This work is supported by NSF DRL-1949384

ImageSTEAM Lesson Plan
Engineering and Design Challenge
Teachable Machines

Grade/Level: 6-8
Time Allotment: 90 mins

Summary

1. Brief: Students will use their understanding of the engineering and design process to design a teachable machine to translate American Sign Language.
2. Standards alignment: MS-ETS1-1. - Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
3. Objective(s): Students will be able to understand the engineering and design process, utilizing the teachable

Materials & Resources

Materials: Computers; Engineering and Design Worksheet; Access to Google's Teachable Machine.

Implementation

Learning Context

Recommend students understand data, and possibly how a neural network functions. Students can use Google Quick Draw as an engagement activity prior to the lesson being taught. Quick Draw will help students understand how a neural network functions as well as help the students understand how data can be categorized.

Procedure

1. Introductory Lecture – Students are introduced to the objectives and tasks that they will complete in this lesson.
2. Direct instruction / activity (without technology) - Students are introduced to the concept of data. Ask and brainstorm with students what data they think they could collect. Ask and brainstorm with students what data they think is collected on them. – height, age, weight, steps per day, hours on phone, hours on a website, time watching YouTube videos about Minecraft, etc.
3. Direct Instruction / activity (with technology) – Use google quick draw to allow students to engage with a neural network. Explain to students that the AI is using inputs from hundreds or thousands of other users who may have drawn before them.

4. Direct instruction – Explain how teachable machine works – by putting input data into different categories or buckets - show them an example that is known to work like teacher with a mask, and teacher without a mask. Give students 5-minutes to explore the tool on their own. Students should use this time to play/explore the teachable machine resource.
5. Direct instruction – Explain the engineering and design process, and challenge the students to design an algorithm to translate American Sign Language.
6. Check for Understanding – Use cold calling to ensure students can define data, and data classification. Use the laboratory worksheet to ensure students understand the engineering and design process.
7. Independent Practice – Give students the opportunity to explore teachable machine on their own.
8. Real World Advanced Application – google translate uses similar technology to teachable machine. Students should be able to articulate that building an ASL translating application has real world solutions.

Assessment

How will you assess the learning objectives?

1. Observational – use active monitoring to assess the students and collaborative groups while they are working on their prototypes.

2. Exit ticket – collect the students' engineering and design worksheet as leave the classroom. Ensure students accurately described why they made the changes to their experiment that they chose to change.

Teacher Script

Hello, today we are going to use the engineering and design process to see if we can build an Artificial Intelligent algorithm to translate American Sign Language.

Today we're going to use teachable machine teachable machine. As you remember takes our data and puts it into categories those categories are what we're going to use to translate or test whether or not our prototypes work. I want you to take a couple minutes to play with teachable machine maybe you have it determine whether you have a pen or a pencil in your hand may be tested with your cell phone or a water bottle or a ball or a toy you might have in your backpack. But I want you to give it a couple of different categories and a couple of things to test with remember take pictures near and far and close up and from different angle so the machine gets as much input data as possible you want 100 to 200 photos per input that you're going to give it.

After we've done experimenting with teachable machine we need to understand the engineering and design process to do that we're going to follow a set of steps. First, we need to understand data and what types of data we can collect and categorize. What types of data do you think you could collect relating to the world around you? What kinds of data do you think is collected on you? Who do you think is collecting this data?

(give students time to answer and collaborate with groups)

Today we have our lesson target, success criteria and daily tasks. We will proceed through this lesson to help us better understand the ED process we will be using in the classroom this year.

This is the basic ed process. At any point we can move from one category to another, we don't have to do it cyclically (but we can). I want to stress the ed process is very much how e do a lot of our thinking naturally, but this process outlines it into 8 different categories

Start with ask, research, then brainstorm and imagine, plan, create, test and improve those prototypes. But if at any point you need to go back and do research, go back and do that! If you need to adjust your plan, go back and rewrite it so you can adjust your prototype as necessary.

Step 1 of ed process starts with asking a question. Today's question is can we build a teachable machine to recognize sign language? So in your lab notebooks I want you to document whether you think you can use AI to translate American sign language. How do you think you will do that?

Step 2: working with your lab groups, do some research. What is the need? What are signs? Talk to your lab group about why building a machine to translate ASL is something new and innovative and not something on market. I can use google translate on my phone to translate any language

but not ASL. Why? Do some research and write some of the answers to the questions you're having in your notebook. Use this website to begin your research.

For those of you who just want to get in and start playing with the teachable machine here are 6 diff words you can sign in ASL that you can teach your machine to recognize. I understand we're still in that research phase of the ed process but sometimes it helps to have some hands on time with the tool. If you want to do this, go ahead and do that now.

In step 3 this is where we begin to imagine our solutions, think about your brainstorm, what might work and might not work. Here we will imagine. What are some of the criteria and restraints? The teachable machine only recognizes machine but some signs require movement. How will you get the machine to recognize images and movement? The machine can only learn from a still image. That might be a constraint. Other constraints might be skin tone. Are we sure the teachable machine will recognize in the pixels ? when the machine analyzes images it is analyzing pixels. Background color, facial features, will all play into effect and we want to design this experiment to minimize as many variables as we can. So image how you will create a solution.

Step 4 we plan it! This is where in your lab journal you document how will you build your machine. What are you going do that's different from other groups? What did your team decide you're going do using that teachable machine.

With that teachable machine you want to begin to create a prototype. This is where with the ed process we will build out what we will use. Remember with your teachable machine you don't need to translate all the dictionary for ASL, you only need 5 or 6 signs to determine whether or not your idea is going to work. If we input the entire dictionary in the teachable machine and it doesn't work, we wasted a lot of time and we probably could have figured out it wasn't going to work had we used a prototype.

Remember in teachable machines we have a recipe we're going to use, we will collect data – images from diff signs – we will label that data and put it in categories, categories the machine will use to learn. We will train the algorithm remember this is where its using computer processing abilities so stay on that tab and don't get distracted. We will test the algorithm once it begins to work.

Step 6 we will test and evaluate. How accurate is it? Give it 5-10 diff signs and document is it accurate? What is it missing? Why is it not being accurate? Go ahead and document in your lab journal if its accurate, what percent accurate, and what you want to do to improve your machine.

In the last step we will improve our design. Remember we weren't satisfied with the cell phone. They change. What will you do to improve your machine to make it better predict which sign you are showing it.