at the Science standards SC.5.N.2.1 and SC.5.L.17.7, and Lesson Four, Robot Sharks, employed the CS standards SC.5.PE.2.3 and SC.5.PE.1.3.

The overall design of this unit utilized a multidisciplinary integration approach (Vasquez et al., 2013), allowing students to acquire shark-related knowledge from various disciplines. However, the final design challenge did not necessarily rely on the information provided in former lessons. For example, in the final engineering design lesson, the students could review and discuss the shark’s features and adaptations, such as length, weight, color, fins, teeth, buoyancy, and skin. However, using this information to design their robot sharks with Sphero was unnecessary. Nonetheless, the last lesson of the unit

emphasized the engineering design process, along with three disciplinary core ideas: defining an engineering problem, developing possible solutions, and iterating design solutions (Roehrig et al., 2021).

This AI and STEM integrated unit engaged elementary students in learning about sharks, a real-world and locally relevant topic, via lenses from multiple disciplines. It highlighted the hands-on experiences in each lesson and emphasized students' creativity in the final engineering design challenge. The students showed apparent engagement and excitement across the five lessons, especially in Lessons Four and Five. On the other side, the preservice teachers also reflected on building connections across various disciplines in the AI, CT, CS, and STEM concepts.

One limitation of this AI and STEM integrated unit was time. Due to the course structure and unexpected weather impacts, it eventually lasted six weeks. The preservice teachers worked very hard to complete all lesson plan activities each week, but they had less time to expand or build the across-lesson connections. Another limitation was the Sphero Bolt robots. We encountered situations where robots were not completely charged or lost battery power quickly. In these cases, some students completed their prototype shark designs but were unable to fully test them due to technological limitations. Therefore, it is suggested that robots be tested in advance of the lesson, and if possible, additional backup robots be provided.

Teachers can customize the lesson to meet their students' prior knowledge and backgrounds. If Sphero is unavailable, the teacher can also employ other robots to do "land sharks." Lessons One to Four can be used separately to address the academic standards, and the last engineering design lesson can be used in informal CS learning scenarios (e.g., STEM Night, Robot Days) at a higher elementary level. For future lesson implementation, we recommend that teachers employ effective strategies while using robots. For example, assigning each student in one group a role (e.g., a coder and a robot manager) and switching the role when it is necessary. Also, adjusting the activities flexibly and leaving the robot activity at the end of the class was one option because once the robots were introduced, it was challenging to redirect student focus to other types of activities. Additionally, we suggested teachers involve more helpers in Lesson Four and Lesson Five to support all students evenly.

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