TEACHABLE MACHINE UNLEASHED



LAB HANDBOOK

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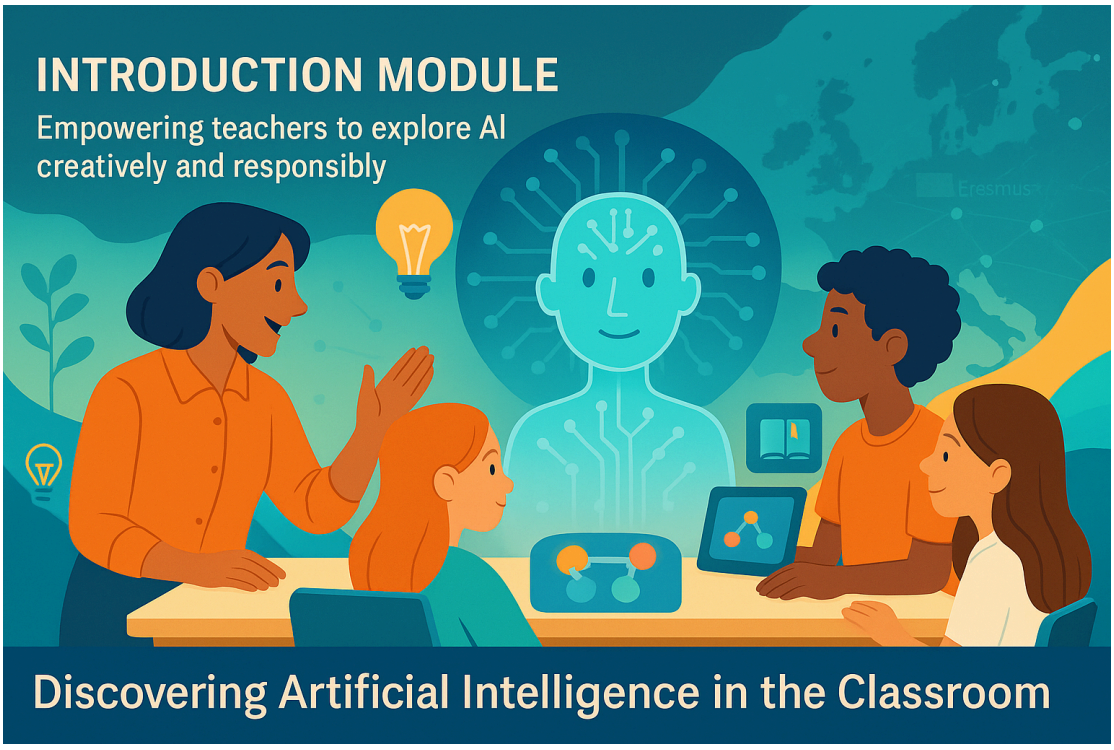
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Introduction – Teachable Machine Unleashed: Lab Handbook

(Creative Edition)

Welcome to the Creative Edition of the Teachable Machine Unleashed Teacher Handbook — a practical and inspiring guide for educators who want to bring Artificial Intelligence (AI) and Machine Learning (ML) into the classroom through playful, inquiry-based learning.



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1. Welcome Section

This handbook is designed for teachers of 10–15-year-old students who wish to integrate AI and ML concepts into their subjects. It provides ready-to-use materials, step-by-step activities, and ethical frameworks for teaching AI through experimentation and creativity.

🎯 **Purpose**

To empower teachers to explore Artificial Intelligence using Google's Teachable Machine — a no-code, hands-on platform for creating models that recognize images, sounds, and poses.

The approach emphasizes curiosity, collaboration, and responsible digital literacy in line with 21st-century education goals.

2. About the Project

This handbook was developed within the framework of the Erasmus+ project **M{AI}L – Machine and Artificial Intelligence Learning for Education**, a collaborative initiative aimed at improving teachers' competences in AI education. It reflects the experience of educators, researchers, and innovators from different European countries who share a common goal: to make AI accessible, ethical, and engaging for all students.

🌍 **Project Context**

Project №: 2024-1-IT02-KA220-SCH-000249373
Implemented by a consortium of schools, and educational partners across Europe.

3. What Is Teachable Machine?

Teachable Machine is a free, web-based tool developed by Google that allows users to train Machine Learning models without coding. Students and teachers can create projects that recognize images, sounds, or poses directly from their browser, turning complex AI processes into simple, visual experiments.

💡 **Key Features**

- No programming required.
- Works on any modern browser.
- Three project types: Image, Audio, Pose.
- Ideal for cross-disciplinary projects and creative exploration.

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4. Why Teaching AI in Schools Matters

AI shapes everyday life — from social media to healthcare — and it's crucial that students understand its logic, limits, and potential. Teaching AI builds not only digital skills but also critical thinking, creativity, and ethical awareness.

🧩 Educational Benefits

- Promotes problem-solving and computational thinking.
- Connects technology with real-world issues.
- Fosters collaboration and inclusion.
- Encourages reflection on fairness, bias, and responsibility.

5. How to Use This Handbook

The handbook is modular and practical. Teachers can explore it sequentially or select specific modules based on their needs. Each module includes theory, activities, and reflection prompts that align with school curricula and European digital competence frameworks.

⚙️ Recommended Use

1. Read the introduction to understand the pedagogical approach.
2. Explore the seven modules progressively.
3. Use the Appendix for ready-to-use activities and templates.
4. Adapt lessons to your context and students' interests.

⚙️ A practical way to use this handbook

Start with one short project and a question linked to your subject. Ask students to collect examples, train a model, test it with new examples, and record at least one error. Then change the dataset and test again. The aim is to explain what the model learned, where it failed, and how human choices affected the result. Modules 2–5 guide the practical work; Module 6 helps you turn it into a lesson; the Appendix contains planning and assessment sheets.

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6. Icons and Visual Conventions

📘 **Icon Legend**

💡 Concept → Key idea or definition.
🧩 Classroom Idea → Practical example or activity.
⚙️ Process → Step-by-step instructions.
🎯 Learning Focus → Learning outcomes or goals.
📘 Ethics Focus → Responsible AI practices.
✅ Checklist → Practical summary or reflection tool.

These visual elements make the handbook more interactive and easier to navigate during teaching and training sessions.

7. Ethical Framework

Ethics is at the heart of AI education. Teachers play a vital role in shaping how students use technology responsibly. This handbook adopts an 'Ethics-by-Design' approach: integrating privacy, consent, and fairness considerations at every stage of learning.

Before collecting data: use objects, drawings, or openly licensed materials when they can meet the learning goal. If an activity involves identifiable students, voices, or body images, follow your school's consent and data-protection procedures. Agree in advance who may access the project or any shared model link, and do not publish student material simply because the platform offers a sharing option.

📘 **Principles**

- Transparency – explain how AI decisions are made.
- Privacy – protect students' data and identity.
- Inclusion – ensure equal representation and accessibility.
- Reflection – encourages dialogue on AI's impact in society.

8. Structure Overview

The handbook is organized into seven modules plus an appendix, each focusing on a specific aspect of AI education with Teachable Machine:

Module	Focus Area
1. Understanding AI and Machine Learning	Core concepts and foundations.

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2. Getting Started with Teachable Machine	Setup, navigation, and first projects.
3. Image Projects	Using images to train and test visual recognition models.
4. Audio Projects	Exploring sound data and pattern recognition.
5. Pose Projects	Learning through movement and body recognition.
6. Integrating AI into Lesson Plans	Designing cross-disciplinary lessons and LUP.
7. Resources and Continued Learning	Ongoing training, communities, and tools.
Appendix	10 classroom activities, templates, and rubrics.

🎓 **Final Note**

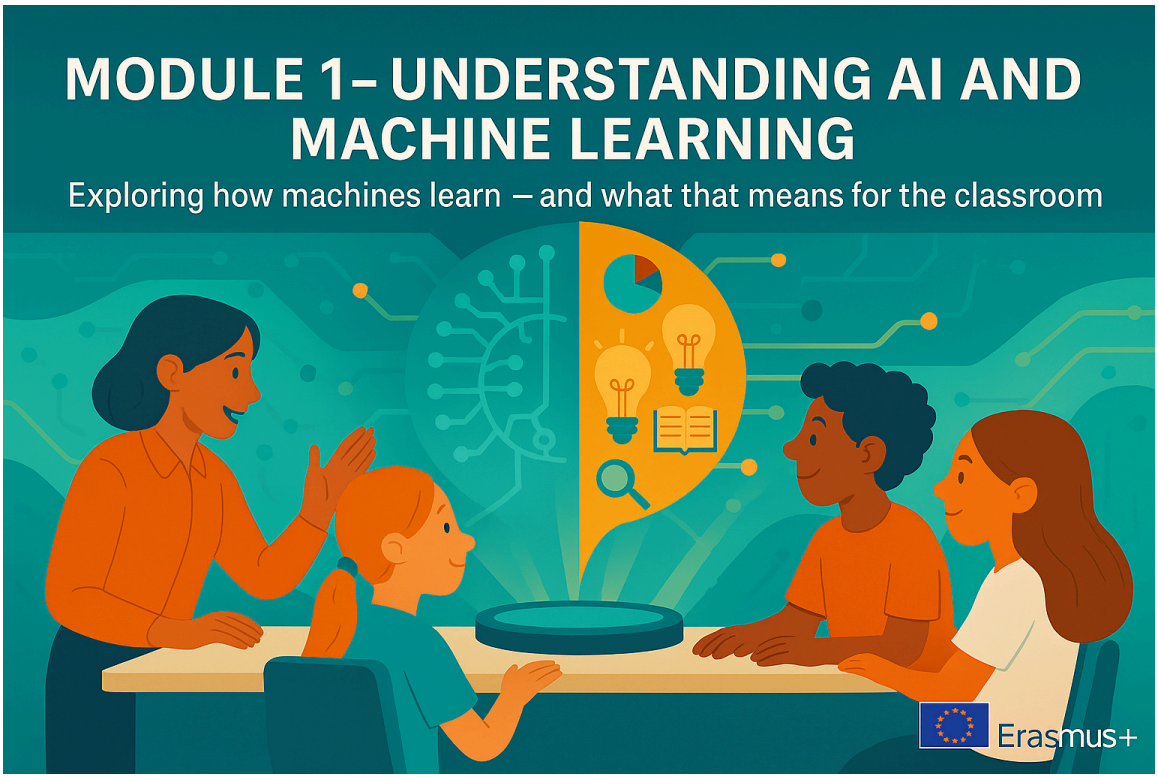
AI education is a journey — start small, experiment often, and involve your students in building a responsible, creative digital future.

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Module 1 – Understanding AI and Machine Learning

Helping teachers and students explore how Artificial Intelligence (AI) and Machine Learning (ML) work, why they matter, and how to introduce them through inquiry and creative classroom activities.



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1. Big Picture: What is AI and Machine Learning?

Artificial Intelligence (AI) refers to computer systems capable of performing tasks that normally require human intelligence, such as pattern recognition, decision-making, or understanding speech. Machine Learning (ML) is a branch of AI that allows systems to learn from examples and improve over time without being explicitly programmed.

AI is now part of daily life—from search engines to digital assistants. For educators, introducing AI means helping students understand how technology can learn, make predictions, and support human creativity.

💡 **Concept**

AI = Thinking systems. ML = Learning systems. AI includes ML, and ML makes AI practical.

AI systems perform tasks that may appear intelligent; ML systems learn statistical patterns from examples.

Micro-history of AI

Year	Milestone
1956	Birth of the term 'Artificial Intelligence' at the Dartmouth Conference.
1980s	Expert systems try to simulate human decision rules.
1997	IBM Deep Blue defeats Garry Kasparov at chess.
2012	Deep learning achieves breakthroughs in image recognition.
2020s	AI becomes mainstream: chatbots, translation, personalized recommendations.
2022-present	**Wider public use of generative AI**. Tools that generate text, images, and other content make AI visible in everyday learning. In this handbook, Teachable Machine offers a different, complementary experience: students train a small model to classify examples they have chosen.

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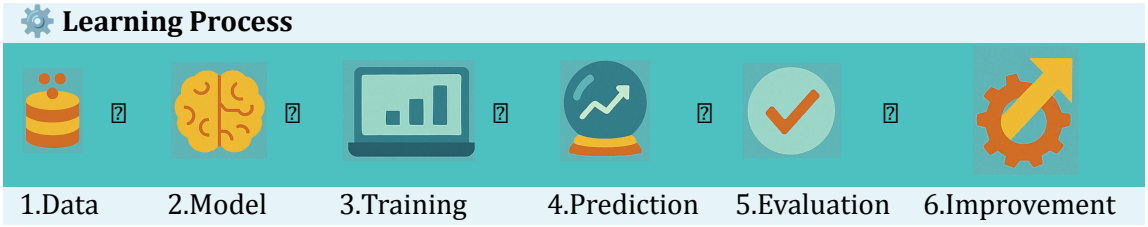
2. Core Concepts of Machine Learning

Machine Learning is the process of teaching a computer by showing it many examples. Instead of writing explicit rules, we provide data—images, sounds, or text—and the system finds patterns.

In **traditional coding**, the programmer writes explicit rules that the computer follows step by step.
👉 In simple terms: *Input + Rules (Algorithm) → Output*
Example: A program that calculates the average of two numbers follows instructions precisely as written by the coder.

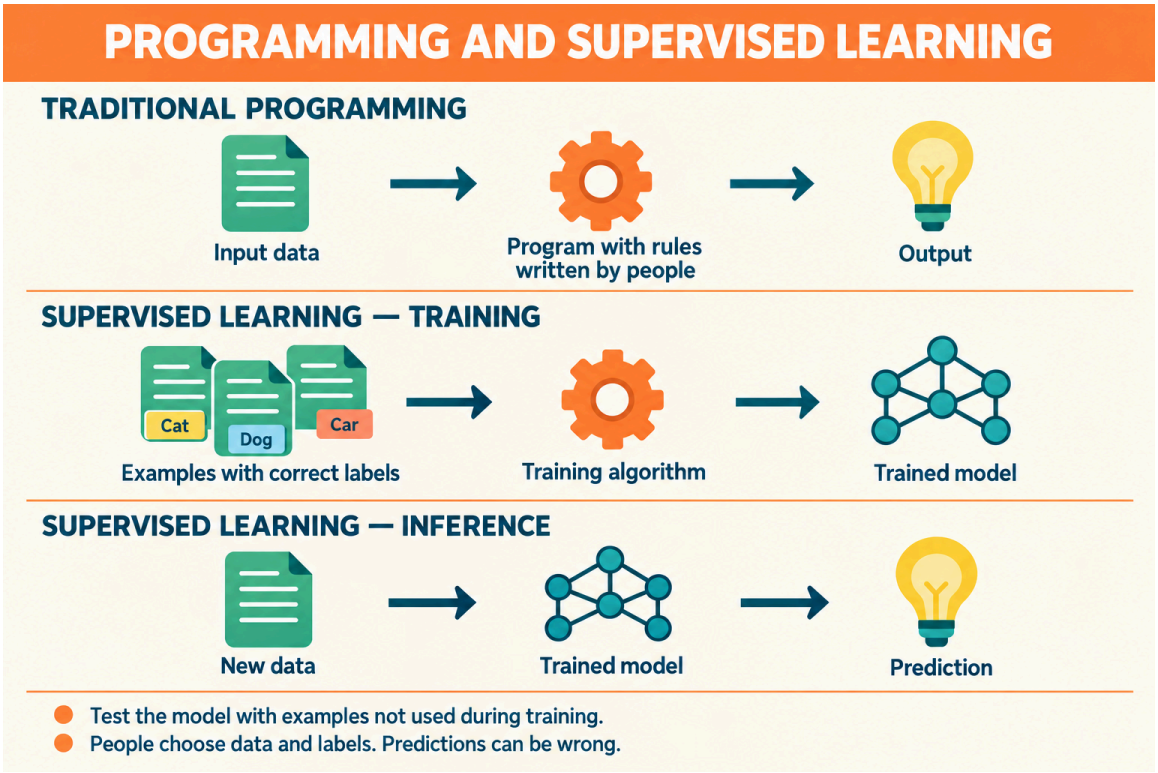
In **Machine Learning,** the computer learns from examples instead of being given explicit rules.
👉 In simple terms. ~~*Input + Output → Algorithm (Model)*~~
In supervised machine learning, people provide examples and the correct labels. During training, the software adjusts a model so that it can associate patterns in the examples with those labels. When it receives a new example, the model produces a prediction based on the patterns it learned. It may also learn irrelevant details, such as the background of a photo, so its predictions must be tested.
This means we don't program the rules; we give the computer data and examples, and it build the model. ~~it "learns" the logic by itself~~.

The result is a model that can make predictions about new data.



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Summary Table

Aspect	Traditional Coding	Machine Learning
Who defines the rules	The programmer	The computer learns from data
Type of knowledge	Explicit (instructions)	Implicit (patterns)
When to use it	For predictable, well-defined problems	For complex problems with lots of data (images, sounds, text)

🧩 Tip for Teachers — A kitchen analogy.

A written recipe resembles a program with specified steps. Training a model is closer to giving a learner many labelled examples and asking them to notice patterns. The analogy has limits: the model does not taste, understand, or reason like a chef. Ask students which details in the examples might mislead it.

Teachers can show this process visually: feed the model examples, let it train, and test with new cases. Discuss why accuracy may vary and what factors (bias, missing data, lighting, sound quality) can affect the results.

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🧩 **Classroom Idea**

Have students train a model in Teachable Machine to recognize classroom objects (e.g., pens, notebooks, bottles). Then test it and discuss how changing data or angles alters predictions.

3. Pedagogical Translation – Explaining AI to 10–15-year-olds

For younger students, connect AI to their own learning: when they study, they review examples, look for patterns, and make generalizations. AI systems do something similar—but only with the data we provide.

🎯 **Learning Focus**

Encourage curiosity: Let students ask 'why' the machine made a mistake. Use mistakes as learning opportunities.

Misconception	**Clarification / Teaching Strategy**
AI is like a human brain.	Explain that AI follows math and data rules—it doesn't feel or think.
More data always means better results.	Highlight quality and diversity of examples instead of quantity.
AI never makes errors.	Show that errors reveal bias and gaps—fixing them is part of learning.
AI is objective because it is a machine.	A model reflects choices made by people: which examples to collect, how to label them, and which cases to leave out. Test it with examples from different contexts to see whether its predictions change.

4. Ethics and Responsibility

AI education must include ethical reflection. Students should understand privacy, consent, and bias in datasets. Teachers can model responsible AI use by choosing safe, inclusive, and transparent activities.

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📘 **Ethics Focus**

Always ask consent before using photos or voice data. Avoid personal information. Discuss how bias can arise if datasets represent only one group or context.

Discussion prompt: **Two classroom cases**.

Different ways of moving: A pose model is trained only with standing students. How might it respond to a student using a wheelchair or performing the activity while seated? How could the class redesign the activity so that everyone can participate?

Different cultural contexts: An image model is trained to recognize breakfast foods using only cereal and toast. What might happen when it sees foods from other countries? Which examples should students add before claiming that the model recognizes "breakfast"?

What could happen if an AI model were trained with photos of only one skin tone or one type of classroom? How can we fix this?

5. Classroom Implementation – Learning by Doing

🧩 **Activity: Train Your First Model**

1. Go to https://teachablemachine.withgoogle.com
2. Select Image Project.
3. Create two classes, e.g., Pen and Notebook.
4. Upload or capture 30–40 images for each class.
5. Click Train Model.
6. Test with new objects.
7. Reflect: What made the model succeed or fail?

✅ **Reflection Checklist**

☐ Students understood how AI learns from examples.
☐ They noticed the impact of biased or limited data.
☐ They discussed ethical implications of AI.
☐ They collaborated and reflected on results.

🧩 **Activity: Beyond STEM**

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In History, students can discuss how pattern recognition might help researchers study difficult-to-read documents, while checking any proposed reading against historical evidence. In Art, they can classify selected images by visible features and debate whether a label captures the meaning of an artwork. In Languages, they can compare how a sound classifier responds to different speakers and accents. In each case, subject knowledge is needed to interpret the model's output.

End-of-Module Summary

Key Takeaways:

- AI and ML allow computers to learn patterns from data.
- Classroom AI should combine experimentation with ethics.
- Responsible datasets and reflection turn technology into learning.

Next Module → Getting Started with Teachable Machine

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Module 2 – Getting Started with Teachable Machine

This module introduces teachers to Google's Teachable Machine (TM): a free, browser-based tool that allows students to create simple Machine Learning models without programming. Through guided exploration, teachers will learn how to set up, use, and apply TM in the classroom.



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1. What is Teachable Machine?

Teachable Machine (TM) is an online platform developed by Google that enables anyone to train a computer to recognize images, sounds, and poses. It simplifies Machine Learning into a visual, interactive process suitable for students of all ages.

💡 **Concept**

Teachable Machine = No-code AI learning platform.
Teachers and students can 'train' models directly from their browser using webcam or microphone.

By using TM, teachers can introduce core concepts of data collection, model training, evaluation, and improvement through hands-on activities. The intuitive interface and real-time feedback make it a perfect entry point to AI education.

2. Getting Ready

~~⚙️ **Requirements**~~

~~✔ Computer or laptop with internet connection~~
~~✔ Chrome or Firefox browser~~
~~✔ Webcam and/or microphone (depending on project type)~~
~~✔ Google account to save or export models~~

~~Before starting, teachers should test the webcam and microphone, ensure a stable connection, and prepare folders for images or sound clips. Encourage students to think critically about what data they will collect and why.~~

✅ **Before the lesson – five-minute check**

☐ Open Teachable Machine on the devices and browser that students will use.
☐ Check the school network, webcam, microphone, and browser permissions.
☐ Close other applications that may be using the camera or microphone.
☐ Prepare a small folder of suitable images in case live capture does not work.
☐ Decide how students will save their editable project and where the file may be stored.
☐ Test the complete sequence — create classes, add examples, train, preview, and save — before teaching it.

A Google account is useful for a Drive-based saving option if available, but it should not be presented as a requirement for every classroom activity.

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🧩 **Tip for Teachers**

Plan 15 minutes for setup and exploration before launching a full project. Let students play with the interface to discover how training works.

3. Exploring the Three Project Types

🖼️ **Image Project**

Students train a model using images captured from their webcam or uploaded from their computer. Ideal for science, art, or environmental lessons.

Example: Classify plant leaves or recycling materials.

🔊 **Audio Project**

Students record sound samples (voice or environmental noises). Ideal for language learning or sound recognition activities.

Example: Recognize vowel sounds or animal noises.

🕺 **Pose Project**

Students use their webcam to train a model based on body positions. Ideal for PE, drama, or storytelling.

Example: Detect different exercise poses or gestures in a story.

🧩 **Witch project should I choose?**

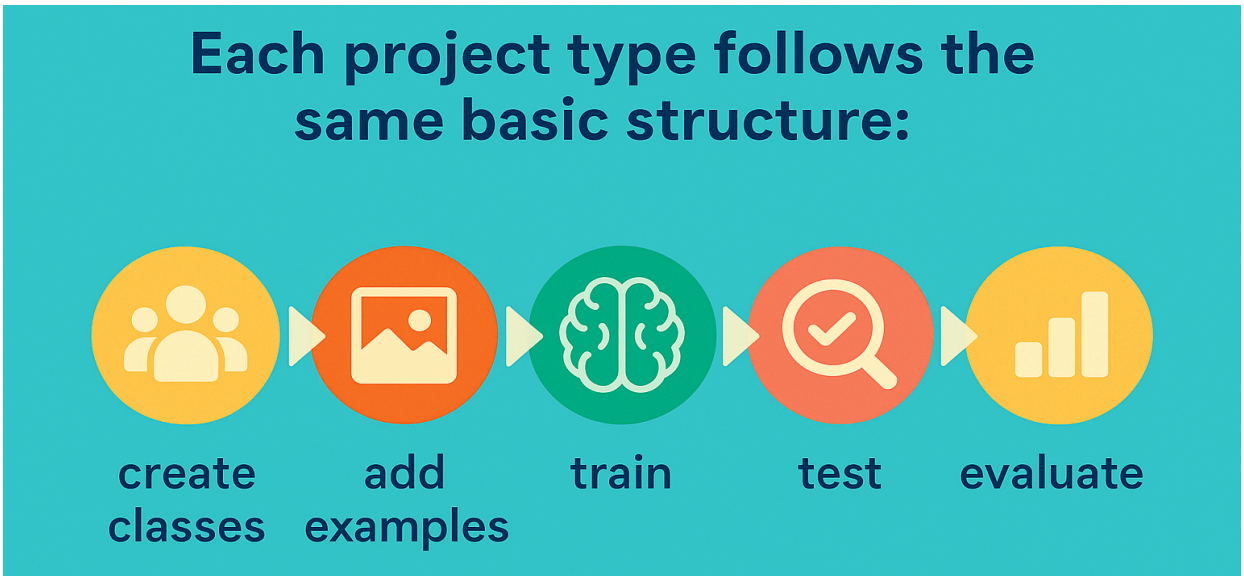
Choose **Image** when students can collect clear, safe visual examples, such as leaves, shapes, or recyclable objects. Choose **Audio** when the learning goal concerns sounds or pronunciation and you can organize recording without interference between groups. Choose **Pose** when body position matters and there is adequate space, lighting, and an inclusive way for all students to participate. Begin with Image if the class is using the tool for the first time; select another type when it serves the subject goal better.

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Each project type follows the same basic structure:

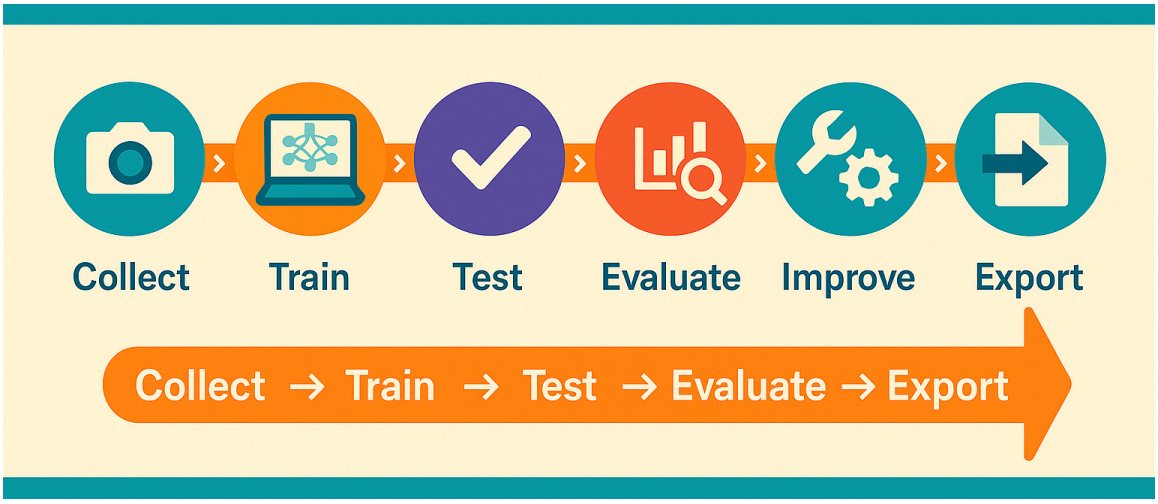
create classes → add examples → train → test → evaluate.



4. Workflow Overview

Teachable Machine uses an easy-to-follow workflow that teachers can model during lessons. This cycle helps students visualize how AI systems learn and improve.

🔄 **TM Workflow**



The workflow is a loop. After training, test the model with examples it has never seen. Write down at least one unexpected prediction. Ask what may have caused it: too few examples, similar-looking classes, a repeated background, noise, or poor camera framing.

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Change one aspect of the dataset, retrain, and test again. Record both results so students can judge whether their change helped.

Each phase of the workflow can become a mini-lesson: data collection teaches ethics and accuracy; training develops patience and observation; evaluation encourages reflection and teamwork.

5. Example Lesson: 'Classroom Object Recognizer'

This beginner activity introduces students to the full cycle of model creation and testing using classroom objects.

🧩 **Activity Steps**

1. Go to https://teachablemachine.withgoogle.com/ ~~the click the Start button~~ then select the option to start a new project
2. Choose 'Image Project'.
3. Create three classes: Pen, Notebook, and Scissors.
4. Take 30–40 photos for each class.
5. Train the model
6. Test the model using real objects.
7. Discuss: What happens if lighting or background changes?
8. Add more examples and retrain to improve accuracy.
9. Export the model if you want to use it with other web applications (ex. pictoblox.ai)

(See the images below)

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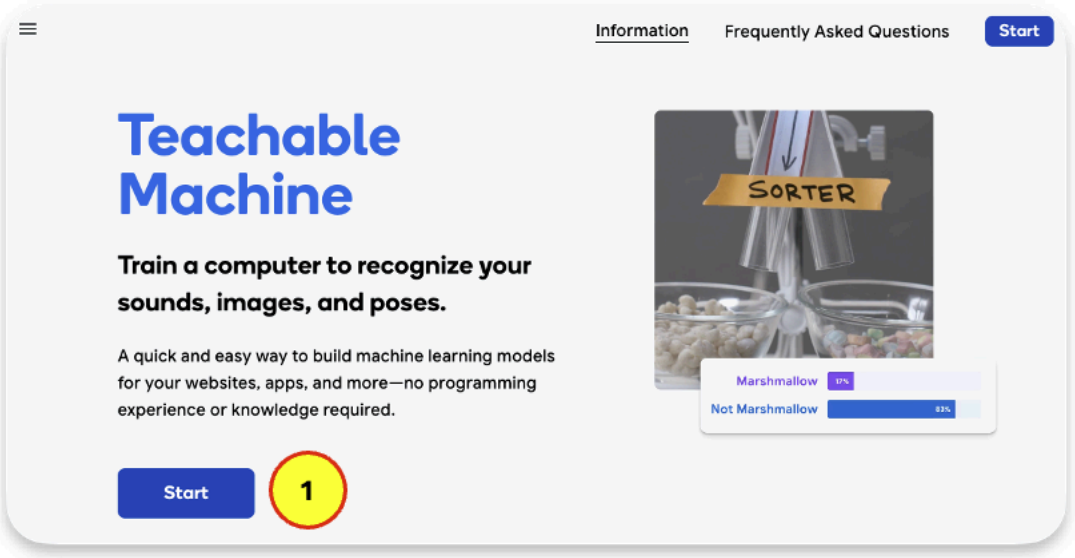


Figure 1 – Select the option to start a new project

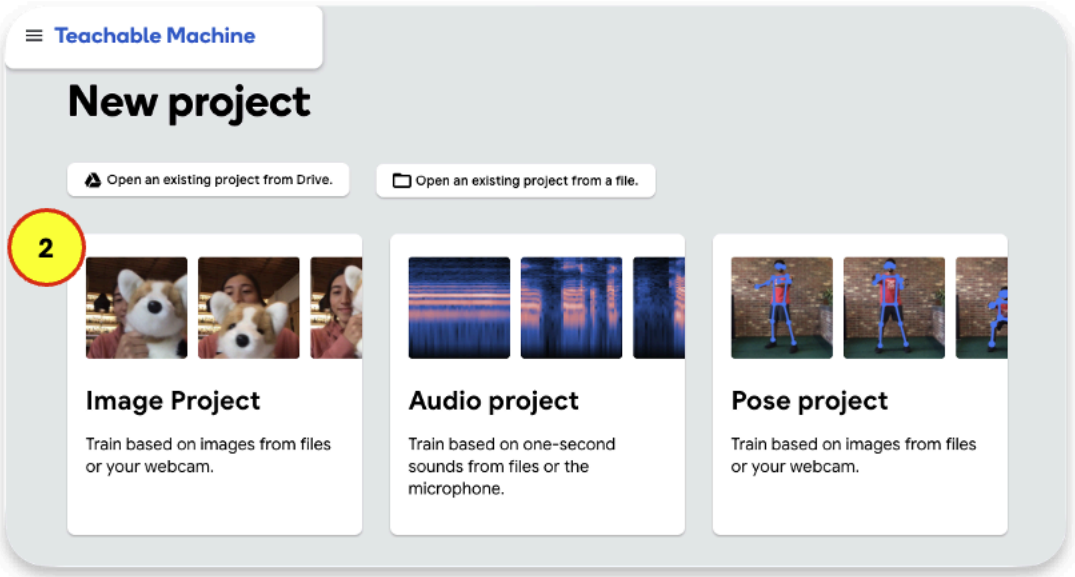


Figure 2 - Choose 'Image Project'

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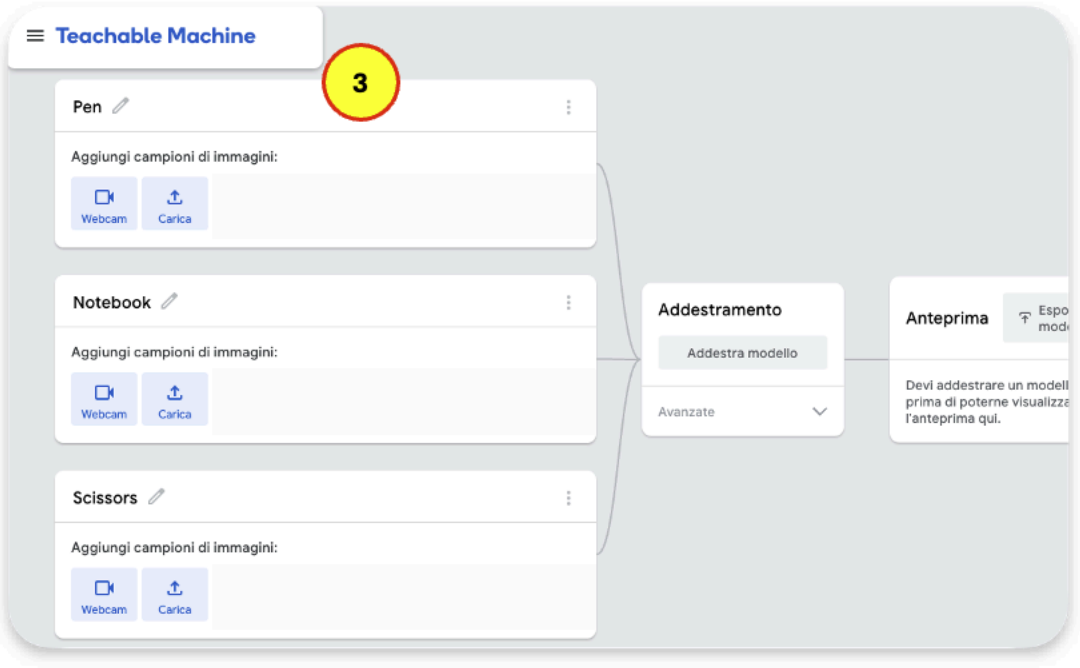


Figure 3 - Create three classes: Pen, Notebook, and Scissors

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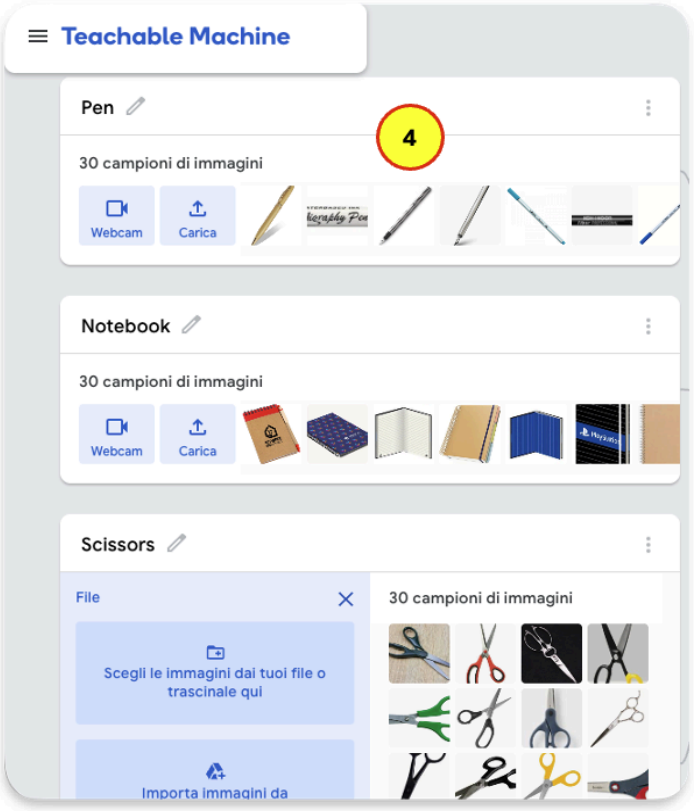


Figure 4 - Take 30-40 photos for each class



Figure 5 - Train the model

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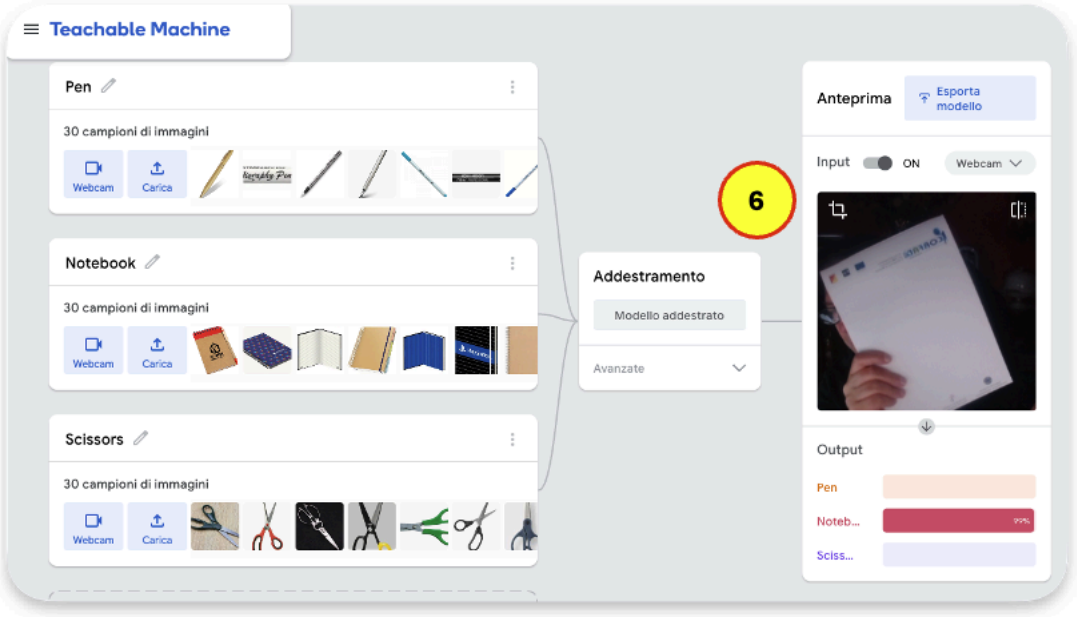


Figure 6 - Test the model using real objects: notebooks

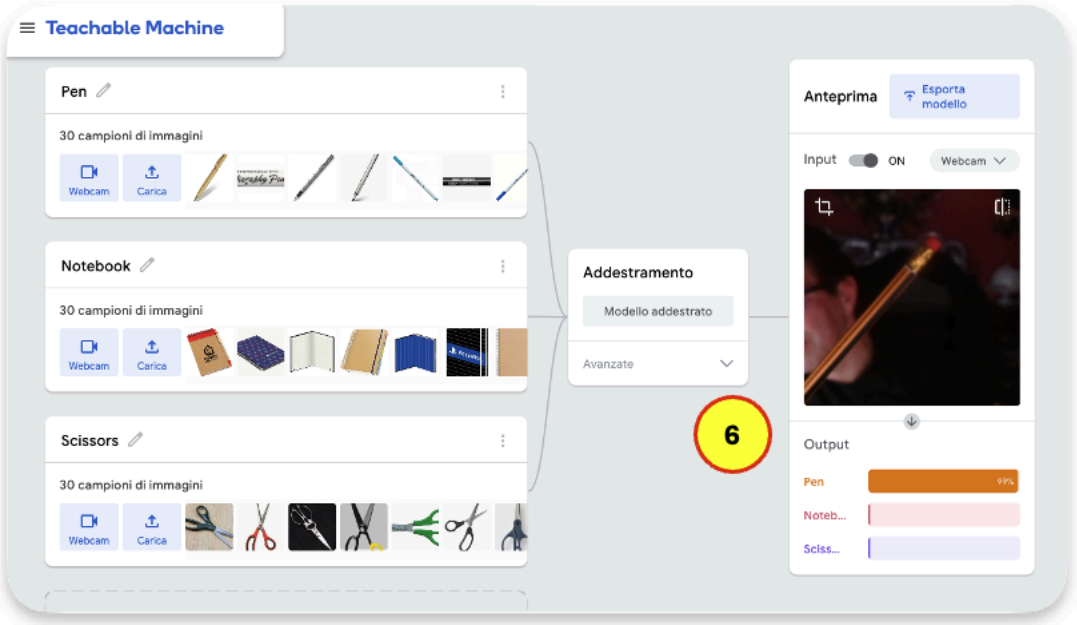


Figure 7 - Test the model using real objects: pens

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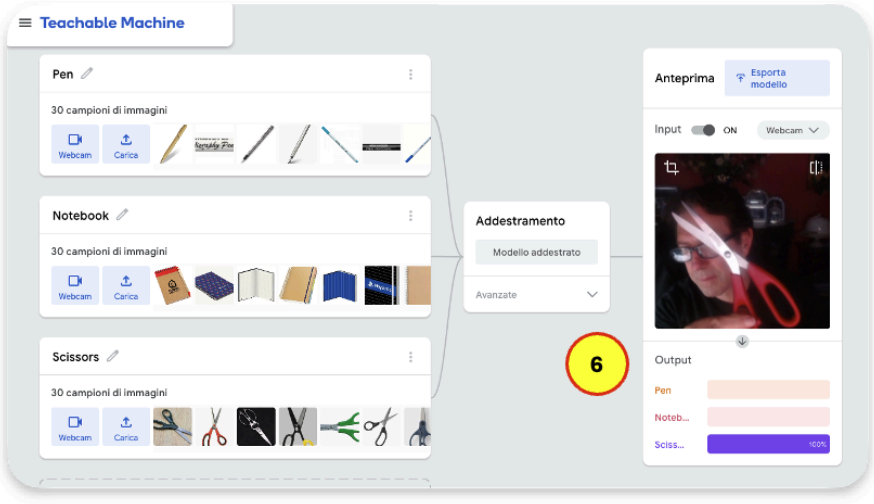


Figure 8 - Test the model using real objects: scissors

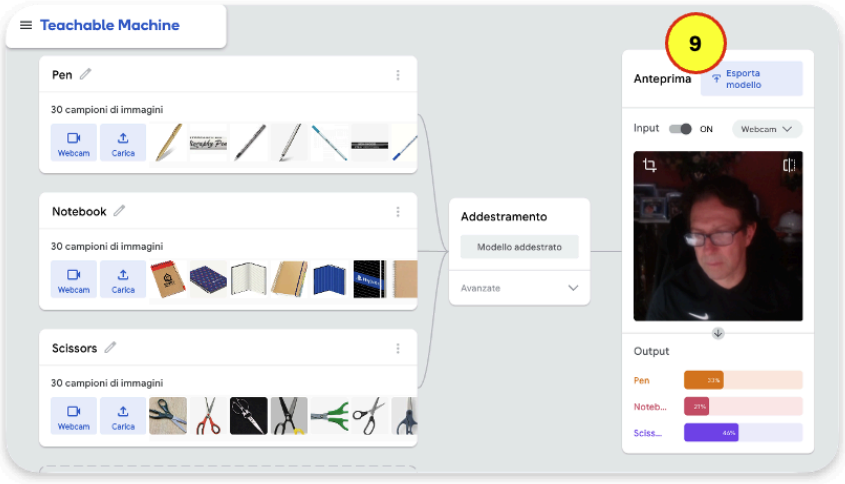


Figure 9 – Select the option to export the model

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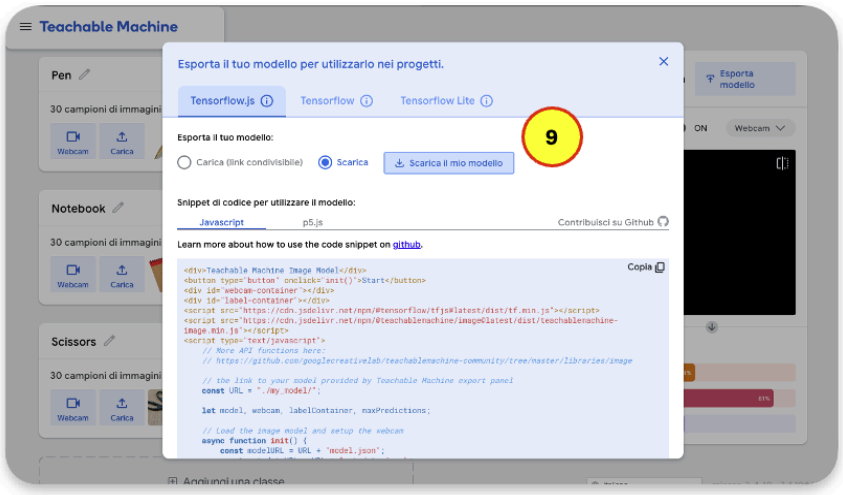


Figure 10 - Export the model if you want to use it with other web applications (ex. pictoblox.ai)

🧩 Save before closing the page

Check the project's save menu and save an editable copy using an option available on your device, such as a project file or an approved Drive location. Give the file a recognizable name and verify that you can reopen it. Exporting or sharing a trained model is a separate action: a model link does not replace an editable copy of the classroom project. Follow school rules before uploading or sharing student-created material.

🎯 Learning Goals

- Understand the AI learning cycle.
- Practice teamwork and data ethics.
- Recognize sources of bias and errors.
- Apply reflection and improvement in real time.

6. Common Issues and How to Fix Them

Issue	Solution / Tip
Model predicts incorrectly	Add more diverse examples and retrain.
Too few samples per class	~~Minimum: 30 images or 10–15 seconds of audio per class~~. Increase the initial data collection target per class and test the model using new examples.

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Lighting or noise affects results	Collect data in various conditions and environments.
File won't export	Check browser permissions or use a different one (Chrome recommended).

7. Ethics and Data Responsibility

AI education requires safe and ethical data use. Students should only use data they created or have permission to use. Teachers should explain that data quality and diversity affect fairness and accuracy.

📘 **Ethics Focus**

- No personal or sensitive data.
- Avoid identifiable faces without consent.
- Collect balanced examples for fairness.
- Discuss how bias can emerge in training data.

8. Reflection and Assessment

🧠 **Reflection Questions**

- What surprised you about how the model learned?
- How did changing data affect accuracy?
- What did you learn about bias and improvement?

✅ **Assessment Checklist**

☐ Students participated actively in data collection.
☐ They can explain how TM trains and tests models.
☐ They identified at least one ethical issue.
☐ They suggested improvements to increase accuracy.

End-of-Module Summary

Key Takeaways:

- Teachable Machine introduces AI and ML through experimentation.
- Image, Audio, and Pose projects engage students across subjects.

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• Ethics and reflection make technology learning meaningful.

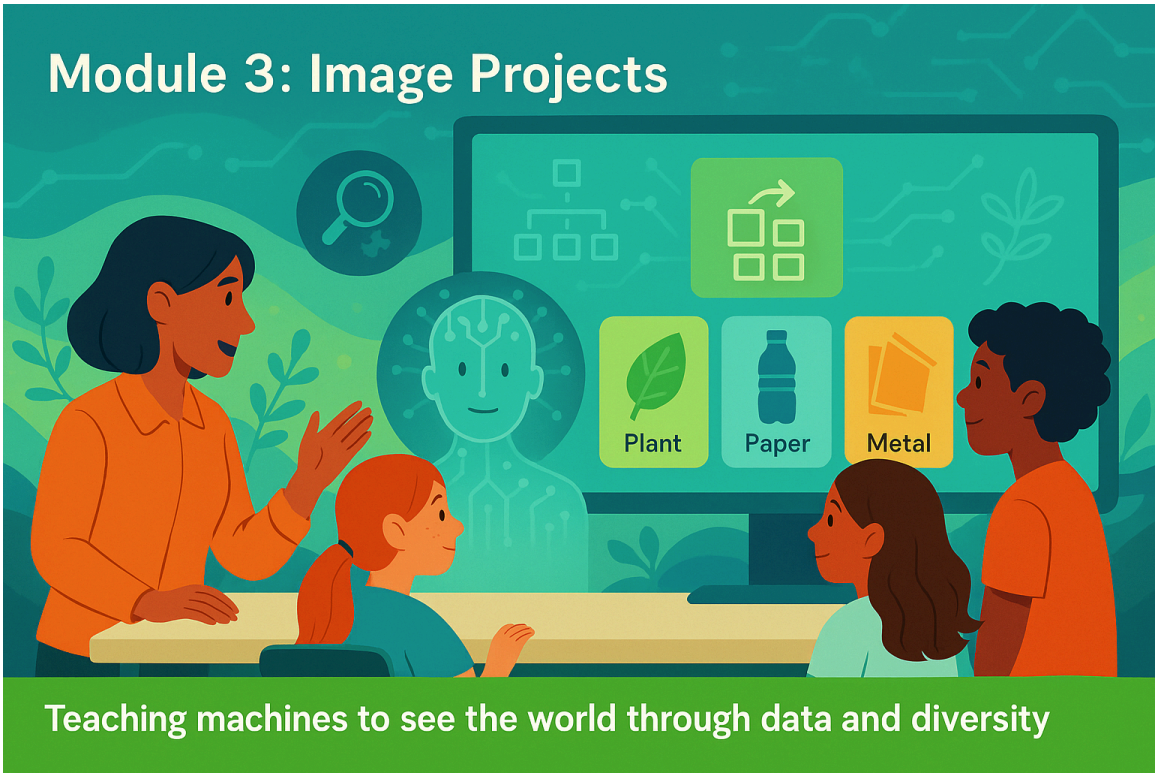
Next Module → Image Projects: Learning through Vision.

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Module 3 – Image Projects

This module explores how to create, train, and apply Image Projects with Teachable Machine. It helps teachers understand how image classification works and how to guide students through hands-on AI learning experiences.



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1. Introduction – Why Image Projects Matter

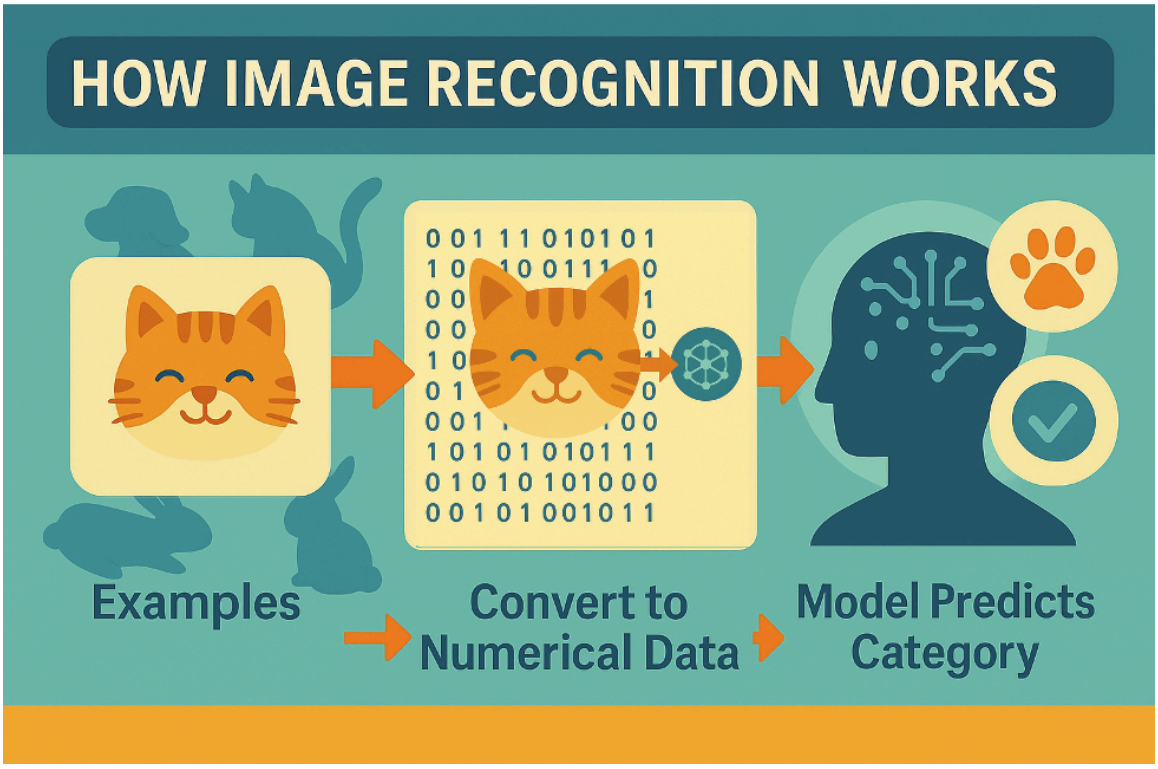
Images are central to how both humans and computers perceive the world. Working with image classification allows students to connect technology with real-life visual experiences, promoting observation, creativity, and digital literacy.

> 💡 **Concept**
>
> Images → Patterns → Predictions. By showing examples, students teach the computer to recognize visual categories such as shapes, colors, or objects.

Image Projects help develop skills in pattern recognition, problem-solving, and ethical awareness. They also support cross-disciplinary links between art, science, and environmental education.

2. How Image Recognition Works (Simplified)

Machine Learning for images relies on large sets of examples. Each image is converted into numerical data (pixels) that the model analyzes to find recurring patterns. After training, the model predicts which category a new image belongs to based on what it has learned.



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🧠 **Simplified Process**



1. Collect examples	2. Train	3. Evaluate	4. Test new images	5. Improve with feedback.

Teachers should emphasize that computers do not truly 'see' images but rather detect mathematical differences between colors, textures, and shapes.

3. Classroom Preparation

⚙️ **Preparation Checklist**

☐ Define project topic (e.g., recycling materials, classroom items, plants).
☐ Ensure webcams or cameras work correctly.
☐ Prepare neutral backgrounds and good lighting.
☐ Plan how to store images safely.
☐ Obtain consent if students' faces appear in photos.

🧩 **Collect useful variation**

Take examples from several angles and distances, with realistic changes in lighting and background. Avoid collecting many nearly identical frames from a webcam burst. For an apple classifier, include different colors and positions in each relevant class. Keep the object visible and label each example carefully. A smaller, varied dataset can teach students more than a large set of repeated pictures.

Encourage students to take diverse pictures—different angles, lighting, and backgrounds—to help the model learn general patterns rather than memorizing one view.

4. Step-by-Step Activity – 'Recycling Classifier'

This activity introduces the complete ML cycle in a context linked to sustainability education. Students build an AI model that distinguishes between different types of waste materials.

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🧩 Activity Steps

1. Visit https://teachablemachine.withgoogle.com/
2. Select 'Image Project'.
3. Create three classes: Plastic, Paper, Metal.
4. Capture 30–40 photos per class using varied angles and lighting.
~~5. Train the model and test predictions using real classroom waste.~~
~~6. Discuss: What errors occur? Why?~~
~~7. Add new examples and retrain to improve accuracy.~~
5. Train the model. Reserve several new objects or photos from each class for testing; do not add these to the training examples yet.
6. Test each new example and record the predicted label, the displayed confidence, and whether the prediction was correct. A high confidence value does not prove that a prediction is correct.
7. Choose one recurring error, discuss a possible cause, add or replace relevant training examples, retrain, and repeat the same test. Compare the results before and after the change.

🎯 Learning Focus

- Understand how data diversity improves fairness.
- Recognize bias and imbalance in datasets.
- Foster environmental awareness through AI applications.

📘 Ethics Focus

Avoid personal or branded content in images. Encourage discussion about how data collection choices affect fairness and representation.

5. Troubleshooting & Improvement

Issue	Solution / Tip
Model confuses similar classes	Add clearer examples or merge overlapping categories.
Overfitting: high training accuracy but poor real-world results	Collect more diverse photos and remove duplicates.

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Low accuracy in one class	Balance dataset size and ensure equal lighting/backgrounds.
Students use repetitive backgrounds	Encourage variety to help generalization.

A quick diagnostic test. If the model recognizes an object only in front of one wall, it may be using the background. Photograph the same object in another place. If it works for one student's examples but not another's, compare the angles, distance, lighting, and objects represented in the training set. Change one factor at a time so that students can explain what improved the result.

6. Pedagogical Extensions

🌍 **Cross-Curricular Ideas**

- **Science**: Identify types of leaves or rocks.
- **Art**: Explore colors, patterns, or artistic styles.
- **ICT**: Connect to pixel and data representation lessons.
- **Civics**: Classify waste types to discuss environmental responsibility.
- **History and Art activity**: Collect permitted images of architectural arches from different periods. Before training, agree on visible features and check that image source or background does not reveal the answer. Test with unseen examples and compare the model's classifications with a short explanation based on historical or artistic evidence.
- **Language activity**: Classify pictures of objects linked to a vocabulary set. When the model predicts a label, the student says or writes the word and checks its meaning. Image classification does not read arbitrary printed words like an OCR tool.

Teachers can also collaborate across subjects, integrating AI into broader STEAM projects or sustainability challenges.

7. Reflection & Assessment

🧠 **Reflection Questions**

- What did students discover about how the model learns?
- How did data variety influence results?
- What ethical aspects emerged during data collection?
- How might this technology help solve real environmental problems?

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✅ **Assessment Checklist**

☐ Students participated actively in data collection.
☐ They can explain why data diversity matters.
☐ They discussed and applied ethical rules.
☐ They reflected on model improvement steps.

End-of-Module Summary

Key Takeaways:
• Image Projects build understanding of how AI perceives visual information.
• Students learn by experimenting, observing, and improving data quality.
• Ethical awareness and cross-disciplinary connections make AI learning authentic.

Next Module → Audio Projects: Learning through Sound.

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Module 4 – Audio Projects

This module focuses on how teachers and students can use Teachable Machine to create Audio Projects. By recording and training AI to recognize sounds, students explore the science of sound, data patterns, and ethical listening practices.



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1. Introduction – Why Audio Projects Matter

Sound recognition projects offer a powerful way to combine technology with music, language, and environmental learning. Students can record their own voices, instruments, or everyday noises and teach the computer to recognize them.

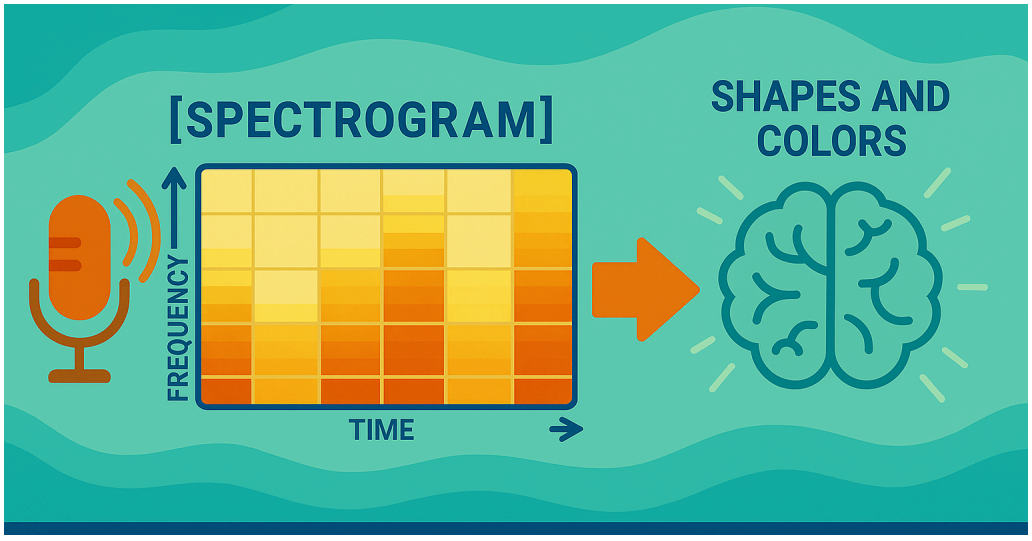
💡 **Concept**

Audio data is made of sound waves that the computer turns into numbers (frequencies and amplitudes). By comparing these patterns, the AI model learns to identify differences between sound types.

These projects support creativity, critical thinking, and digital literacy by encouraging students to listen carefully and analyze data from their own environment.

2. How Audio Recognition Works (Simplified)

Machine Learning for audio works by transforming sound into a visual map of frequencies called a spectrogram. The system detects shapes and colors on this map to find patterns unique to each sound.



🧠 **Simplified Process**



1. Record samples	2. Convert to spectrograms	3. Train model	4. Test new sounds	5. Improve

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Teachers can show how changing volume, background noise, or microphone distance affects results. This helps students understand why controlled, varied data is important.

3. Classroom Preparation

⚙️ **Preparation Checklist**

☐ Quiet room with minimal background noise.
☐ Microphones tested and ready.
☐ Plan for sound samples (e.g., voice, instruments, nature sounds).
☐ Obtain consent before recording people's voices.
☐ Prepare a short naming scheme for files (e.g., class_label_01).

Record the real listening environment. If the activity uses a background-noise category, record ordinary classroom sounds at a level similar to the one expected during testing. Avoid using only perfect silence as a substitute for keyboard clicks, ventilation, or distant voices. Keep target sounds distinct from the background examples and test the model in the actual room.

Encourage students to record ~~short clips (0.5–2 seconds)~~ and to experiment with variations in pitch, tone, or rhythm.

Recording tip. Follow the sample length shown in the Audio Project interface and keep each sound clearly inside the recorded segment. Collect several examples per class from different attempts and, where appropriate and consented, different speakers or sound sources. Start with approximately 20–30 usable examples per class, then judge sufficiency by testing with new sounds.

4. Step-by-Step Activity – 'Sound Identifier'

This activity helps students understand how AI can distinguish between different sounds. It also builds awareness of how data quality impacts model performance.

🧩 **Activity Steps**

1. Visit https://teachablemachine.withgoogle.com/
2. Choose 'Audio Project'.
3. ~~Create three classes: Clap, Snap, Silence.~~ Create target classes such as Clap and Snap. Use the platform's background-noise category, if shown, to represent ordinary classroom noise. Explain what each class contains before recording.
4. Record 20–30 short clips per class.
5. Train the model and test using new sounds.
6. Compare results and discuss possible errors.
7. Add varied examples and retrain to improve performance.

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🎯 Learning Focus

- Understand sound as data.
- Recognize how training affects predictions.
- Explore environmental sounds and acoustic patterns.
- Foster creativity and collaboration in data creation.

📘 Ethics Focus

Always ask for permission before recording voices. Discuss sound privacy and respect for personal or cultural content.

🧩 Classroom management — recording turns

Do not ask every group to record at the same time. Set up one or two recording stations or let half the groups prepare class labels and test questions while the others record. Rotate after a few minutes. Listen to a sample before training: if another group's voice or sound is clearly audible, record it again.

5. Troubleshooting & Improvement

Issue	Solution / Tip
Background noise lowers accuracy	Record in a quieter setting or use a noise-reduction tool.
Model favors one accent or voice	Add samples from multiple people with varied tones and accents.
Volume differences affect predictions	Normalize recording levels; keep consistent distance to the mic.
Latency during testing	Simplify project; limit number of classes or clip length.

6. Pedagogical Extensions

🌍 Cross-Curricular Ideas

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- Music: Identify instruments or rhythm patterns.
- Language: Practice pronunciation or phonetics.
- Science: Explore animal calls or sound frequencies.
- Environmental Education: Detect local noise pollution levels.

Try it in another subject. In Music, compare short notes from two instruments recorded at similar volume. In Languages, compare clearly defined sounds spoken by several volunteers, without treating one accent as the only "correct" form. In Science, compare sounds made by different materials under similar recording conditions. Ask students which differences come from the target sound, and which come from the recording conditions.

Teachers can also connect audio projects to storytelling or theatre: students create interactive stories where sound triggers actions or visual responses.

7. Reflection & Assessment

🧠 **Reflection Questions**

- What made your model accurate or inaccurate?
- How did background noise influence the results?
- What ethical issues did you consider before recording?
- How could this project apply to real-life sound problems?

✅ **Assessment Checklist**

☐ Students followed ethical recording practices.
☐ They experimented with varied sound sources.
☐ They analyzed causes of errors and improvements.
☐ They reflected on applications of audio AI.

End-of-Module Summary

Key Takeaways:
- Audio Projects develop listening, analysis, and collaboration skills.
- Sound recognition demonstrates how AI learns from acoustic data.
- Ethics, consent, and inclusivity are essential in AI audio projects.

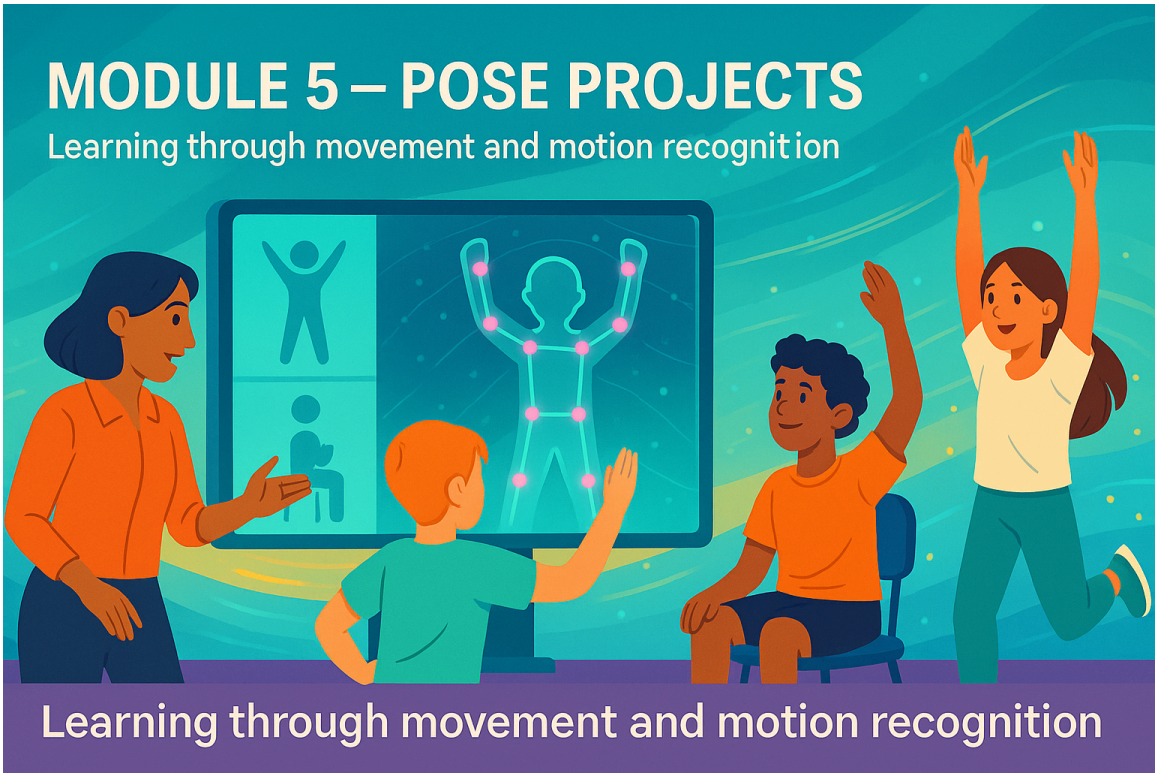
Next Module → Pose Projects: Learning through Movement.

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Module 5 – Pose Projects

This module introduces Pose Projects using Teachable Machine. By recognizing human movements through the webcam, students learn about body positions, computer vision, and ethical considerations in AI.



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1. Introduction – Why Pose Projects Matter

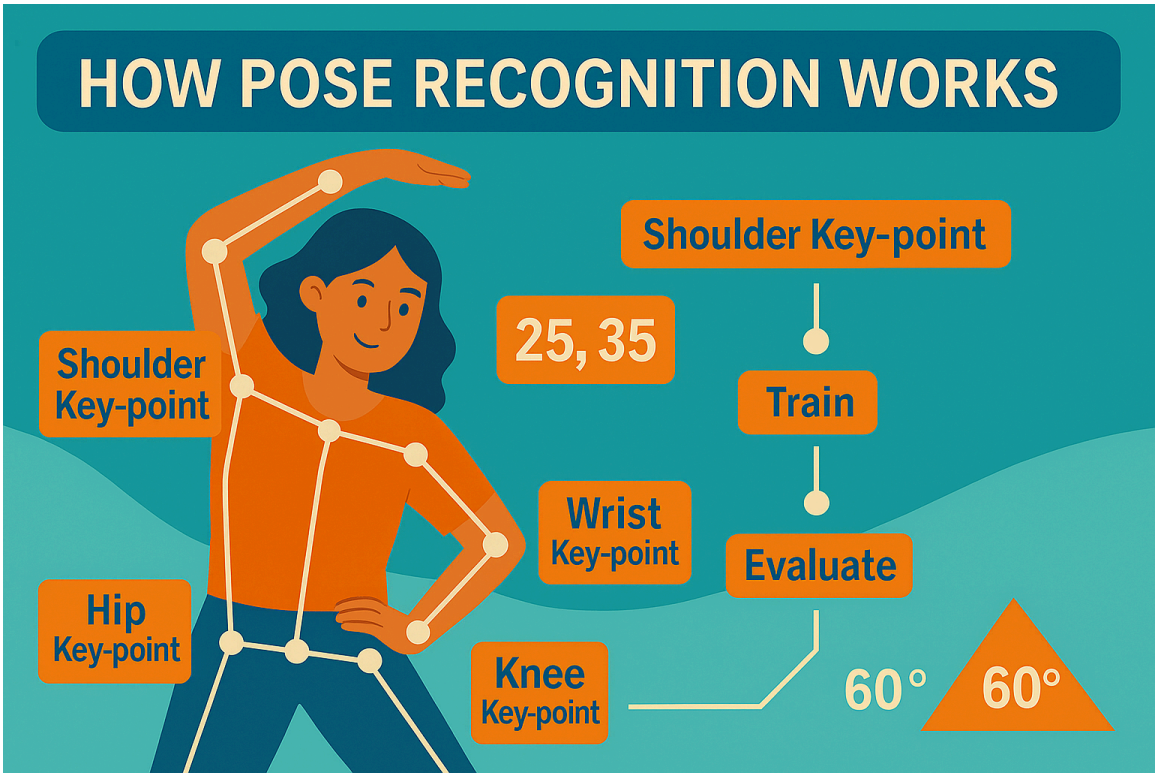
Pose recognition connects physical movement with digital creativity. It encourages students to explore how technology can interpret motion, opening discussions on biomechanics, coding, and human-computer interaction.

> 💡 **Concept**
>
> Pose Projects use the webcam to detect key points on the body (shoulders, arms, legs). The model learns to recognize patterns in body position and classify them into defined categories.

This module blends physical education, art, and digital literacy—making it ideal for kinesthetic learners and interdisciplinary teaching.

2. How Pose Recognition Works (Simplified)

Teachable Machine's pose model uses an algorithm based on key-points—specific coordinates on the human body (like joints). It captures relative positions and angles, turning them into numbers for training and prediction.



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🧠 **Simplified Process**



1. Webcam captures body posture	2. Key-points are detected	3. Patterns are analyzed	4. Model learns to classify movements

Pose recognition demonstrates how AI can interpret motion, but also highlights its limits—camera angle, lighting, and movement speed can all affect accuracy.

Pose versus image. In an Image Project, the model learns patterns from the whole image. In a Pose Project, a pose estimator identifies body landmarks, and the classifier learns patterns in their positions. This can reduce attention to some image details, but camera angle, clothing, occlusion, and differences between people can still affect landmark detection. Check the on-screen pose preview instead of assuming that every joint has been detected correctly.

3. Classroom Preparation

⚙️ **Preparation Checklist**

☐ Clear, well-lit space for movement.
☐ ~~Webcam positioned to capture full body.~~ Position the camera so that the body parts needed for the chosen poses remain visible throughout recording and testing.
☐ Avoid backgrounds with other people or clutter.
☐ Obtain consent for filming.
☐ Plan 2–3 simple, distinct poses for training (e.g., standing, arms up, sitting).

Set up the space. Check the camera preview before collecting examples. For a full-body activity, move far enough away to keep the whole body in frame; the appropriate distance depends on the camera and room. Use even light, reduce visual clutter, and avoid other people entering the frame. If the room is small, design distinct seated or upper body poses instead of requiring everyone to stand at a fixed distance.

Safety first: ensure students have enough space to move comfortably. Teachers can demonstrate first to show how to maintain the same pose distance and timing.

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4. Step-by-Step Activity – 'Form Checker'

This project introduces students to pose recognition while promoting physical activity and self-assessment. The AI model helps identify correct or incorrect forms in simple exercises.

Choose the learning claim carefully. The classes "Standing", "Arms Up", and "Sitting" distinguish positions; by themselves, they do not judge whether an exercise is medically safe or technically correct. For a form-checking activity, define a small number of visible positions with the PE teacher and use the model as a prompt for discussion, not as an authority on a student's body or ability.

🧩 Activity Steps

1. Visit https://teachablemachine.withgoogle.com/
2. Choose 'Pose Project'.
3. Create three classes: Standing, Arms Up, Sitting.
4. ~~Record 20–30 short clips per pose~~ Capture varied, clearly labelled examples of each pose while checking the on-screen body landmarks. Include suitable variations across participants and camera positions, with consent. Save several new performances for testing rather than training on every example. (Students model each one).
5. Train the model and test using real-time webcam input.
6. Evaluate performance: which poses are harder to detect?
7. Add examples from different students to increase diversity and fairness.

🎯 Learning Focus

- Understand how AI perceives movement.
- Reflect on accuracy vs diversity of data.
- Link physical learning with computational thinking.

📘 Ethics Focus

Respect privacy when capturing images. Avoid saving or sharing videos unless students and guardians give permission.

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5. Troubleshooting & Improvement

Issue	Solution / Tip
Model struggles to detect pose	Ensure the camera captures the full body and consistent lighting.
Different students perform poses differently	Include examples from multiple students to help generalize patterns.
Misclassification between similar poses	Simplify the number of classes or make poses more distinct.
Background distractions	Use plain backgrounds and stable lighting to reduce confusion.

🧩 Small room and inclusive participation

Work with one group in the camera area while others observe predictions or document test results. Where appropriate, use seated or upper-body movements that everyone in the group can perform or represent. Do not label a student's natural movement as "incorrect" because the training examples represent only one body type or way of moving. Test the activity with the people for whom it is intended and redesign the labels when needed.

6. Pedagogical Extensions

🌍 Cross-Curricular Ideas

- **Physical Education**: Evaluate warm-up or yoga poses.
- **Art**: Combine poses with digital silhouettes and motion sketches.
- **Drama**: Create gesture-based interactive stories.
- **ICT**: Discuss sensors, motion capture, and human-computer interaction.
- **Biology**: identify deliberately chosen joint positions, then compare the model's labels with a diagram of the movement.
- **Drama**: classify two clearly different gestures and discuss why body language cannot reliably reveal a person's actual emotion.
- **Accessibility**: co-design optional, comfortable signals for interacting with a classroom demonstration; do not present a simple pose classifier as a reliable emergency or accessibility system.

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Teachers can extend Pose Projects into creative storytelling: students build interactive performances where body movements trigger music or animation.

7. Reflection & Assessment

🧠 **Reflection Questions**

- What did students notice about how AI reads movement?
- How do body diversity and camera settings affect fairness?
- What ethical issues arise when using body data?
- How can pose recognition be used for learning or inclusion?

✅ **Assessment Checklist**

☐ Students followed safe and ethical recording practices.
☐ They experimented with different angles and participants.
☐ They reflected on accuracy, diversity, and bias.
☐ They discussed real-world uses of motion recognition.

End-of-Module Summary

Key Takeaways:

- Pose Projects connect movement, technology, and creativity.
- Students experience AI as a bridge between physical and digital learning.
- Ethics and inclusion ensure responsible use of body data.

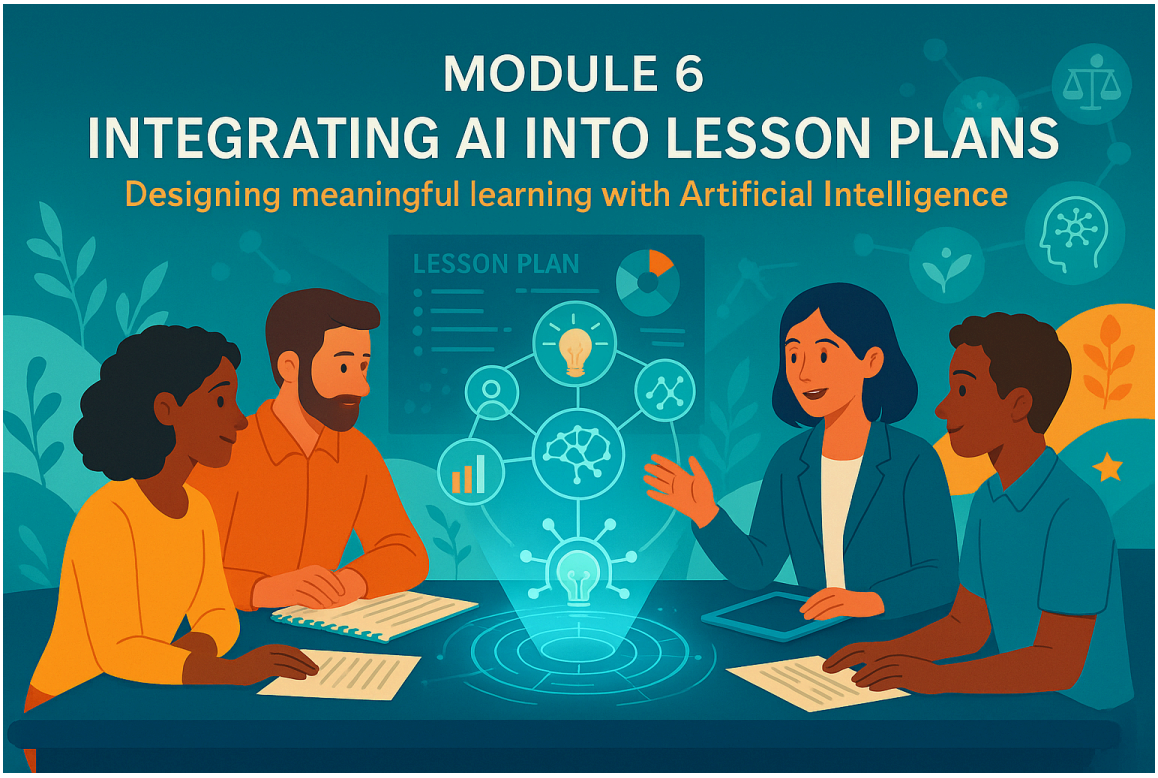
Next Module → Integrating AI into Lesson Plans.

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Module 6 – Integrating AI into Lesson Plans

This module helps teachers design Learning Unit Plans (LUPs) that incorporate Artificial Intelligence and Machine Learning concepts. It provides strategies, templates, and examples for connecting AI with subject-specific learning and ethical reflection.



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1. Why Integrate AI into Lesson Plans?

Integrating AI into existing subjects promotes critical thinking, creativity, and digital literacy. AI-based projects empower students to explore how technology works and to apply computational thinking across disciplines.

💡 **Concept**

AI in education is not only about technology—it's about inquiry, ethics, and real-world problem solving. Teachers become facilitators who guide exploration, reflection, and collaboration.

AI activities can enrich traditional subjects by transforming abstract topics into hands-on investigations and cross-curricular projects.

2. Pedagogical Strategies

🧩 **Effective Approaches**

- *Inquiry-Based Learning* (IBL): Students ask questions, experiment, and draw conclusions.
- *Project-Based Learning* (PBL): Teams create AI-based artifacts or demonstrations.
- *Interdisciplinary Teaching*: AI connects sciences, arts, and humanities.
- *Reflective Practice*: Students discuss implications, ethics, and societal impact.

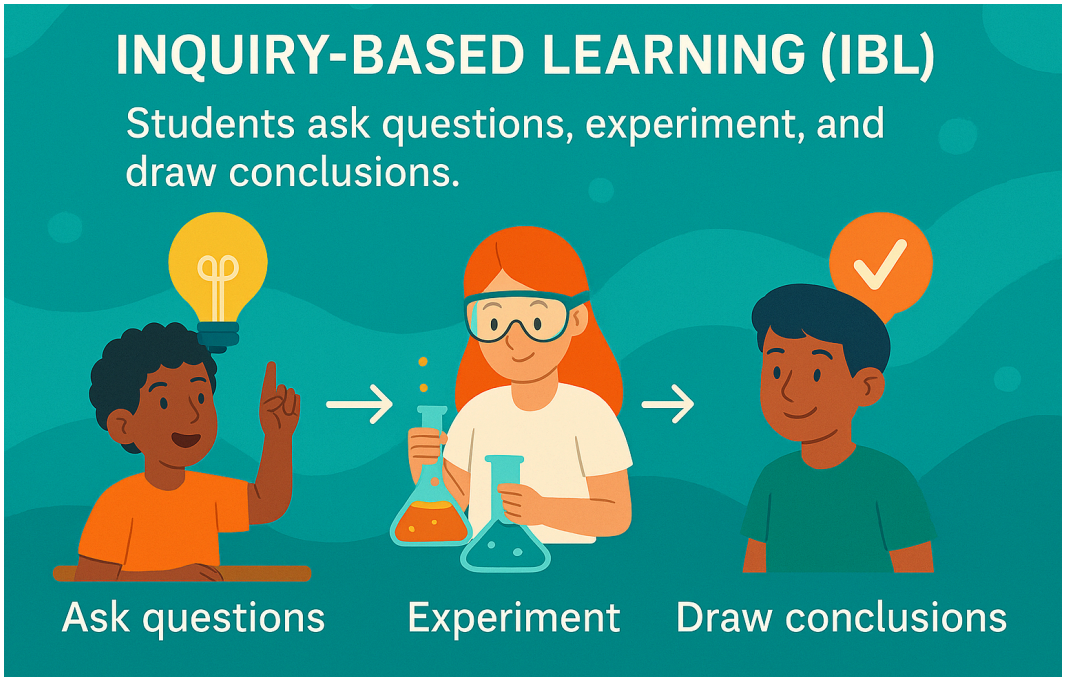


Figure 11 - Inquiry-Based Learning approach

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Inquiry-Based Learning places students at the center of discovery. They ask questions, explore, collect data, and build understanding through investigation.

How to apply it with Teachable Machine:
• Students start from a question: "How does a computer learn to recognize objects?"
• They collect images or sounds, train a model, and observe the outcomes.
• They reflect on what the AI learned and how to improve it (diversity, lighting, noise).
👉 Example: "Can AI tell the difference between ripe and unripe fruit?"

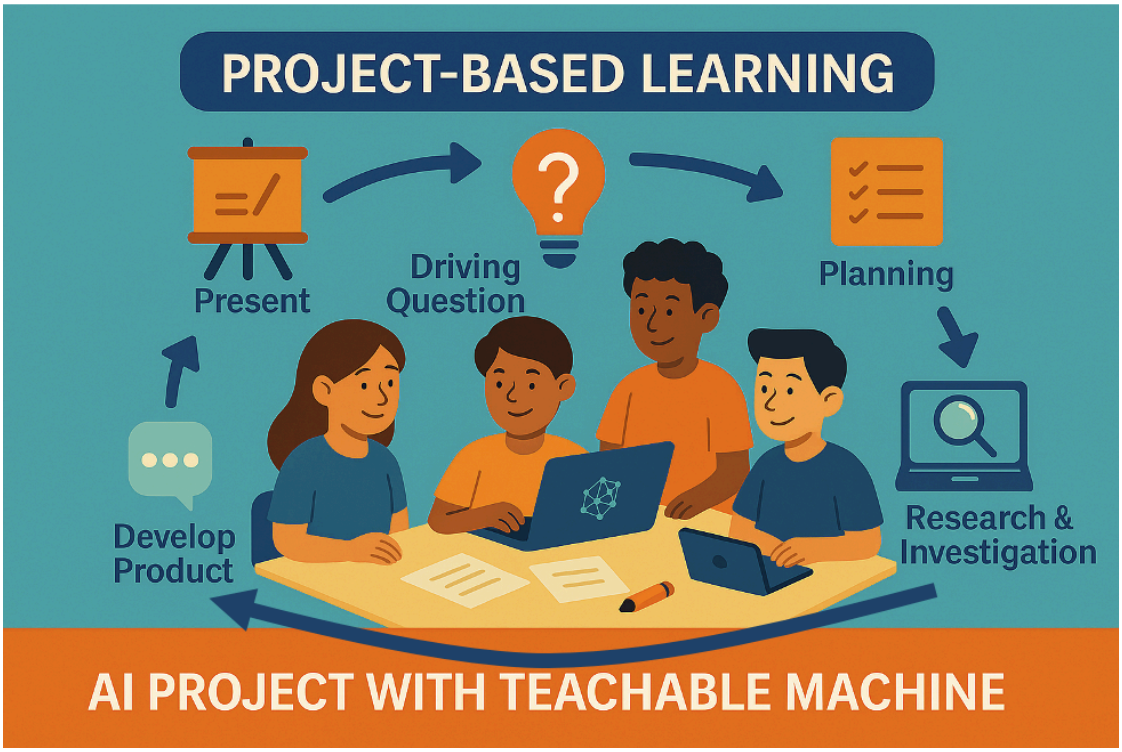


Figure 12 - Project-Based Learning approach

With **Project Based Learning** students learn by creating meaningful projects that solve real problems or produce tangible outcomes.

How to apply it with Teachable Machine:
• Students design useful AI systems: a waste classifier, sound recognizer, or gesture detector.
• They work collaboratively, following the workflow: Collect → Train → Test → Improve → Present.
• The project ends with a demonstration or public presentation.
👉 Example: "Build a machine that helps the school identify recyclable materials."

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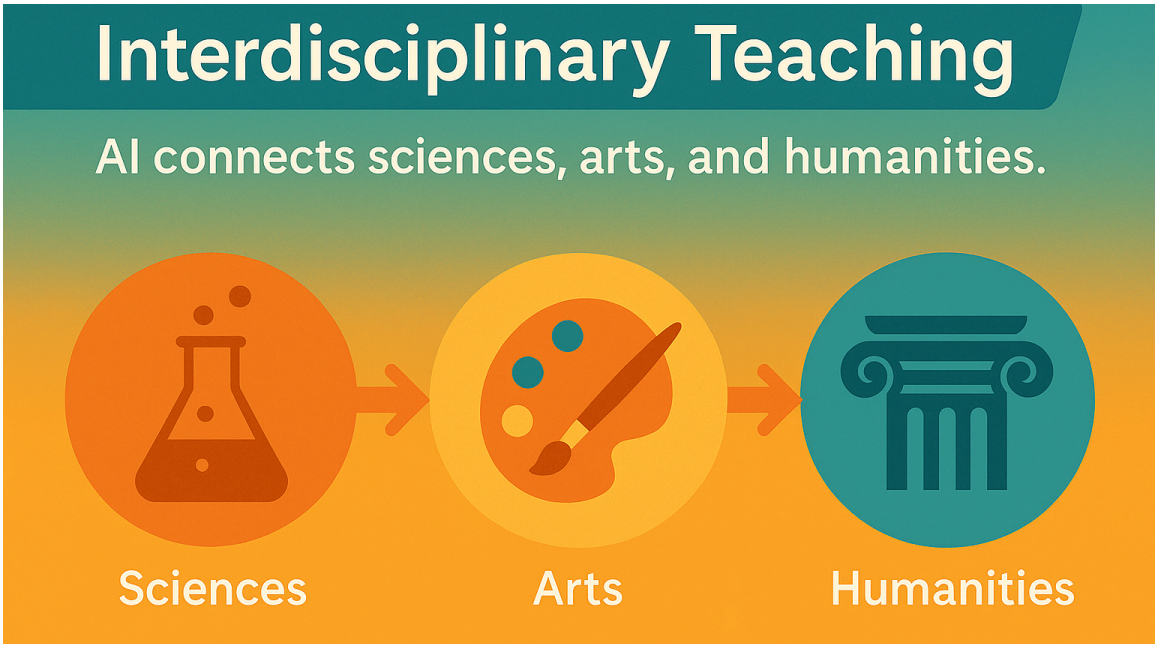


Figure 13 - interdisciplinary Teaching approach

Interdisciplinary Teaching combines knowledge and methods from different subjects—science, arts, ICT, and citizenship—to explore shared concepts or real-world issues.

How to apply it with Teachable Machine:
• Students work on cross-curricular projects:
• Science + ICT: classify plants or animal species.
• Art + AI: recognize artistic styles or color palettes.
• Civics + AI: detect environmental or safety symbols.
👉 Example: "Use AI to identify different artistic styles."

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Figure 14 - Reflective Practice approach

Reflective Practice encourages students to discuss, evaluate, and reflect on what they have learned, focusing on ethics, fairness, and social impact.

How to apply it with Teachable Machine:
• After each activity, students analyze their AI model's performance and ethical implications.
• Guiding questions:
• Is my model fair?
• What happens when the data is unbalanced?
• How could this technology be useful or harmful?
• Students can summarize their reflections in posters or short presentations.
👉 Example: "What happens if an AI recognizes certain types of faces better than others?"

These strategies align AI education with 21st-century skills—collaboration, problem-solving, and adaptability.

3. Step-by-Step Framework for Designing an AI Lesson



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1. Define learning goals → 2. Select AI project type (image/audio/pose) →
3. Plan data collection → 4. Train and test → 5. Reflect and assess.

Teachers can adapt this framework for short classroom sessions or extended Learning Unit Plans (LUPs). Each step encourages student autonomy while maintaining ethical awareness.

🧩 A 60 – minute introductory lesson – Classroom Object Recognizer

0–10 min | Question and ethics: Can a model distinguish a pen from a notebook? Agree on safe examples and explain the difference between training and testing.
10–25 min | Collect: In small groups, capture varied, labelled examples for each class. Keep a few different objects or views aside for testing.
25–35 min | Train: Train the model and predict which new examples may be difficult.
35–50 min | Test and improve: Test unseen examples, record two errors, change the training set, retrain, and compare results.
50–60 min | Explain and save: Each group explains one error, one improvement, and one remaining limitation; then saves its editable project.
If time is short: complete collection in one lesson and testing in the next. Times are planning estimates, not guaranteed training times.

4. Example Learning Unit – 'AI for Ecosystems'

This example shows how to integrate AI concepts into science and environmental studies using Teachable Machine. Students will design an AI model that classifies plant species or natural elements and reflect on biodiversity and bias.

📘 Lesson Overview

- Duration: 6–8 hours (over 2–3 weeks)
- Subjects: Science, ICT, and Language
- Target Age: 13–15 years
- AI Tool: Teachable Machine – Image Project

🧠 Learning Goals

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- Understand ecosystems and species diversity.
- Learn how AI classifies images and the role of data variety.
- Reflect on ethical use of AI for environmental purposes.

🧩 Activity Steps

1. Introduce biodiversity and data representation concepts.
2. Collect images of local plants (or use open datasets).
3. Train an image classifier with 3–4 categories.
4. Test, refine, and document results.
5. Present findings and discuss ecological and ethical implications.

🎯 Assessment Criteria

- Content knowledge (ecosystem understanding).
- Technical competence (model accuracy and data management).
- Collaboration and documentation.
- Ethical reflection and communication.

🧩 What students should be able to show.

Students can (1) explain the difference between labelled training examples and new test examples; (2) identify at least one dataset limitation; (3) document a change and compare predictions before and after retraining; (4) explain a subject-specific finding without treating the model's output as proof; and (5) describe how they protected people's data.

5. Template for Planning an AI Lesson

Section	Description / Notes
Learning Objectives	Define clear, measurable outcomes related to content and AI skills.
Project Type	Image / Audio / Pose (select according to subject).
Required Resources	Devices, internet connection, camera or microphone.
Data Collection Plan	Outline sources, ethics, and balance of examples.

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Activity Flow	Plan the sequence: introduce → build → test → reflect.
Assessment & Reflection	Use rubrics, peer feedback, and ethical discussion.
Timing and group roles	Estimate time for setup, collection, training, testing, and discussion. Assign roles such as collector, tester, recorder, and presenter.
Differentiation and accessibility	Offer an alternative way to participate, adapt the number or type of classes, and provide an extension task for students who finish early.
Contingency and saving plan	Prepare approved sample files or an unplugged alternative. Decide how the editable project and test notes will be saved.

6. Ethics-by-Design

📘 **Ethical Checklist**

☐ Obtain consent for all media collected.
☐ Avoid personal or sensitive content.
☐ Ensure dataset diversity (age, color, environment, context).
☐ Discuss fairness and bias during analysis.
☐ Promote inclusion and respect in all student projects.

Ethics-by-design means embedding responsible practices from the start of project planning. Teachers can model ethical reflection by openly discussing data selection, privacy, and algorithmic bias.

If the technology fails. If the webcam is unavailable, upload prepared images when the project allows it. If the network is unavailable, give groups printed examples and labels. One student acts as a "human classifier" by proposing a rule from the examples; classmates challenge the rule with new cases. Record which examples caused mistakes. This preserves the lesson goal: understanding how examples and testing affect a classification rule.

7. Reflection and Assessment

🧠 **Reflection Questions**

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- How does AI support learning in my subject?
- What challenges did students face during training and testing?
- How did ethical discussions change student perspectives?
- How can this lesson be improved for future iterations?

🧠 Peer-review questions

- What were the classes and where did the examples come from?
- Which test examples had not been used for training?
- Show one error and explain your most likely cause.
- What did you change, and did the repeated test improve?
- Who or what might be missing from your dataset?

Evaluate the explanation and investigation as well as model performance.

✅ Teacher's Self-Assessment

☐ The lesson linked AI concepts to curriculum goals.
☐ Students demonstrated understanding and reflection.
☐ The project respected ethical and inclusive standards.
☐ Cross-disciplinary collaboration was encouraged.

End-of-Module Summary

Key Takeaways:
- Integrating AI enhances student engagement and interdisciplinary learning.
- Teachers should combine creativity, critical thinking, and ethics.
- Lesson planning with AI builds future-ready skills.

Next Module → Resources and Continued Learning.

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Module 7 – Resources and Continued Learning

This module provides teachers with resources, communities, and training opportunities to continue learning about Artificial Intelligence in education. It focuses on professional development, collaboration, and access to quality materials for long-term impact.



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1. Staying Updated with AI in Education

Artificial Intelligence is a rapidly evolving field. Teachers need ongoing opportunities to update their knowledge and skills. Continuous professional development ensures that classroom practices remain ethical, inclusive, and aligned with technological advancements.

💡 **Concept**

AI literacy is not a one-time achievement—it's a lifelong learning process that grows with technology and society.

The following resources offer reliable, educationally focused materials for teachers who want to continue exploring AI and Machine Learning.

2. Official and Educational Resources

📘 **Key Online Platforms**

- Google Teachable Machine – https://teachablemachine.withgoogle.com/
- Google for Education – AI Resources: https://edu.google.com/intl/ALL_en/ai/education/
- Google Grow – https://grow.google/intl/uk/courses-and-tools/?category=career&topic=ai
- AI.Google – https://ai.google/learn-ai-skills/
- AI4K12 Initiative – https://ai4k12.org/
- European Schoolnet – AI in Education Toolkit: https://www.eun.org/
- UNESCO – Guidance for AI in Education: https://unesdoc.unesco.org/

These platforms provide access to lesson ideas, ethics guidelines, open datasets, and teacher training materials tailored to different educational levels.

3. Professional Development and MOOCs

🎓 **Recommended Courses**

- Elements of AI – University of Helsinki (Free) https://studies.helsinki.fi/courses/course-implementation/otm-abc65bb3-701a-4b34-a4cd-d068f22d9895
- AI for Everyone – https://www.coursera.org
- AI in Education – https://www.futurelearn.com/courses/ai-in-education
- Building AI – University of Helsinki – https://buildingai.elementsofai.com
- Google AI Essentials Specialization – https://www.coursera.org/specializations/ai-essentials-google
- Google Grow - Experience AI - https://experience-ai.org/en

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Encourage teachers to participate in MOOCs or webinars and to integrate reflections from these experiences into their teaching practices.

4. Communities and Collaboration

🌍 **Networks and Communities**

- European Schoolnet (EUN) Teacher Networks
- eTwinning Projects on Digital Literacy and AI
- AI Educators Facebook and LinkedIn Groups
- National and local Erasmus+ partner networks
- OpenAI Educator Community

Joining professional communities allows teachers to exchange best practices, co-create lesson plans, and share classroom success stories. Collaboration fosters innovation and helps maintain motivation.

5. Tools and Toolkits for the Classroom

🧩 **Practical Tools**

- Scratch + AI Extensions (MIT) – creative programming for kids.
- PictoBlox + AI & ML Extensions – creative programming for kids and young adults.
- Delightex Edu + Merge Cube – AR and VR environments for immersive AI learning.
- Teachable Machine + Google Colab – transition from no-code to code-based AI.
- Canva for Education – visual storytelling with data and AI integration.
- Adobe Firefly – responsible AI image generation for creative arts.

These tools can extend learning beyond Teachable Machine, allowing teachers to introduce AI concepts through art, design, and storytelling.

6. Save, share, or extend?

🌍 **Choose according to your goal**

- Save an **editable project copy** when students need to return to their classes and examples.
- Use a **shared model link**, when available and permitted by school rules, when another person needs to test a trained model; explain that this is different from sharing the editable project.
- Choose a **downloadable model or code example** when an advanced class plans to integrate predictions into another application.
- Check the export options shown for the particular Image, Audio, or Pose project before promising a format or an integration.

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Optional extension — model-driven interaction. Students can design a simple action triggered by a model prediction, such as changing a character's costume when an object is recognized. First verify that the chosen programming environment supports the exported model type or link. Agree on a confidence threshold, test false triggers, and keep a manual way to stop the action. Document the software version and steps in a separate technical worksheet so this handbook does not depend on one extension's changing interface.

7. Ethics, Policy, and Global Frameworks

📘 **Key References**

- UNESCO Recommendation on the Ethics of Artificial Intelligence (2021) https://www.unesco.org/en/articles/recommendation-ethics-artificial-intelligence
- EU Guidelines for Trustworthy AI (European Commission, 2019) https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai
- OECD AI Principles (2019) - https://oecd.ai/en/ai-principles
- Council of Europe https://rm.coe.int/brochure-artificial-intelligence-en-march-2023-print/1680aab8e6

Teachers can use these frameworks to initiate discussions about digital ethics, fairness, and inclusion. Encouraging students to think critically about AI's impact on society promotes responsible citizenship.

8. Sustainability and Dissemination

🌱 **Building Sustainable Practice**

- Create a local network of AI-ready teachers.
- Organize school workshops or exhibitions of student AI projects.
- Encourage peer-to-peer training among teachers.
- Document and share experiences through Erasmus+ and other educational platforms.

M{AI}L classroom challenge. Invite groups to choose a local question linked to environmental care, inclusion, or responsible consumption. They should define what a small Teachable Machine demonstration can actually classify, test it in realistic conditions, and explain why its output cannot by itself solve the wider problem. Display the question, dataset choices, errors, and improvements alongside the demonstration.

Sustainability means embedding AI literacy into everyday teaching practice. Sharing and disseminating experiences ensures that AI education continues to grow across the school community.

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9. Reflection and Future Pathways

🧠 **Reflection Questions**

- Which AI resources are most relevant to my teaching context?
- How can I build a personal learning plan for AI education?
- What partnerships or networks could enhance my professional growth?
- How can I share what I've learned with my colleagues?

Three-minute student presentation. State the subject question and the classes. Explain where the training and test examples came from. Demonstrate one successful prediction and one error. Describe the change you made after the error, show the new result, and name one limitation that remains. End by explaining how the project protected privacy and who should be allowed to use or view it.

✅ **Teacher's Action Plan**

☐ Identify one new AI resource or course to explore this term.
☐ Join an educator community focused on digital innovation.
☐ Plan a short AI activity or project to test with students.
☐ Share outcomes with peers or in a professional forum.

✅ **Before closing the project**

☐ Save and reopen an editable copy, where the chosen saving option permits it.
☐ Record the class names, data sources, and at least one before-and-after test.
☐ Copy a model link only if it is needed and sharing is permitted.
☐ Check what the link makes accessible to others.
☐ Remove or securely store student media according to school procedures.
☐ Prepare one sentence explaining what the model still cannot do.

End-of-Module Summary

Key Takeaways:

- Continuous learning keeps teachers prepared for the evolving AI landscape.
- Collaboration and community are central to sustained innovation.
- Ethical and inclusive AI education supports responsible digital citizenship.
- Dissemination multiplies the impact of AI learning initiatives.

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Appendix – Ready-to-Use Classroom Activities and Templates

This appendix provides practical classroom activities, printable templates, and evaluation tools to support teachers in implementing AI projects using Teachable Machine.



How to use the activity cards. Each activity should state a subject question, suggested classes, safe data sources, one test with unseen examples, a likely difficulty, an improvement step, and an observable student output. The estimated duration is a guide: allow more time when recording, accessibility adaptations, or technical setup require it.

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1. Ready-to-Use Classroom Activities (10)

1. Science – Leaf Classifier

Question: Can our model distinguish two or three locally collected leaf types?
Students collect and classify images of local leaves using TM's Image Project to learn about plant diversity.

🎯 Objectives

- Understand AI data training and testing.
- Apply subject knowledge creatively.
- Encourage reflection on bias and ethics.

🧩 Materials & Duration

~~• Devices with webcam/mic • Teachable Machine • 1–2 hours per activity.~~

• **Suggested classes**: Choose two or three plants that students can identify with the Science teacher and a reliable botanical source. Use verified plant names as labels. Avoid guessing species from appearance alone and distinguish classifying the selected plants from identifying any unknown leaf.
• **Data and preparation:** Photograph several different leaves of each plant type, using varied angles, distances, lighting, and backgrounds. Check identification before labelling the images. Collect fallen leaves or photograph plants without damaging them, following any site rules. Avoid identifiable people in photographs. Reserve separate leaves for testing; different photographs of the same leaf should not appear in both training and test sets.
• **Test and improve:** Test with leaves not used during training. The model may follow the background or lighting rather than leaf features. Add examples photographed under varied conditions across all classes, retrain, and repeat the test. Try a leaf from an untrained plant type and discuss why the model may still assign it one of the known labels.
• **Student output:** A short, illustrated table showing the verified plant type, predicted label, and results before and after retraining. Describe relevant leaf features, such as shape, margin, and vein pattern. Explain one error, the change made, and why the model is not a botanical authority or a complete measure of plant diversity.
• **Estimated time:** Approximately **75–90 minutes** with leaves or photographs prepared: introduction and identification (15 minutes), image collection and labelling (20–25 minutes), training (5–10 minutes), testing and improvement (20–25 minutes), and explanation and saving (15 minutes). Allow an additional session for outdoor collection and identification. As an alternative without Teachable Machine, students can sort leaves

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or photographs using an identification key, justify their choices, and test their criteria with unfamiliar examples.

📘 **Ethical Focus**

Obtain consent for recordings. Avoid personal or sensitive data. Discuss fairness and bias.

2. Music – Instrument Identifier

Question: Can our model distinguish the sounds of two or three musical instruments when tested with new recordings?

Record short audio clips of musical instruments to train an Audio Project that recognizes sound patterns.

🎯 **Objectives**

- Understand AI data training and testing.
- Apply subject knowledge creatively.
- Encourage reflection on bias and ethics.

🧩 **Materials & Duration**

~~• Devices with webcam/mic • Teachable Machine • 1–2 hours per activity.~~

• **Suggested classes**: Choose instruments with clearly different sounds, such as **Piano**, **Guitar**, and **Flute**. Use the background-noise category, where provided, for ordinary room sounds.

• **Data and preparation:** Record several examples of each instrument, using different notes and short musical phrases. Follow the sample length shown in the Audio Project interface. Keep microphone distance and recording volume reasonably consistent across classes so that loudness does not reveal the label. Use live instruments or appropriately licensed recordings, document their sources, and obtain permission when recording identifiable participants. Reserve separate recordings for testing.

• **Test and improve:** Test with recordings not used during training, including new notes or phrases. A likely error is confusing instruments playing similar notes or recognizing recording conditions rather than the instrument. Add varied examples to the confused classes, retrain, and repeat the same test. If possible, finish with an additional new recording.

• **Student output:** A short table showing the actual instrument, predicted label, and whether each prediction was correct before and after retraining. Add an explanation of one error, the change made, and a remaining limitation. Explain that the model recognizes

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the selected sound classes and may fail with unfamiliar instruments or several instruments playing together.
• **Estimated time:** Approximately **75–90 minutes**: introduction and setup (10 minutes), recording and labelling (20–25 minutes), training (5–10 minutes), testing and improvement (25–30 minutes), and discussion and saving (15 minutes). Allow extra time for recording turns. As an alternative without Teachable Machine, students can listen to unfamiliar clips, classify the instruments, and explain which sound features guided their decisions.

📘 **Ethical Focus**

Obtain consent for recordings. Avoid personal or sensitive data. Discuss fairness and bias.

3. Language – Pronunciation Coach

Question: Can our model distinguish two selected vowel sounds in new recordings from different speakers?
Use Audio Project to distinguish between vowel sounds or intonation differences.

🎯 **Objectives**

• Understand AI data training and testing.
• Apply subject knowledge creatively.
• Encourage reflection on bias and ethics.

🧩 **Materials & Duration**

~~• Devices with webcam/mic • Teachable Machine • 1–2 hours per activity.~~

• **Suggested classes:** Choose two contrasting vowel sounds relevant to the language being studied, such as **/iː/** and **/ɪ/** in English, using **sheep** and **ship** as initial examples. Include ordinary room sounds in the background-noise category, where provided. For an alternative activity, use **Rising intonation** and **Falling intonation** with the same short phrase; investigate vowels and intonation separately.
• **Data and preparation:** With the language teacher, establish examples of the selected contrast. Record several attempts from different consenting volunteers, following the sample length shown in the interface. Keep microphone distance and volume reasonably consistent. Ensure that each speaker contributes to both classes, so the model does not simply distinguish voices. Reserve separate recordings for testing. Respect different accents and follow school procedures for recording and storing voices.
• **Test and improve:** Test with new recordings from the original speakers and, where

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possible, another consenting speaker. The model may recognize a particular voice or whole word rather than the intended vowel contrast. Add examples from more speakers and, as an extension, additional word pairs containing the same vowels. Retrain and compare results. For intonation, keep the words constant while varying the pitch pattern.
• **Student output:** A short table of intended sounds, predicted labels, and results before and after retraining. Include an explanation of one error and whether it may relate to the speaker, word, noise, or pronunciation. Clarify that the classifier is a classroom experiment: its predictions do not establish whether a learner's pronunciation is correct.
• **Estimated time:** Approximately **75–90 minutes**: introduction and listening practice (15 minutes), recording and labelling (20–25 minutes), training (5–10 minutes), testing and improvement (25 minutes), and reflection and saving (10–15 minutes). Allow extra time for recording turns. As an alternative without Teachable Machine, students can classify teacher-selected recordings and explain the differences they hear, using peer feedback guided by the language teacher.

📘 **Ethical Focus**

Obtain consent for recordings. Avoid personal or sensitive data. Discuss fairness and bias.

4. Art – Style Spotter

Question: Can our model distinguish two selected artistic styles in unfamiliar artworks using visible features?

Train a model to recognize artistic styles or color palettes from digital artworks.

🎯 **Objectives**

• Understand AI data training and testing.
• Apply subject knowledge creatively.
• Encourage reflection on bias and ethics.

🧩 **Materials & Duration**

~~• Devices with webcam/mic • Teachable Machine • 1–2 hours per activity.~~

• **Suggested classes:** Choose two styles studied in class, such as **Impressionism** and **Cubism**, using examples checked by the Art teacher. Alternatively, investigate **Predominantly warm colours** and **Predominantly cool colours**, with clear labelling criteria. Treat style classification and colour-palette classification as separate activities.
• **Data and preparation:** Collect public-domain or appropriately licensed digital images from museums or other reliable sources, recording the artist, title, source, and licence.

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Include several artists and works in each style. Avoid visible captions, frames, watermarks, or differences in image quality that could reveal the class. Reserve entire artworks for testing; different crops of the same work should not appear in both training and test sets.

• **Test and improve:** Test with artworks not used during training, preferably including an artist absent from the training set. A likely error is classifying mainly by color rather than by stylistic features. Examine misclassified works, add examples showing a wider range of colors and compositions within each style, retrain, and repeat the test. Discuss ambiguous works rather than forcing every artwork into a single category.

• **Student output:** A short, illustrated table showing each test artwork, its reference classification, the predicted label, and results before and after retraining. Explain one error using artistic vocabulary and identify a remaining limitation. Clarify that recognizing visual patterns does not establish an artwork's meaning, quality, or definitive historical classification.

• **Estimated time:** Approximately **75–90 minutes** with a prepared image collection: introduction and classification criteria (15 minutes), image selection and labelling (20 minutes), training (5–10 minutes), testing and improvement (20–25 minutes), and discussion and saving (15–20 minutes). Allow an additional lesson if students research sources and licences themselves. As an alternative without Teachable Machine, students can sort printed artworks, justify their choices through visible features, and discuss examples that challenge their categories.

📘 **Ethical Focus**

Obtain consent for recordings. Avoid personal or sensitive data. Discuss fairness and bias.

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5. PE – Form Checker

Question: Can a pose model distinguish two agreed movement positions under classroom conditions?

Use Pose Project to recognize correct and incorrect exercise postures.

🎯 Objectives

- Understand AI data training and testing.
- Apply subject knowledge creatively.
- Encourage reflection on bias and ethics.

🧩 Materials & Duration

~~• Devices with webcam/mic • Teachable Machine • 1–2 hours per activity.~~

• **Suggested classes:** With the PE teacher, define two comfortable, visually distinct positions, such as **Arms at shoulder height** and **Arms below shoulder height**. If using "correct" and "incorrect" labels, specify the single visible criterion being assessed. Offer equivalent seated or upper-body options and avoid requiring students to perform unsafe movements.
• **Data and preparation:** Check camera framing and the visibility of the relevant body landmarks. Collect varied, clearly labelled examples from consenting participants, following school procedures for capturing and storing identifiable images. Include suitable differences in body proportions and camera distance without rating students' bodies. Reserve separate performances for testing.
• **Test and improve:** Test with new performances and, where appropriate, another participant or a slightly different camera position. Missed landmarks or differences between participants may cause incorrect predictions. Review the camera preview, improve framing, add relevant examples, retrain, and repeat the test. Compare predictions with the PE teacher's observation of the agreed criterion. Explain that the model cannot establish whether an exercise is medically safe or assess overall technique.
• **Student output:** A diagram showing the two positions and the visible criterion, plus a short table of predictions before and after retraining. Explain one error, the change made, and a remaining limitation. Reflect on why the teacher's judgement and inclusive adaptations remain necessary.
• **Estimated time:** Approximately **75–90 minutes**: exercise introduction and position selection (15 minutes), setup and data collection (20–25 minutes), training (5–10 minutes), testing and improvement (20–25 minutes), and reflection and saving (15 minutes). Allow additional setup time when space is limited. As an alternative without Teachable Machine, students can use a teacher-approved observation checklist to identify the agreed positions and discuss how viewpoint affects their judgement.

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📘 **Ethical Focus**

Obtain consent for recordings. Avoid personal or sensitive data. Discuss fairness and bias.

6. Geography – Landmark Recognizer

Question: Can our model distinguish two or three famous landmarks in unfamiliar photographs taken from different viewpoints?

Image Project used to identify famous landmarks and discuss geography and culture.

🎯 **Objectives**

- Understand AI data training and testing.
- Apply subject knowledge creatively.
- Encourage reflection on bias and ethics.

🧩 **Materials & Duration**

~~• Devices with webcam/mic • Teachable Machine • 1–2 hours per activity.~~

• **Suggested classes:** Choose clearly defined landmarks, such as the **Eiffel Tower**, **Colosseum**, and **Taj Mahal**. Locate each on a map and introduce its geographical and cultural context before collecting images.
• **Data and preparation:** Collect public-domain or appropriately licensed photographs from reliable sources and record their origins and licences. Include different viewpoints, distances, lighting conditions, and seasons for each landmark. Avoid captions, watermarks, or repeated images that could reveal the label. Set aside separate photographs for testing; crops or duplicates of a training photograph should not enter the test set. Prefer images without identifiable people.
• **Test and improve:** Test with unseen photographs, including an unusual viewpoint or a partly obscured landmark. The model may rely on the sky, surrounding scenery, or photographic style rather than the building. Add examples that vary these features across classes, retrain, and repeat the test. Try an unrelated landmark and discuss why a classifier trained on only three classes may still assign it one of those labels.
• **Student output:** A short table showing the actual landmark, predicted label, and results before and after retraining. Include a map locating the landmarks, a brief geographical and cultural description of each, and an explanation of one error. Clarify that recognising a photograph does not demonstrate understanding of a place or its culture.
• **Estimated time:** Approximately **75–90 minutes** with a prepared image collection: geographical introduction (15 minutes), image selection and labelling (20 minutes),

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training (5–10 minutes), testing and improvement (20–25 minutes), and presentation and saving (15–20 minutes). Allow extra time for researching sources and cultural context. As an alternative without Teachable Machine, students can match printed photographs to landmarks and map locations, explaining the visual clues and discussing unfamiliar viewpoints.

📘 **Ethical Focus**

Obtain consent for recordings. Avoid personal or sensitive data. Discuss fairness and bias.

7. Biology – Animal Sound Safari

Question: Can our model distinguish the calls of two or three selected animal species in unfamiliar recordings?

Audio Project recognizing animal calls; link to biodiversity and habitats.

🎯 **Objectives**

- Understand AI data training and testing.
- Apply subject knowledge creatively.
- Encourage reflection on bias and ethics.

🧩 **Materials & Duration**

~~• Devices with webcam/mic • Teachable Machine • 1–2 hours per activity.~~

• **Suggested classes:** Choose species with clearly distinguishable calls verified through a reliable wildlife source, such as **Common blackbird**, **Common cuckoo**, and **Tawny owl**. Introduce their habitats and geographical distribution. Include ordinary ambient sounds in the background-noise category, where provided.

• **Data and preparation:** Collect appropriately licensed recordings with verified species labels, documenting their sources and licences. Include several independent recordings per species, with different individuals and recording conditions where available. Avoid spoken introductions, music, and clips containing several target species. Follow the sample length shown in the interface. Reserve complete recordings for testing; segments from the same original recording should not appear in both training and test sets. If collecting outdoors, avoid disturbing wildlife or recording identifiable conversations.

• **Test and improve:** Test with clips from recordings not used during training. The model may confuse similar calls or associate a species with background sounds, such as wind or traffic. Add clearer examples and a wider range of recording conditions across classes, retrain, and repeat the test. Try a non-target animal call and discuss why the model may

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still assign it a known label.
• **Student output:** A short table showing the verified species, predicted label, and results before and after retraining. Add a brief habitat profile for each species and explain one error and a remaining limitation. Clarify that the classifier is a learning demonstration and cannot reliably establish a species' presence or measure biodiversity.
• **Estimated time:** Approximately **75–90 minutes** with prepared recordings: introduction to species and habitats (15 minutes), listening, sample preparation and labelling (20–25 minutes), training (5–10 minutes), testing and improvement (20–25 minutes), and discussion and saving (15 minutes). Allow additional time for source research or fieldwork. As an alternative without Teachable Machine, students can match unfamiliar calls to species reference recordings and habitat cards, explaining their evidence and uncertainty.

📘 **Ethical Focus**

Obtain consent for recordings. Avoid personal or sensitive data. Discuss fairness and bias.

8. Math – Shape Detector

Question: Can our model distinguish three geometric shapes in unfamiliar images despite changes in size, color, and orientation?
Image Project recognizing geometric shapes or objects with symmetry.

🎯 **Objectives**

• Understand AI data training and testing.
• Apply subject knowledge creatively.
• Encourage reflection on bias and ethics.

🧩 **Materials & Duration**

~~• Devices with webcam/mic • Teachable Machine • 1–2 hours per activity.~~

• **Suggested classes:** Use **Triangle**, **Square**, and **Circle**, with definitions established by the Math's teacher. Alternatively, investigate **At least one line of reflection symmetry** and **No line of reflection symmetry** using clearly defined flat figures. Treat shape recognition and symmetry classification as separate activities.
• **Data and preparation:** Create drawings or paper cut-outs and photograph each class against varied backgrounds. Include different sizes, colors, and orientations across all classes; for triangles, include several types. Keep the complete outline visible and avoid written labels. Use student-created materials or appropriately licensed images. Reserve

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separate figures for testing rather than different photographs of the same training cut-out.
• **Test and improve:** Test with unseen figures, including a rotated square and a triangle unlike those used during training. The model may associate a shape with its color or orientation. Add examples that vary these features across classes, retrain, and repeat the test. For the symmetry activity, include unfamiliar figures and check predictions by drawing reflection axes. Discuss why recognizing familiar appearances does not demonstrate understanding of a mathematical property.
• **Student output:** A short table showing each test figure, its mathematically verified class, the predicted label, and results before and after retraining. Explain one error using properties such as sides, angles, or reflection symmetry. Include a remaining limitation and distinguish the model's prediction from a mathematical justification.
• **Estimated time:** Approximately **60–75 minutes**: definitions and task introduction (10 minutes), figure creation and data collection (15–20 minutes), training (5–10 minutes), testing and improvement (20 minutes), and explanation and saving (10–15 minutes). Allow extra preparation time for the symmetry activity. As an alternative without Teachable Machine, students can sort paper figures, challenge each other with new examples, and justify classifications through definitions, measurements, or folding.

📘 Ethical Focus

Obtain consent for recordings. Avoid personal or sensitive data. Discuss fairness and bias.

9. Civics – Recycling Sorter

Question: Can our model distinguish selected paper, plastic, and metal objects in unfamiliar photographs, and how do these material labels relate to local recycling rules?
Classify recyclable materials (plastic, paper, metal) to link AI with sustainability.

🎯 Objectives

• Understand AI data training and testing.
• Apply subject knowledge creatively.
• Encourage reflection on bias and ethics.

🧩 Materials & Duration

~~• Devices with webcam/mic • Teachable Machine • 1–2 hours per activity.~~

• **Suggested classes:** Use **Paper**, **Plastic**, and **Metal** with clean, clearly identifiable objects. Explain that these are material categories: they do not automatically determine

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whether an item belongs in a particular recycling bin.
• **Data and preparation:** Collect safe, clean objects such as plain paper, plastic bottles, and metal cans without sharp edges. Verify their materials and consult teacher-provided local recycling guidance. Photograph several different objects per class from varied angles and against different backgrounds. Avoid giving each class a distinctive background or bin color. Reserve separate objects for testing. Exclude hazardous waste, dirty packaging, and objects whose material is uncertain.
• **Test and improve:** Test with objects not used during training. The model may associate a material with an object's shape, color, or brand rather than relevant visual features. Add more varied objects to the confused classes, retrain, and repeat the test. Try a composite item, such as a drink carton, and discuss why a single material label may be misleading. Check disposal decisions against local guidance rather than relying on the prediction.
• **Student output:** A short table showing each object, its verified material, the predicted label, and results before and after retraining. Add the disposal route indicated by local guidance for the tested items. Explain one classification error and why material recognition alone cannot guarantee correct recycling.
• **Estimated time:** Approximately **75–90 minutes**: sustainability and sorting guidance (15 minutes), object preparation and data collection (20–25 minutes), training (5–10 minutes), testing and improvement (20–25 minutes), and reflection and saving (15 minutes). As an alternative without Teachable Machine, students can sort clean objects or picture cards, justify their choices using local guidance, and discuss ambiguous or composite packaging.

📘 **Ethical Focus**

Obtain consent for recordings. Avoid personal or sensitive data. Discuss fairness and bias.

10. Drama – Gesture-to-Story

Question: Can our pose model distinguish two or three deliberate gestures and use its predictions to cue actions in a short story?

Pose Project controlling digital characters or triggering animations with body gestures.

🎯 **Objectives**

• Understand AI data training and testing.
• Apply subject knowledge creatively.
• Encourage reflection on bias and ethics.

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🧩 Materials & Duration

~~• Devices with webcam/mic • Teachable Machine • 1–2 hours per activity.~~

• **Suggested classes:** Choose comfortable, visually distinct positions, such as **One arm raised**, **Both arms extended sideways**, and **Rest position**. Agree on a story action for each gesture. Offer suitable seated or upper-body alternatives. Explain that the labels describe visible positions, not a performer's emotions or intentions.
• **Data and preparation:** Check that the relevant body parts and detected landmarks remain visible in the camera preview. Collect varied examples from consenting participants, including small differences in position and camera distance. Follow school procedures for capturing and storing identifiable student images. Reserve separate performances for testing. Prepare a simple storyboard and, if using digital characters, verify the connection between the pose model and the chosen programming environment before the lesson.
• **Test and improve:** Test with new performances and, where appropriate, another participant. Similar gestures, hidden body landmarks, or transitions between positions may trigger the wrong action. Make the gestures more distinct, add relevant examples, retrain, and repeat the test. Check that the rest position avoids unwanted actions. For a digital implementation, test repeated or accidental triggers and provide a manual stop control.
• **Student output:** A short storyboard linking gestures to story actions, a record of predictions before and after retraining, and a brief performance or demonstration. Explain one incorrect trigger, the change made, and a remaining limitation. Reflect on how performers communicate meaning beyond the positions recognized by the model.
• **Estimated time:** Approximately **90–120 minutes** with a tested digital connection: story planning and gesture selection (15–20 minutes), setup and data collection (20–25 minutes), training (5–10 minutes), testing and improvement (20–25 minutes), rehearsal and presentation (20–25 minutes), and reflection and saving (10–15 minutes). Allow an additional lesson if students must build the digital integration. Without an integration, students can respond manually to predictions shown in the preview. As an alternative without technology, a student "gesture reader" can cue story actions while the group explores ambiguous gestures and revises its rules.

📘 Ethical Focus

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2. Printable Templates

Lesson Plan Template (1 page)

Section	Notes / Example
Topic / Title	AI for [Subject/Theme]
Students age	10-15 years old
Learning Objectives	List specific, measurable goals.
Duration	e.g., 90 minutes
AI Project Type	Image / Audio / Pose
Activity Flow	1. Introduce concept 2. Collect data 3. Train model 4. Test and reflect
Resources	Devices, camera/mic, internet
Assessment	Rubric, peer feedback, reflection questions

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Student Data Collection Sheet

🧩 Instructions

Use this sheet to plan your data collection for Teachable Machine. Fill it out before starting your project.

Requirement	Details
Project Title	
Classes / Labels	e.g., Cats, Dogs
Items per Class	~~At least 30 images or 10–15s audio per class~~ Initial collection target: _____ per class. Justify the amount after testing; prioritize clear labels and varied examples.
Diversity Plan	Varied angles, lighting, speakers, etc.
Ethical Considerations	Consent obtained? Sensitive data avoided?
Test Set	10–20% unseen data for testing

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Mini-Reflection Sheet (Student Self-Assessment)

🧠 **Reflection Prompts**

1. What did I learn about how AI learns?
2. What surprised me about the results?
3. How could I improve my data or model?
4. What ethical issues did I notice?
5. How did I contribute to the team?
6. Which prediction was wrong?
7. What did we change?
8. What happened when we tested again?

Student answers	
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	

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3. Evaluation Rubrics

Teacher Rubric (10 points)

Criterion	Description	Points (0–3 or 0–2)
Data Quality & Diversity	Images/sounds varied and balanced	0–3
Model Performance	~~Student can explain accuracy and errors~~ Testing and explanation of errors: uses new test examples, documents an error, and explains an improvement.	0–3
Collaboration & Documentation	Evidence of teamwork and clear reporting	0–2
Ethical Reflection	Respect for privacy and consent	0–2

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Student Peer-Review Form

🧩 Questions for Review

1. Did the team explain how their AI model works?
2. Was their dataset diverse and fair?
3. How did they improve their model?
4. What did you learn from their project?
5. Did the team test with examples that were not used for training?
6. What evidence shows that its revision helped or did not help?

	Student answers
1.	
2.	
3.	
4.	
5.	
6.	

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Ethics Checklist

📘 Ethical Guidelines

☐ I obtained consent for all collected media.
☐ I avoided personal/sensitive content.
☐ My dataset is diverse and fair.
☐ I discussed potential bias in class.
☐ I respect all participants' privacy.
☐ I know where project files and media are stored and who can access any shared link.

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