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AI INQUIRY CURRICULUM

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Lesson Plans

Standards and Guidelines Cited

ISTE Standards

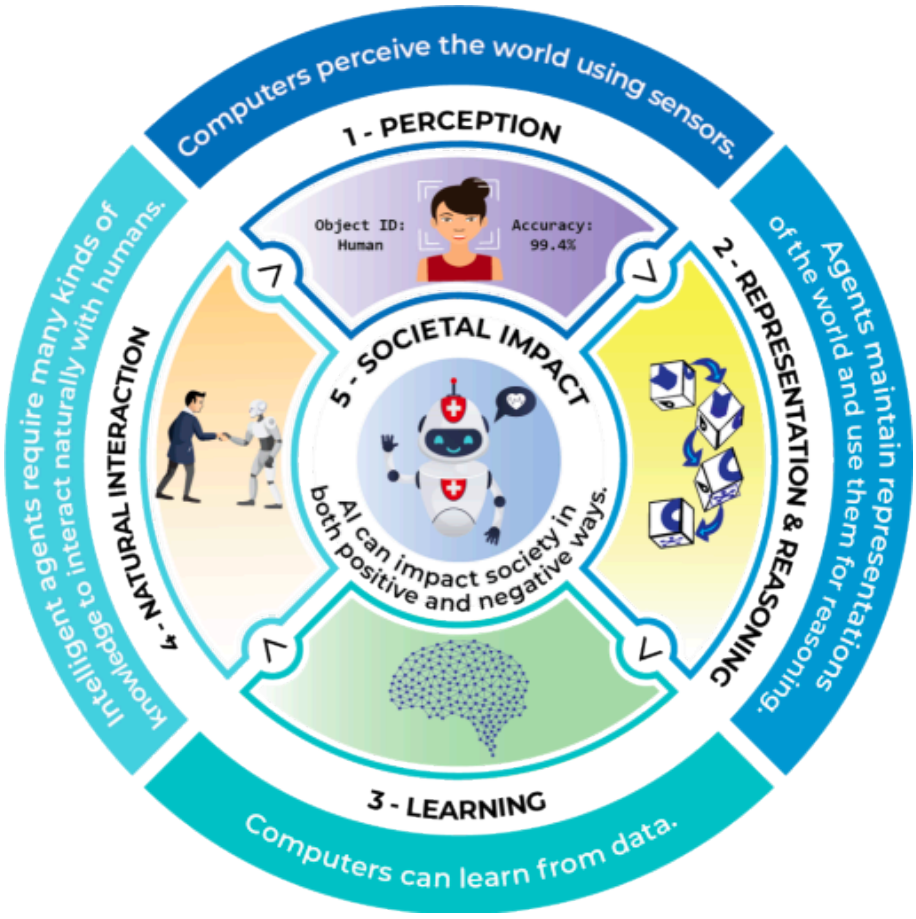
The International Society for Technology in Education (ISTE) produces a series of standards for those involved in education. The lessons in the following curriculum utilize the seven ISTE Student Standards.

- The ISTE Student Standards can be found at https://www.iste.org/standards/iste-standards-for-students

AI4K12 Guidelines

AI4K12.org has released a list of “Five Big Ideas in AI” along with draft grade band progression charts for each of these ideas.

- The five big ideas are summarized on a poster that can be found at https://ai4k12.org/resources/big-ideas-poster/.
- The grade band progression charts are available at https://ai4k12.org/gradeband-progression-charts/



Big Idea 1 - Perception: Computers perceive the world using sensors.

Big Idea 2 - Representation and Reasoning: Agents maintain representations of the world and use them for reasoning.

Big Idea 3 - Learning: Computers can learn from data.

Big Idea 4 - Natural Interaction: Intelligent agents require many kinds of knowledge to interact naturally with humans.

Big Idea 5 - Societal Impact: AI can impact society in both positive and negative ways.

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01

Teachable Machine

TEACHING GUIDE

Lesson Objectives:
By the end of this lesson, students will be able to
- demonstrate proficiency in computer training using Teachable Machine
- explain the meaning of the confidence bar in Teachable Machine
- create a practical use for Teachable Machine

Alignment with Big Ideas:
Big Idea #3: Machine Learning

ISTE Standards for Students:
1.1 Empowered Learner
1.3 Knowledge Constructor

Key Ideas

1. **AI solves different kinds of reasoning problems**. Teachable Machine is good for a specific kind of problem called "**classification**." Teachable Machine builds a classifier, which is a mechanism that takes an input and tries to assign it to a predetermined class. For instance, here are dogs and here are cats. Is this new image a cat or a dog?
2. There are differences between collecting data, training data, and applying the classifier to new data.
    a. The first step is to gather data. In this lesson, the data comes from the webcam. Other data might come from the internet such as a Google Image search. Teachable Machine lets you collect large amounts of data and insert it as a zip file. Training data should include a variety of images. Move back and forth. Move directions. Move the mouth and eyes. The images should have differences. This way, the machine represents all the different ways this 'class' can look. A diverse set of images is needed for the system to learn well. Without a good dataset, the information can be easily fooled.
    b. Learning takes place when you click "Train." Teachable Machine is using an algorithm behind the scenes. It is using feature detectors to help classify images into the correct class. This is largely invisible to students, but inside Teachable Machine, the AI is processing all the new data.
    c. Applying the model to new data. After the model is finished training, Teachable Machine will start recording from the webcam. It starts grabbing images in real time and applies them to the training it received. If you trained it on apples, and if you find a new apple that was not in the training set, can it recognize it as an apple? If the question is apple versus banana, the system should be able to distinguish the new apple. If it is one kind of apple and a tomato, it might have a harder time since they are both round and red. This is a concept called generalization. Can the system generalize to new images? A good machine learning system should generalize well to new data.

Equipment

Laptop connected to the internet. Webcam. Access to Teachable Machine. Random objects from around the classroom or the school.

Preparation

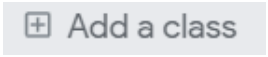
Access Teachable Machine on each device. Ensure permissions allow for webcam use.

Topics Covered

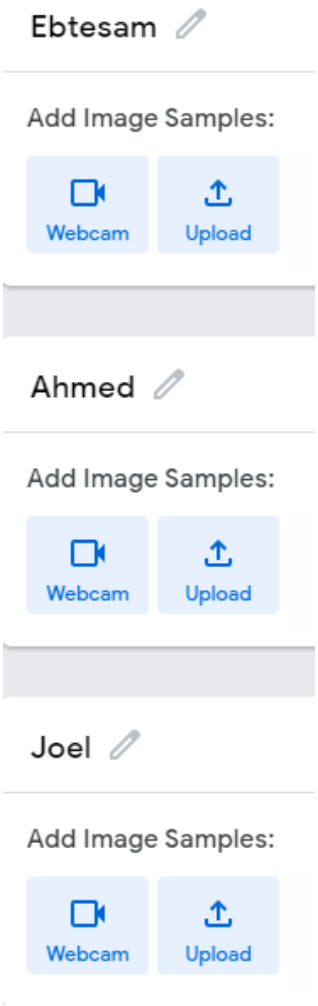
1. Classifying People
2. Classifying Body Language and Poses
3. Classifying Gestures

Classifying People

The most common student use of Teachable Machine is to tell who a person is and to differentiate one person from another. In this first experiment, students will engage Teachable Machine in this way, asking the system to identify people based on training sets and differentiate one person from another, also known as classification.

1. Begin by opening Teachable Machine on each laptop. Explain that Teachable Machine is a web-based program that lets us 'teach' a computer. Introduce Big Idea #3 - Computers can learn from data.
2. Ask students what data is. (Answers may include information drawn from sensors such as images and sounds as well as documents that store large amounts of information like Excel spreadsheets and Word documents.) Explain to students that every time they are online, they are generating data. (Examples may include websites they visit, how long they stay on a site, what searches they conduct, and so forth.)
3. Tell students to click Get Started and then Image Project. Finally, click Standard Image Model.
4. Explain that students will begin by teaching the computer to recognize between different people. Have students click  and put in their name. If there are more than two students, create new student "classes" by clicking on 

. Here is an example:



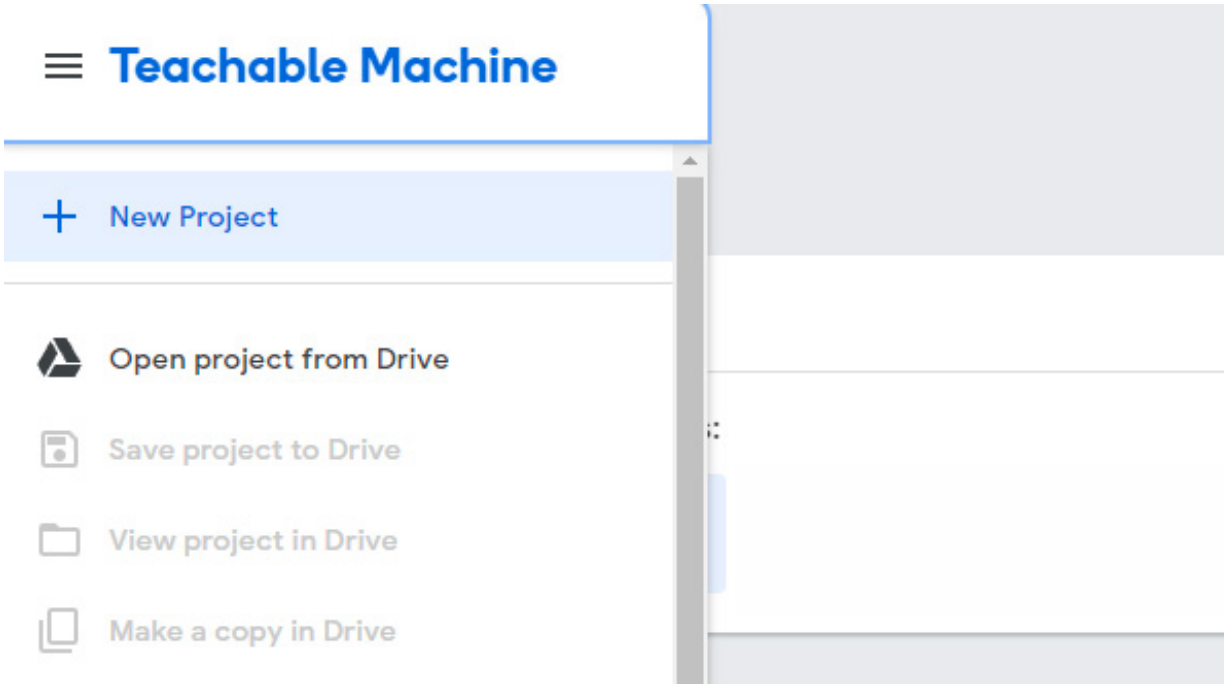
5. Ask students what "class" means. (Answer: "Class" refers to the categories that you want the computer to learn.)
6. Explain to students that they will now "teach" the computer by using its webcam function. Begin by having one student click "Webcam." Have the first student in each group take many pictures of himself or herself, varying the distance from the webcam and his or her position in the camera. Then, the next student should provide data to the computer on his or her image and so forth until all the students have trained their pictures.
7. **Experiment**: Once each student has several images collected, students should click on **Train Model**. Students should then test that the computer can accurately identify them and differentiate between each student.
8. Students can then begin to complicate the testing process. For instance, students can
   - Obscure a portion of their face
   - Remove/Put on glasses/hats/etc.
   - Move closer / further away from the webcam
9. Students will begin to recognize that the system is not consistent in identifying them when these testing variables are introduced. Ask students why this may be the case. (Answer: The datasets are limited, i.e. not enough images were taken.)

10. Tell students to retrain Teachable Machine. They should take many pictures from different angles, distances, wearing different items, obscuring parts of their faces, and so forth.
11. There is no set number of images required. More images can mean better accuracy, but the more images collected, the longer the system takes to train. Also, having lots of similar images is not helpful; the images must be diverse. Students should begin to readily identify how increasing the size and diversity of the dataset leads to increased accuracy.
12. Students can play with the system and introduce poses, hats, and other articles of clothing and identify the confidence the system places in accurately identifying the person.
13. **Experiment**: Students should bring in another person and check who the system identifies this person as. Students will likely realize that the computer does not offer an "I don't know" option. It identifies the person with one class or another, not an unknown class. Ask students why this may be. (Answer: The system does not know what it does not know. It is being forced to choose between existing classes even if none represent the new person.)
14. The teacher should introduce the confidence bar. The confidence bar indicates how sure Teachable Machine is with its identification. A new person in this experiment might generate a low or moderate confidence. The teacher should ask why this might be (Answer: The computer recognizes certain similar features, such as hair color, shirt color, etc.) The teacher should explain that several classes might even have moderate confidence.

Classifying Dance Moves

Teachable Machine can recognize faces, but the abilities it provides users are much greater than just this function. For instance, it can provide computers a way to learn poses and body language. In this exercise, students will teach the machine to distinguish between dance moves using Teachable Machine's **Pose Project** tool.

15. Ask students to begin a new Teachable Machine project. They can do this by clicking the waffle button in the top left and then New Project.



16. Students should replicate the process from earlier, but this time, instead of training the computer on different people as classes, they will train two different dances. To do this, the teacher should play the following two dance videos and ask students to try the motions of the dance.

    The Macarena Dance

    GANGNAM STYLE | 2021 HOW TO DANCE
17. Once students feel confident with the dance, one student should do the dance as the other(s) in the group use the computer's webcam to collect images (data). The student should provide one dance as one class and the other dance as the other class.
18. Once images have been collected for both dances, students should train the computer on the data.
19. Once Teachable Machine has processed the data, other members of the group should try the dance in front of the webcam. As they do, other members of the group should note the confidence meter.
20. The teacher should ask the class to identify poses that earn higher confidence levels and what students learn (some dances have similar poses, other dances have very specific gestures or movements, AI can quickly identify poses).
21. **Additional**: Students may introduce new dance moves, such as a disco move or other popular dances as new classes with which to train Teachable Machine.

Classifying Gestures

To close the lesson, students will experiment with Teachable Machine's generalizations. Using hand gestures such as "peace" and "thumbs up," students will test different hands, different orientations, and different people.

22. Students can save the previous project if they would like. Students should begin a new Teachable Machine Project.
23. Students should take pictures for one class with one person's thumbs up on one hand. In other words, Student A uses only his right hand with a thumb up to provide the data for the first class.
24. Students should train the second class with the peace sign on one hand.
25. Experiment: After training Teachable Machine, students should test the computer's ability to identify onee gesture from the next. Students can test this training by
    - introducing other students' hands and gestures.
    - flipping the direction of their hands.
    - switching between left and right hands.
26. The teacher explains that distinguishing you from me might be an easy problem if we're wearing different color shirts. Our faces wouldn't even matter. But distinguishing a "thumbs up" gesture from "peace" or "okay" is a harder problem, because you have to look at what the fingers are doing and which way they're pointing. Teachable Machine is not going to find one simple cue that makes the problem easy, like "bright red region in the image" for my shirt and "dark blue region in the image" for your shirt. The teacher should emphasize that Teachable Machine can learn to make subtle discriminations, but it might require more training images to get it to generalize reliably. Some things are simply too subtle, as well. For example, showing the system an entire paragraph of text and asking it to distinguish English text from French text is probably too hard for it.

Enrichment

If time permits, students can be asked to demonstrate their ability to gather data and train a classifier using Teachable Machine by gathering additional items to use as teaching items for the computer. Some possible examples might include two different types of book, objects of similar color but different shapes, and so forth. Older or more advanced students should be encouraged to identify objects that require more subtle differentiation that may be more difficult for people to readily distinguish.

Students should be encouraged to posit what enables Teachable Machine to distinguish objects. (Answer: Someone trained the computer to distinguish among 1,000 different types of objects. In the process of learning this task, the computer created a set of visual “features” to look for, like “shiny thing” or “thing with fur” or “thing with sharp edges” or “thing with wheels.” Now when we want to teach the computer some new categories, it takes combinations of the features it learned and uses them to describe each of the new categories.)