

Hands-On AI Projects for the Classroom

A Guide on Ethics and AI



ISTE



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The International Society for Technology in Education (ISTE) is a nonprofit organization that works with the global education community to accelerate the use of technology to solve tough problems and inspire innovation. Our worldwide network believes in the potential technology holds to transform teaching and learning.

ISTE sets a bold vision for education transformation through the ISTE Standards, a framework for students, educators, administrators, coaches and computer science educators to rethink education and create innovative learning environments. ISTE hosts the annual ISTE Conference & Expo, one of the world's most influential edtech events. The organization's professional learning offerings include online courses, professional networks, year-round academies, peer-reviewed journals and other publications. ISTE is also the leading publisher of books focused on technology in education. For more information or to become an ISTE member, visit iste.org. Subscribe to ISTE's YouTube channel and connect with ISTE on Twitter, Facebook and LinkedIn.

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Hands-On AI Projects for the Classroom: A Guide for Elementary Teachers

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Hands-On AI Projects for the Classroom: A Guide for Electives Teachers

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Foreword

Welcome to the *Hands-On AI Projects for the Classroom* series, a set of guides for teachers who are seeking instructional and curricular resources about artificial intelligence (AI) for various grade levels and across a range of subject areas.

We know that the jobs of the future will increasingly demand knowledge of how to leverage and collaborate with AI as a tool for problem solving. Unfortunately, most students today are not on a trajectory to fill those jobs. To prepare students, all educators need to understand the implications, applications, and creation methods behind AI. After all, teachers are the most important link in developing the new generation of AI-savvy learners, workers, and leaders.

That's why ISTE has partnered with General Motors (GM) to lead the way regarding AI in education. Over the past three years, we have teamed up with GM to create scalable professional learning experiences to help educators bring AI to their classrooms in relevant ways, and to support students' exploration of AI-related careers.

These guides are an extension of our work and feature student-driven AI projects curated from educators in the field, as well as strategies to support teachers in implementing the projects in a variety of K-12 classrooms. The projects engage students in both unplugged and technology-infused activities that explore key facets of AI technologies.

The *Hands-On AI Projects for the Classroom* series is just one of the resources ISTE is creating to help educators implement powerful AI projects to prepare students for their futures.

We are convinced that the language of future problem-solving will be the language of AI, and that educators must accelerate their understanding of AI in order to guide the next generation. We are here to help you make that happen!

Joseph South
ISTE Chief Learning Officer



Introduction

What Is AI?

AI pervades learning, working, and living in the modern world. In fact, AI technologies are being developed and applied across all fields of study—from science and government to language acquisition and art. We believe that, in order to be successful in school and in life, *all* K-12 students need a foundational understanding of what AI is, how it works, and how it impacts society. AI education is important across *all* subject areas, not just computer science classes.

Yet, even if we believe that, most of us as K-12 educators and education leaders have not had much education in AI ourselves. You might even find yourself wondering: What exactly is AI? And if you are, you are not alone. In fact, even professionals in the field of AI do not always agree on the answer. Nevertheless, it is important to know what we mean in this guide when we refer to AI.

According to John McCarthy, who first coined the term, “[Artificial Intelligence] is the science and engineering of making intelligent machines, especially intelligent computer programs” (McCarthy, J., 2007)¹. A technology powered by AI is capable of such things as using sensors to meaningfully perceive the world around it, of analyzing and organizing the data it perceives, and of autonomously using that data to make predictions and decisions.

In fact, the autonomous decision-making nature of AI technologies is part of what helps us to distinguish technologies that are and are not AI. For example, autonomous decision-making separates the non-AI automatic doors at your grocery store—which do use sensors to perceive, but open in response to simple if-then conditional statements—from AI-powered, self-driving cars that use sensors to perceive and analyze visual data, represent that data as a map of the world, and make time-sensitive, life-and-death decisions about which direction to move in next, and at what speed.

At their best, AI technologies accomplish tasks that are difficult or impossible for humans to accomplish by themselves. While early AI made decisions based on a preprogrammed set of data and actions, many newer AI technologies use machine learning to improve based on novel data as it is presented. When trained well, AI software is able to efficiently and effectively process, recognize patterns in, and extrapolate conclusions from large datasets across various fields of study. Similarly, robots powered by AI have the potential to complete tasks that are physically complicated, demanding, or even dangerous for their human counterparts. The projects in this guide and in the other volumes of the *Hands-On AI Projects for the Classroom* series reveal these capabilities to K-12 students across various subject areas and grade levels.

You can learn more about AI and access supporting resources in Appendix A: Unpacking Artificial Intelligence.

¹ McCarthy, J. (2007). What is artificial intelligence? Retrieved from jmc.stanford.edu/articles/whatisai/whatisai.pdf



Why Is It Important to Teach About AI in Your Courses?

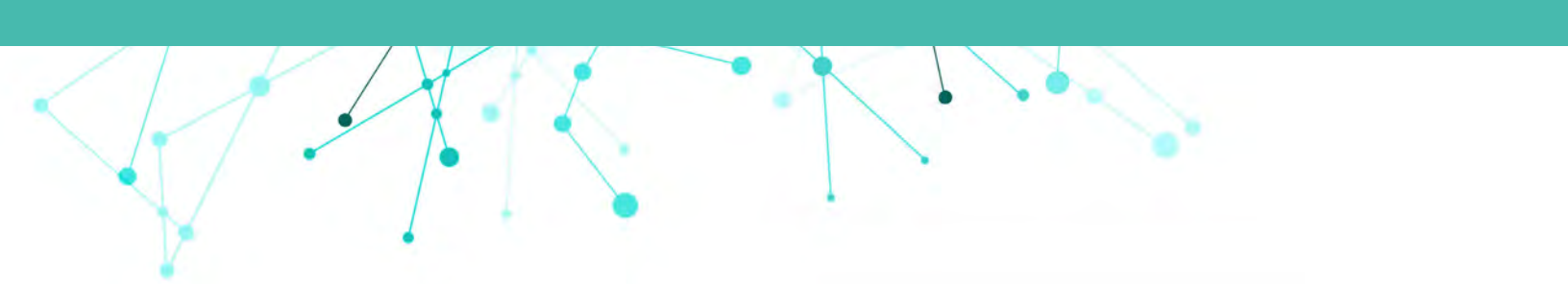
Think about articles you may have read related to the use of AI in K-12 education. Odds are the majority are focused on two general areas: automating administrative tasks like attendance and grading, or increasing student performance and engagement through AI-supported assessment and personalized learning. Yes, AI can be used in these ways. However, strategies of this kind barely scratch the surface when it comes to AI's potential for impacting students' lives—not only in the classroom but throughout their daily activities. The driving purpose of the *Hands-On AI Projects for the Classroom* series is to look beyond the kinds of strategies mentioned above to consider not only how AI makes life easier at a superficial level, but also what students need to know and understand about AI to ensure they become thoughtful users, managers, and even creators of these powerful tools.

So, why devote an entire guide to AI and ethics? Once the stuff of science fiction, AI now permeates nearly every facet of our lives, and while most of us are aware of tools like virtual assistants or AI robots, we may not be cognizant of the many ways that AI is impacting society. For example:

- People routinely rely on AI technologies—like media recommender systems—to make decisions about what shows to watch or what music to listen to.
- Personalization of AI-powered search engine results provides users with unique results based on their previous search results and web browsing behaviors, creating information echo-chambers in the process.
- While students are using social media tools to connect with their friends, AI algorithms are silently collecting data on the profiles they view, which ads they watch, which links they click on, the amount of time they spend in the app, what time of day they use the app, and the location from which they use the app.
- Complex machine learning algorithms are being used by companies to make hiring and firing decisions, often with unintended results.

These examples point out the importance of all students understanding the degree to which AI is being used to influence what and how we learn, how we consume media, and how we solve problems. Awareness at this level does not require specific technical expertise. Educators with little or no prior experience with AI may still help their students become more informed about AI technologies. Educators can help students by identifying instances of AI use, exploring the ethics of machines influencing decisions we make, and thinking about ways that AI technologies impact diverse human populations.

This guide is for all K-12 educators, across subject areas and grade levels. Until recently, conventional wisdom has suggested that instruction about AI should be confined to computer science courses at the high school level and above. However, the use of AI is becoming so pervasive throughout society that a basic understanding of what AI is and what its capabilities are is becoming as necessary as more traditional literacy skills such as reading, writing, and computation. As you will see throughout the activities in the *Hands-On AI Projects for the Classroom* series, AI is truly impacting every field of study, work, and daily life. And while most of the people who will design these tools in the



future may continue to come from math, science, and computer science disciplines, we are all end users and therefore must be participants in the conversation if these tools are to effectively meet our needs.

As you read and teach the projects in this guide, you may be surprised to find that they do not tell students what to believe about what is good or bad, right or wrong, and fair or unfair when it comes to AI technologies. This is by design. Dr. Melvin Kranzberg, a professor of the history of technology at the Georgia Institute of Technology, stated that “technology is neither good nor bad; nor is it neutral.” Keeping this statement in mind, this guide asks students to think critically about the impact AI has on society. They will consider the tradeoffs (both good and bad) of various AI innovations and will consider ways that biases and negative impacts in AI might be identified and mitigated. They will also analyze how various AI technologies might affect a wide range of stakeholders, especially those who have been traditionally marginalized by technology or underrepresented in STEM fields. Students will discover that often a technology will have inequitable impacts: positive on some users or stakeholders and detrimental on others. Students will understand that while they might use AI to improve efficiency or accuracy of one task, at the same time they may be asked to give away personal data, civil rights, or personal freedoms in return. This guide asks students to consider timeless ethical questions, diverse perspectives, and even gray areas as they begin to construct their own ideas about how to determine if an AI is ethically developed, designed, and used.

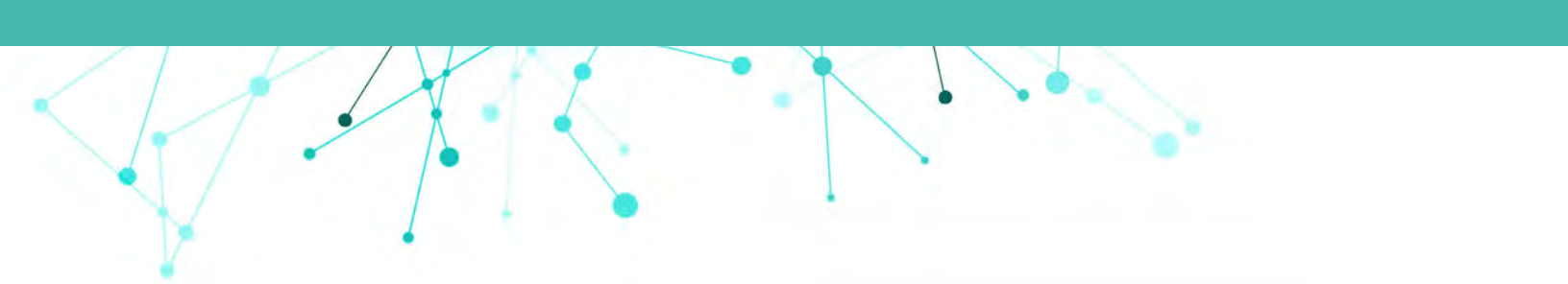
Finally, this guide makes the fundamental assumption that ethical AI is a shared responsibility. Students, teachers, users, programmers, investors, regulators, and others all play a role in determining the future of AI technology development and use. Each project in this guide is an entry point for teachers and students to co-learn and expand their knowledge of the field of AI, and to consider its real and imagined impacts on society. As students engage with the projects in this guide, they will discover their own critical role in shaping how AI technologies are used to solve problems in their life, community, and world.

Considerations for Developing and Implementing AI Projects

This guide provides student-driven projects that can directly teach subject area standards in tandem with foundational understandings of what AI is, how it works, and how it impacts society. Several key approaches were taken into consideration in the design of these projects. Understanding these approaches will support both your understanding and implementation of the projects in this guide, as well as your own work to design further activities that integrate AI education into your curriculum.

Our Student-Driven Approach

The projects in this guide use a student-driven approach to learning. Instead of simply learning *about* AI through videos or lectures, the students completing these projects are active participants in their AI exploration. In the process, students work directly with innovative AI technologies, participate in “unplugged” activities that further their



understanding of how AI technologies work, and create various authentic products—from machine learning models to video games—to demonstrate their learning.

Each project's student-driven activities are divided into three sections: Getting Started, Take a Closer Look, and Culminating Performances.

Getting Started activities hook students' interest, activate prior knowledge, and introduce them to the project's objectives.

Take a Closer Look activities develop students' AI understanding by providing students with scaffolded, guided learning activities that make connections between AI concepts and subject-area content. Students will learn key vocabulary, discover and analyze how real-world AI technologies work, and apply AI tools as they relate to subject-area problems.

Culminating Performances challenge students to synthesize their learning, complete a meaningful performance task, and reflect on the societal impact of what they have learned.

Moreover, in this guide, students' exploration of AI is framed within the context of ethical considerations and aligned with standards and concepts, and depths of understanding that would be appropriate across various subject areas and grade levels in K-12. Depending on the level of your students and the amount of time you have available, you might complete the entire project from Getting Started to Culminating Performances, you might pick and choose from the listed activities, or you might take students' learning further by taking advantage of the additional extensions and resources provided for you. For students with no previous experience with AI education, exposure to the guided learning activities alone will create an understanding of their world that they likely did not previously have. And for those with some background in computer science or AI, the complete projects and resources will still challenge their thinking and expose them to new AI technologies and applications across various fields of study.

In addition to modifying which project activities you implement, you can also modify the projects themselves as needed to support learning at various grade and ability levels. You might provide simpler explanations and vocabulary definitions; assign students to work as individuals, small groups, or a whole class; or adjust the output of the Culminating Performance to better suit their abilities. For example, Project 3: The Tradeoffs of AI Technology can be completed by students in either middle school or high school; however, older students should be presented with deeper instruction on how various AI technologies work and the ethical consequences of how those technologies impact various stakeholders. Early and repeated success with these and other AI learning activities can encourage students to continue their exploration into important field-relevant AI applications in the future.

Frameworks and Standards

When making decisions about what to teach about AI in K-12 classrooms, we recommend considering related educational standards and frameworks. In terms of frameworks for teaching AI, this guide references the Five Big Ideas in AI.

The Five Big Ideas in AI (shown in Figure 1) serve as an organizing framework for the national AI in K-12 education guidelines developed by the [AI4K12 Initiative](#). These guidelines articulate what all K-12 students should learn about AI. Each of the projects in this guide illuminates one or more of the first four foundational concepts—perception, representation and reasoning, learning, and natural interaction—as well the societal impact that the concept has in the context of the project.

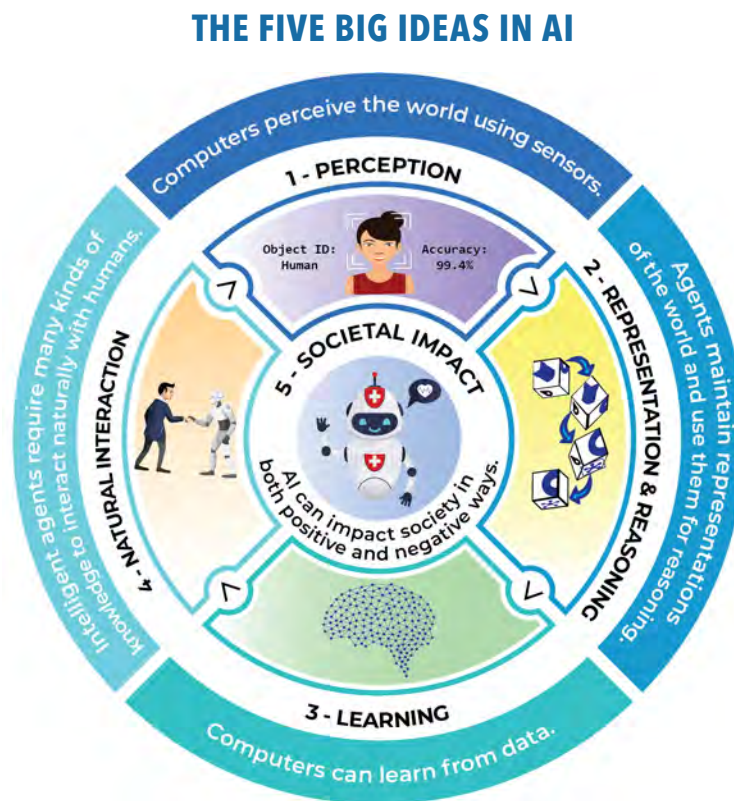
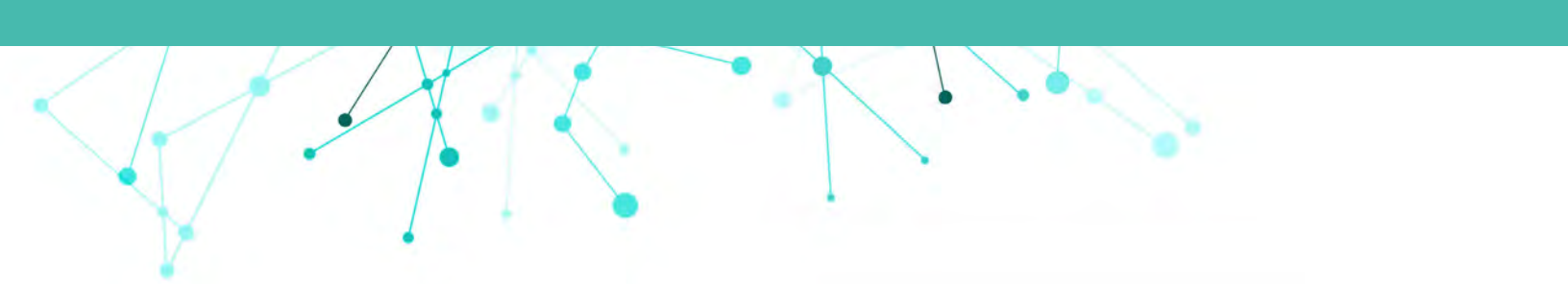


FIGURE 1. Five big ideas in AI. Credit: AI4K12 Initiative. Licensed under the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License.

Additionally, the ISTE Standards and Computational Thinking Competencies can help frame the inclusion and development of AI-related projects in K-12 classrooms. The [ISTE Standards for Students](#) identify the skills and knowledge that K-12 students need to thrive, grow, and contribute in a global, interconnected, and constantly changing society. The [Computational Thinking Competencies for Educators](#) identify the skills educators need to



successfully prepare students to become innovators and problem-solvers in a digital world. Together, the standards and competencies can give us a language and lens for understanding how these AI projects fit into the greater goal of teaching all students to become computational thinkers. Each of this guide's projects will indicate alignment points with both the ISTE Standards for Students and the Computational Thinking Competencies.

Finally, another way to think about technology use in these student-driven projects is with the SAMR model, developed by Dr. Ruben Puentedura. This model classifies the use of technology into four categories: Substitution, Augmentation, Modification, and Redefinition. While uses of technology at the substitution and augmentation level might enhance learning or the performing of tasks, uses at the modification and redefinition level transform the learning experience or task into something that was previously inconceivable, difficult, or even impossible. Many of the activities in this guide will push students' use of technology to the modification and redefinition levels. And while other activities might have students engage with AI technologies conceptually through unplugged activities, or work with AI technologies at the substitution or augmentation level of SAMR, each of the new understandings students walk away with will empower them to understand, use, and possibly even create AI technologies that will fundamentally redefine the way humans live and work.

How to Use This Guide

There are many courses, workshops, seminars, and other learning opportunities both on- and off-line that focus on the fundamentals of AI. There are also resources that target very tech-savvy educators who have backgrounds in AI concepts and the programming skills necessary to teach students how to code AI-based projects. However, when it comes to the educators who are themselves in the early stages of learning about AI, very little is available to help them transfer what they are learning into meaningful, student-driven classroom activities. That's where the *Hands-On AI Projects for the Classroom* series of guides comes in.

Each guide in this series offers information and activity suggestions that educators can use—regardless of their own experience and background—to ensure their students are afforded opportunities to engage in meaningful activities related to AI. Each guide consists of three parts: Introduction, Projects, and Appendixes. Let's briefly review each section.

Introduction

Each of the guides in the *Hands-On AI Projects for the Classroom* series is directed toward a specific group of educators: elementary, secondary, teachers of electives, and computer science teachers. In addition to this How To section, the introductory section of each guide includes the following information:

- An overview of the *Hands-On AI Projects for the Classroom* series
- A discussion entitled "What Is Artificial Intelligence?"
- An explanation of how AI fits into the context for that guide
- Considerations for designing and implementing AI-related projects



Project Design

For ease of use, every project in each of the guides is designed using a consistent format, as follows.

Project Overview

The project overview offers an explanation of what the project is, how it ties to research-based standards, and what students will learn and be able to do as a result of completing the project. Specific sections include a brief overview of the project; the subject, target grades, and duration of the project; objectives for the project; and a listing of relevant standards addressed, such as the ISTE Standards for Students, Computational Thinking Competencies, AI4K12 Five Big Ideas in AI, and content-area standards.

Preparation

Preparation provides the information educators need in order to put the project into action with students. This section includes a list of materials required for project completion; a list of supporting resources for the educator, if applicable; and a list of planning tasks to complete prior to implementation, such as selecting tools, reviewing online resources, etc.

Instructions

Each project includes instructions for:

- Getting Started activities that hook students' interest, activate prior knowledge, and introduce them to the project's objectives.
- Take a Closer Look activities that develop students' AI understanding by providing students with scaffolded, guided learning activities that make connections between AI concepts and subject-area content.
- Culminating Performances that challenge students to synthesize their learning, complete a meaningful performance task, and reflect on the societal impact of what they've learned.

While we have provided links to resources to support these activities, in most cases, these activities could be successfully implemented with a variety of similar tools. Moreover, new or improved tools may become available in coming years. Consider the tools and resources listed in the guides simply as suggestions.

Additionally, the inclusion of any material is not intended to endorse any views expressed, or products or services offered. These materials may contain the views and recommendations of various subject-matter experts as well as hypertext links to information created and maintained by other public and private organizations. The opinions expressed in any of these materials do not necessarily reflect the positions or policies of ISTE. ISTE does not control or guarantee the accuracy, relevance, timeliness, or completeness of any outside information included in these materials.

Moreover, prior to using any of the cited resources with students, it is imperative that you check the account requirements for each resource against your school/district student data privacy policy to ensure the application complies with that policy. In addition, some resources' Terms of Service may require parental permission to be COPPA and FERPA compliant for students younger than thirteen years of age.



Extensions

Extensions include strategies and resources for expanding or enhancing the project to support extended student learning.

Appendices

Appendix A: Unpacking Artificial Intelligence

Appendix A provides basic explanations and resources for understanding and teaching fundamental AI concepts.

Appendix B: Alignment to ISTE Standards and AI4K12 Big Ideas

This section provides a high-level overview of how the projects in the Hands-On AI Projects for the Classroom series align with the ISTE Standards for Students, ISTE Computational Thinking Competencies, and AI4K12 Five Big Ideas in AI.



PROJECT 1

Fair's Fair

Students in elementary school may not be ready to grasp esoteric ethical questions, but most have already developed a strong sense of fairness. Students use this lens as they explore why the quality of datasets used to train artificial intelligence matters.



This project connects to everyday experiences and is timely. It also outlines how teachers can carry out a conversation following each activity where students get to share their input and opinion as they discuss how AI applications can impact society in a positive and negative way. The activities are inclusive and allow students to share their choices and thoughts regardless of their academic or social background. The extensions also provide teachers in ways they can further student exploration and also adapt lessons to different grade levels.

—Michelle Vehlo, Teacher and STEAM Curriculum Coordinator, Hudson Montessori School

Project Overview

This project introduces some basic ethical concepts related to fairness and equity using data quality and its impact on how machine learning algorithms make decisions and predictions that can impact people's lives.

SUBJECT

Mathematics and English Language Arts

ESTIMATED DURATION

6 hours

TARGET GRADES

K-5

VOCABULARY

artificial intelligence

data

feature

stereotype

survey

training data

unconscious bias

OBJECTIVES

At the end of this project, students will be able to:

- Understand that the ability to accurately represent and interpret data depends on the quality of the datasets being used, and that datasets are created by people.
- Understand that when people make decisions about data used, those decisions may not be fair (i.e. inclusive or representative).
- Understand that predictions made based on patterns identified in data may be helpful, but may also be harmful.
- Understand that these concepts relate to datasets used to train AI.

STANDARDS

ISTE Standards for Students

2. Digital Citizen

- b. Students engage in positive, safe, legal and ethical behavior when using technology, including social interactions online or when using networked devices.

3. Knowledge Constructor

- a. Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits.
- b. Students evaluate the accuracy, perspective, credibility and relevance of information, media, data or other resources.

5. Computational Thinker

- b. Students collect data or identify relevant datasets, use digital tools to analyze them, and represent data in various ways to facilitate problem solving and decision making.

ISTE Computational Thinking Competencies

1. Computational Thinking

- e. Recognize how computing and society interact to create opportunities, inequities, responsibilities and threats for individuals and organizations.

2. Equity Leader

- b. Construct and implement culturally relevant learning activities that address a diverse range of ethical, social and cultural perspectives on computing and highlight computing achievements from diverse role models and teams.

4. Creativity & Design

- b. Design authentic learning activities that ask students to leverage a design process to solve problems with awareness of technical and human constraints and defend their design choices.

AI4K12 Five Big Ideas in AI

3. Learning

Computers can learn from data.

5. Societal Impact

AI can impact society in both positive and negative ways.

Common Core State Standards for English Language Arts

CCSS.ELA-LITERACY.RI.K.3: With prompting and support, describe the connection between two individuals, events, ideas, or pieces of information in a text.

CCSS.ELA-LITERACY.RI.1.3: Describe the connection between two individuals, events, ideas, or pieces of information in a text.

CCSS.ELA-LITERACY.RI.2.3: Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text.

Common Core State Standards for Mathematical Practice

CCSS.MATH.CONTENT.1.MD.C.4: Organize, represent, and interpret data with up to three categories

CCSS.MATH.CONTENT.2.MD.D.10: Draw a picture graph and a bar graph (with single-unit scale) to represent a dataset with up to four categories.

Preparation

MATERIALS

- Computer and projection system to share images with students (optional for Activity 1, recommended for Activity 4)
- Drawing materials such as blank paper, pencils, crayons, colored pencils
- Writing materials such as slips of paper, pens, pencils
- Several sheets of chart-sized grid paper
- YouTube Kids app

SUPPORTING RESOURCES FOR EDUCATORS

- Video: "[A Class That Turned Around Kids' Assumptions of Gender Roles!](#)"
- Article: "[Beyond Gender Stereotypes](#)"
- Article: "[50 Years of Children Drawing Scientists](#)"
- Article: "[Siri, Are You My Best Friend?](#)"

- Article: “[Teaching Artificial Intelligence in Kindergarten](#)”
- Lesson Plan: “[That’s a \(Gender\) Stereotype!](#)”

ADVANCED PREPARATION

- Familiarize yourself with the topics addressed in this project by viewing the video, “A Class That Turned Around Kids’ Assumptions of Gender Roles!” and reading the articles listed under Supporting Resources for Educators. Moreover, while the project refers to girls and boys at various points, also consider how including other gender references, such as intersex or non-binary, might enhance this discussion and create a more inclusive environment in your classroom.
- If you decide to use screenshots of image searches for Activity 1, prepare those.
- Study the activities and decide in advance how you want to create the surveys and collect responses.
- Set up a parent account for the YouTube Kids app. Despite being asked to, you do not have to associate your Google account with the app in order to use it for Activity 4. (Just ignore that option.) Enable the Search feature before you bypass setting up an account. Spend a little time familiarizing yourself with the app.

Instructions

GETTING STARTED

Activity 1: What are Stereotypes and Unconscious Biases?

In this activity, students engage with the topic of stereotypes and unconscious biases, discovering how they influence people’s perceptions in positive and negative ways.

1. Distribute plain paper and tools for drawing (pencils, crayons, or colored pencils).
 - Ask students to draw a picture of a teacher.
 - When they are finished, have students display the pictures so everyone can see them.

NOTE: This activity can also be done by searching online for images using the keyword “teacher” and projecting the results for students to see and discuss.
2. Stop and Think: Ask students to study the drawings, considering the following questions:
 - What patterns do they see?
 - Are there **features**—unique measurable properties—that they notice in several of the drawings (e.g., what the teacher looks like, what setting the teacher is in, or the teacher’s facial expressions)?
 - Do they notice differences?
 - Are there any drawings or images that are completely different from all the rest?

3. Lead a whole class discussion using the following (or similar) questions:

- How many of the drawings or images show the teacher as a woman? As a man? Why might that be?
- Are there other features that are similar, such as facial expressions?
- Are any of the teachers holding an object?
- What features do people associate with teachers?
- Do these pictures actually represent all teachers in the world?

Allow time for students to talk about what they are noticing.

4. Introduce students to the concepts of **stereotypes** and **unconscious bias**.

- Point out that all people rely on patterns and past experiences to help them make sense of what's around them. These patterns and past experiences often become something called stereotypes, simple ideas we use to describe to ourselves how a person who does a special kind of work might look or behave.
- Explain that many times these ideas have become such a common way of thinking about these people that we decide we know all about them before we even meet them! This is called unconscious bias, when we form opinions or make decisions about people or things before fully learning about them. Sometimes we decide we like or dislike someone or something just based only on what we think we already know about the person or thing. Provide examples, such as choosing not to play with someone because of the way they are dressed or the way they talk.
- Ask the following questions:
 - Is it fair to treat people this way?
 - What about deciding not to eat something new because you don't like the way it looks or smells?
 - There are times when that could be a good decision, but what harm could be caused?

NOTE: As a follow-up activity, you could create a learning center where students draw or view images of people in other occupations (scientist, farmer, fire fighter, secretary, etc.) and compare those drawings to identify common stereotypes which we internalize to the point where they become unconscious biases. See also Extension Activity 1.

TAKE A CLOSER LOOK

Activity 2: Best Games Ever

In this activity, students explore the idea that data collected from one group that reflects multiple common features does not necessarily represent members of other, similar groups.

1. Introduce the concept that **data**—information—collected from one group that reflects multiple common features does not necessarily represent members of other, similar groups.
 - Begin this activity by explaining to students that we sometimes make decisions based on unconscious bias, and that this can make people happy or unhappy.

- Point out that people often pick friends who think the same way about what they like or don't like. Then, because the people they are spending time with agree with them most of the time, they start to think that most people think like they do.
 - Ask if it is true that all people think alike.
 - Say that you are going to imagine how that might work.
2. Tell students they will now have an opportunity to explore this idea further.
- Ask students to think about their favorite games to play.
 - Brainstorm a list of favorite games with the class and title the list "Best Games Ever."
 - Ask students to think about the following questions related to the list:
 - Would it be fair to say that people of all ages would agree that this list includes all of the best games ever? Why or why not?
 - Imagine that we made copies of this list, gave it to all parents with students at the school, and told them that these are the games their children want as gifts. Would this make all of the students happy? Why or why not?
 - How could the title of the list be changed to make it more accurate? Brainstorm new titles, and discuss whether they are an improvement, and why.
 - How could the list be better? What could be done to make it be more helpful to parents who want a gift list?
3. Guide the conversation to ensure students explore the following questions:
- Could we collect more data from other students like them?
 - Could we collect data from students of different ages?
 - What other things could we do?

Activity 3: Choosing a Class Pet

In this activity, students begin to explore the concept of representative survey groups and how these groups impact survey results.

1. Ask students if they know what a survey is. Ensure they understand that a survey is used to collect information by asking people what they think or know about something. Point out that the question asked in Activity 2 was one kind of survey. Explain that while this can be a good way to get information, it's important for the person who creates the survey to be careful about who is asked to answer survey questions. Tell students that in this activity they will have a chance to learn why.
2. Tell students that in this activity they will imagine they are going to choose a new class pet. Set the stage by explaining that every student will get to name the kind of animal they want and the kind of animal mentioned most often will be the new class pet. Ask them to think to themselves about what animal they predict that the class will select.

3. If your students are literate, give them each a slip of paper and ask them to write their name, age, and the kind of animal they want as a pet. If your students are pre-literate, ask each one privately for the same information. Record each child's name, age, and answer.
4. Create a bar graph of the survey results. Use the slips of paper or the list you made to create a bar graph of the students' preferences for a new pet.
 - Build an on-the-spot bar graph on a sheet of chart-sized graph paper.
 - Label a column for each kind of animal named.
 - Color one square in that column each time that animal is named.
 - Use colored markers (a different color for each column) to make the differences from one column to the next even easier to see.
5. When you have tallied all the results, ask students the following questions:
 - Is there a clear first choice?
 - Is there a tie?
 - Does the result represent what everyone in the class wants?
 - How could we learn more about students' pet preferences?
6. Create a stacked bar graph that shows results by gender or by age, and ask students the following questions:
 - What happens if we just look at what the boys want or what the girls want?
 - How else could we group responses? (e.g., by age, birthday month, students' eye color, etc.) How would that change the results?
7. Ask students to share their thoughts about the following in a class discussion: Is it more fair to make a decision based on the wishes of all of the students or just some of the students? Why or why not?

Activity 4: Decisions, Decisions

In this activity, students explore surveying **sample groups** and how that might impact the quality of data collected.

1. Remind students that at the end of Activity 3, we discussed if it would be fair to use survey results to make a decision for an entire group if only some members of that group answered the survey questions.
2. Tell students that in this activity they are asked to imagine that all the students in their grade have a chance to help pick new play equipment for recess. Set the stage by explaining that:
 - They will be given a list of five things to choose from: rubber kickballs, jump ropes, frisbees, soccer balls, and hula hoops (you may need to adjust this list based upon location or activity preferences).
 - A survey will be used to find the two most popular items.

3. Explain that there won't be time to survey every student, so the teacher who will order the equipment decides to survey a smaller sample group of students and use their answers to make a decision.
4. Ask students to consider how the teacher should pick the students to survey using the following questions:
 - What do we know about students in our grade level?
 - How many are there?
 - If we ask only the girls what they want, will that represent all the students in this grade?
 - What if we ask only those students who say they like to play ball during recess?

Point out that decisions made about who to survey can change the predictions made based on survey answers.

5. As a class, create a student survey about new play equipment for recess. Consider the following questions:
 - What information do you need to collect besides favorite equipment?
 - Would it help to know gender? Age? If the student likes recess? Why or why not?
 - What else might be important to know? Note: Keep this step simple and use survey creation and collection tools familiar to yourself and your students.
6. Make a plan for administering the survey.
 - Tell students that since there is not time to survey every student in their grade level, you will help them decide how many students to survey as a sample.
 - Explain that in the real world, 100 surveys is normally the smallest sample size used, but for this activity you will sample 25% of the students in that grade level. If your students know how to calculate 25% of the total number of students in that grade level, let them do it. If they do not, explain that 25% is one-fourth of the students in their grade level and tell them how many students that is.
 - Make a plan for collecting surveys. Ask the following questions:
 - Should they survey a set number of students from each classroom?
 - How will the students who take the survey be selected?
 - Is it a good idea to have half the students surveyed be girls and half be boys?
 - Who will survey the students?
7. Conduct the survey using the plan created in steps 5 and 6.
8. Tally and chart the results.
 - Since students have had opportunities to participate in tallying survey results in a previous activity, decide if you want to do the tallying as a class activity or to do it yourself and share the results with them.
 - Make the same decision related to creating the bar graph that shows votes for each kind of playground equipment.
 - Discuss the results.

9. Expand the review of the results by asking what other data were collected in the survey (e.g., gender, age).
 - Ask students if it would be of value to graph those results? Why or why not?
 - Optional: You may want to have students work in small groups to graph results using gender, age, or other attributes that were collected in the survey.
10. Lead a discussion (whole class for students in grades K-2, small groups for students in grades 3-5). Ask students the following questions:
 - What do you think about the results?
 - Do they represent all students at their grade level?
 - Is there a better way to think about their results?
 - Will most students be satisfied with the playground equipment that would be purchased if this survey were really used to make decisions?
 - Is this a fair way to make decisions? Why or why not?
 - Could this decision hurt anyone? How?

CULMINATING PERFORMANCE

Activity 5: What Does This Have to Do with AI?

In this culminating performance, students will explore the connection between the preceding activities and artificially intelligent apps that use machine learning algorithms to make video and music recommendations for people who use those apps.

1. Demonstrate the use of YouTube Kids or another app that uses data it collects to make decisions about what videos a student might want to watch.

NOTE: The demonstration directions in the following steps are based on use of YouTube Kids. If you demonstrate a different app you will need to adjust the demonstration accordingly.

- Ask how many students watch videos using the YouTube Kids app, or something similar.
- If any students say they do, ask them to explain how they decide what videos or music they want to watch or listen to.
- Open the video app you selected for this demonstration on your laptop and project it for the class to see. Point out that when you open the app, you are able to choose an age group and also indicate if you want to select a show, music, an educational video, or just want to explore.
- Remind students that you collected information from them during Activities 3 and 4 when you pretended first to select a classroom pet and then when you pretended to choose new playground equipment. Ask:
 - What kinds of information did our surveys include (e.g., name, gender, age, kind of animal, or type of playground equipment)?

- How might that information be used to make decisions?
 - What information is the app collecting as you get to where you can choose something to watch or listen to (age group and type of video or music)?
2. Make the connection between data collection and apps that make recommendations.
- Mention that this information is being collected because the app uses **artificial intelligence** (AI) to learn what each user likes or dislikes.
 - Tell students that AI is the science, engineering, and creation of computer programs that attempt to imitate human intelligence.
 - Explain that one thing AI can do is collect data and then analyze it to find patterns, just like we collected information and looked at patterns in that information in Activities 3 and 4. Examples used to teach an AI is called **training data**. The app makes predictions or decisions about what a user might like or want to do next, based on what the user has already done (as well as what other similar users have done).
 - Click on the various categories. Ask students what they see (lists of preselected options they can choose from that are different based on the category they choose).
 - Explain that right now their choices are based on the two pieces of information they have given the app: the class age group and the type of video or music you click on.
3. Explore Search function.
- Ask students what they think will happen if you type a word like "spider" or "egg" into the Search bar and press Enter.
 - Demonstrate searching using these two keywords.
 - Point out that the results now are organized not by type of video or music but by the search topic, with all categories mixed together.
 - Try a couple of other searches using key words the students suggest.
 - Ask them what new information the app has collected from the searches (possible areas of interest like spiders, eggs, or whatever else they searched for).
 - Explain that just as it was possible to learn more about what different groups of students in the class thought would make a good pet when age or gender were considered, every word used as a search term is teaching the app's AI more about what a particular user might want to watch or listen to. The next time that user logs on, the app will be able to recommend videos and music based on the information it was given before.
 - Remind students that in this case, AI is a computer program that collects information and then makes predictions about something a person might be interested in based on that information. But the decision about what to collect and how to collect it comes from people, and as we have learned in other activities, people often make decisions based on unconscious bias. In addition, just because an app makes a suggestion doesn't mean that the user must take it. Users are always in charge of the decisions they make.

4. Use direct instruction to help students develop an understanding of how the data are used over time to train the app.
 - Explain that the app tracks several pieces of data for each user including:
 - Which videos you choose and how much of each video you watch.
 - What search words you use and if you make selections from the results.
 - Say that all of this information is used as training data to teach the app what a user likes and doesn't like.
 - At the same time, every user's data also teaches the app what other users who are the same age might like and dislike. That information is used to make suggestions to other app users who are the same age.
 - Remind students to keep in mind that even then, their choices are always limited to what is included in the training data, such as the previous search terms provided by other users. Ask students to think about this carefully. When they first use an app like YouTube Kids, the suggested videos/music are based on very little information about them individually. Instead, the app uses information it has gathered from all users in the same age group who have used the app previously. But just as was learned in Activities 3 and 4, not all students like the same things. So, when an app makes predictions for one user based on what others like or don't like, it can be very wrong because its choices are limited to the interests of a specific group of users, even when those choices might reflect stereotypes about students in general.
5. In a whole class discussion, introduce the idea that users—and the data they provide—can change what a program has been taught about them.
 - Ask students if they think it is possible to change what a program has been taught about them. Accept all answers at this point.
 - Explain that it can be done, but it might take a little while, because the AI would need a lot of new examples to unlearn what it already has learned about you.
 - Brainstorm a list of the kinds of information the app already collected during the demonstration.
 - Ask the following questions:
 - Imagine your parents gave you permission to change your profile's age group How might that affect the videos you get to choose from? (Hint: this would make a significant change right away.)
 - Now, pretend you clicked on videos you aren't interested in watching but let them play all the way through anyway. Would that affect the program's predictions about what you might want to watch next?
 - Imagine searching for topics you really aren't interested in. Could that affect the suggestions you get for videos/music?
 - Finally, what if you were able to access the app's settings and either change permissions to access and use your data, or change the topics the app has set as preferences?
 - The answer to each of these questions is yes, using these strategies could change what an app has been taught about a user.

6. Finally, ask students to think about other apps they know about that make suggestions for users. (Possible answers include Netflix, HBO Max, Hulu)
 - Have students turn to a shoulder partner to talk about what they understand now about these AI-powered apps that they didn't know before.
 - Then have students share their thoughts with the entire class.

Activity 6: Reflect

In this activity, students should discuss the following questions to reflect on the societal impact of AI and how it makes decisions:

- What have you learned about how data are used to make predictions or decisions about what people might like?
- Does AI always make predictions or decisions that are correct? Why or why not?
- Who is really responsible for the decisions made by AI?

Extensions

Following are two ways you can expand students' exploration of how fairness and equity are impacted by the quality of data used by AI to make predictions and decisions about things people might like or want to do:

1. Give students additional practice in recognizing stereotypes and unconscious bias in training data through a learning center. For example, capture screenshots of image searches of people in specific occupations, such as nurses, farmers, stay-at-home parents, or scientists. Give copies of these screenshots to students and ask them to analyze the patterns in the features they see in each screen shot. Help them make the connection to how training data (in this example photos of people in specific occupations) can impact datasets. For example, if most training of the data for identifying nurses includes female nurses, the AI will learn that all (or most) nurses are women.
2. Extend students' thinking about the ethics and societal impact of using AI technologies through the "What AI Does Well and Does Not Do as Well" and "Training Data and Machine Learning" projects found in *Hands-on AI Projects for the Classroom: A Guide for Elementary Teachers*.



I'm excited about this project because it integrates several activities into learning standards across the curriculum. Students could have a nuanced discussion of these ethical topics and dig into both math and language arts while learning about AI. We can think effectively because of how easily we remember patterns (like the shape of letters that we turn into words—we don't have to keep sounding out every letter forever), but not all patterns are good, and we have to spend time rethinking patterns that are untrue or unhelpful.

—Charlotte Dungan, AI Program Architect, North Carolina School of Science and Mathematics



PROJECT 2

Who Is in Control?

Students discovered in Project 1: Fair's Fair that people are often unaware that they are participating in passive data collection through surveys and other activities, both on- and offline. In this project, students' attention is directed toward how their personal data may be used to influence their thinking.



It is so incredibly important that we teach our students about the ethical implications of artificial intelligence and its impact on our society—both positively and negatively. After watching “The Social Dilemma,” I really wanted to find a way to teach my young students (grades 3–6) about the ethics of AI, but in a more age-appropriate way than the documentary. This project hits the nail on the head!

—Adam Brua, Technology Integrationist, Rutland City Public Schools

Project Overview

This project offers students opportunities to explore different ways people become consumers of targeted marketing based on personal and group profiles. These profiles are created by machine learning algorithms using data trails left during their online activity. One critical ethical question asked in this project is: Should we be concerned about how algorithms influence our lives?

SUBJECT

English Language Arts
Technology/Computer Science

ESTIMATED DURATION

6–7 hours

TARGET GRADES

3–7

VOCABULARY

artificial intelligence
recommender systems
dataset
data trail

machine learning algorithm
targeted marketing
training data

OBJECTIVES

At the end of this project, students will be able to:

- Define the term targeted marketing, describe its purpose, and explain how targeted marketing is used to influence decisions people make.
- Understand that artificially intelligent computer programs create profiles of individuals or groups of people who have something in common (e.g., age, grade level, or membership in a club) based on personal data gathered online and then use these profiles to predict what online information—in the form of advertisements, search results, videos, or other information—people in these groups will like or believe. This is done using something called a machine learning algorithm.
- Understand that machine learning algorithms filter online information that people see based on individual and group profiles.
- Consider the positive and negative impacts of the choices people make based on online information they receive as determined by machine learning algorithms.

STANDARDS

ISTE Standards for Students

1. Empowered Learner

- d. Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.

2. Digital Citizen

- a. Students cultivate and manage their digital identity and reputation and are aware of the permanence of their actions in the digital world.
- d. Students manage their personal data to maintain digital privacy and security and are aware of data-collection technology used to track their navigation online.

3. Knowledge Constructor

- b. Students evaluate the accuracy, perspective, credibility and relevance of information, media, data or other resources.

ISTE Computational Thinking Competencies

1. Computational Thinking

- e. Recognize how computing and society interact to create opportunities, inequities, responsibilities and threats for individuals and organizations.

2. Equity Leader

- b. Construct and implement culturally relevant learning activities that address a diverse range of ethical, social and cultural perspectives on computing and highlight computing achievements from diverse role models and teams.
- e. Communicate with students, parents and leaders about the impacts of computing in our world and across diverse roles and professional life, and why these skills are essential for all students.

AI4K12 Five Big Ideas in AI

3. Learning

Computers can learn from data.

5. Societal Impact

AI can impact society in both positive and negative ways.

Common Core State Standards for English Language Arts

CCSS.ELA-LITERACY.SL.3.1, 4.1, 5.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade appropriate topics and texts, building on others' ideas and expressing their own clearly.

CCSS.ELA-LITERACY.SL.3.2, 4.2, 5.2: Determine the main ideas and supporting details of (grade 3), paraphrase (grade 4), or summarize (grade 5) a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.

CSTA K-12 Computer Science Standards

1B-IC-18: Discuss computing technologies that have changed the world, and express how those technologies influence, and are influenced by, cultural practices.

Media Literacy Standards to Counter Truth Decay

- 3. Understand how modern information sources and tools can limit available facts and perspectives (e.g., search engine algorithms; specialized discussion groups; selection in social media connections).
- 4. Identify the expertise (e.g., academic, office held, firsthand knowledge) and consider the motivations (e.g., political, financial) of the creator of an information product.
- 6. Analyze information for bias, deception, or manipulation.
- 11. Recognize the ways that media and information products might trigger emotional responses that influence attitudes or elicit specific behaviors.

Preparation

MATERIALS

- Computer(s) or tablet(s) (one per student) with internet connection for accessing web browsers (e.g., Chrome, Safari, or Microsoft Edge), specific search engines (e.g., Google, Bing, or DuckDuckGo), and other online resources
- Writing materials such as paper, pens, pencils
- Chart paper and markers for brainstorming

SUPPORTING RESOURCES FOR EDUCATORS

- Video: ["What even is an algorithm?"](#)
- Video: ["There's No Anonymity"](#)
- Article: ["A simple way to explain the Recommendation Engine in AI"](#)
- Article: ["DuckDuckGo vs. Google: An In-Depth Search Engine Comparison"](#)
- Article: ["How Google Search Works"](#)
- Article: ["Media Literacy Standards to Counter Truth Decay"](#)
- Article: ["So Many Choices"](#)
- Activity: ["Privacy in the Information Age"](#)

ADVANCED PREPARATION

- Familiarize yourself with the topics addressed in this project by viewing the video, "What Even Is an Algorithm?" (which you may decide to show to the class) and reading the articles listed under Supporting Resources for Educators.
- Study the activities and decide ahead of time how you want to approach each of them.

Instructions

GETTING STARTED

Activity 1: Online Information and You

In this activity, students consider the kinds of online information they encounter in their daily lives, such as advertisements, search results, and more. They are asked to consider why someone might want to be very scientific about who receives the information they are distributing online and why.

1. Engage students' interest by referencing previous online experiences they may have had.
 - Ask students if they have experienced searching for something online—perhaps a game or an article of clothing—and later on noticed many ads for that same thing on websites they visit. Or, have they watched a video on a streaming site and then had a similar video automatically start to play as soon as the first one they watched ended?
 - Ask if they know why that happens. Guide the conversation to the concept that the appearance of related ads or videos is not accidental—that these are examples of something called **targeted marketing**.
 - Tell students that for this activity, your definition of targeted marketing is the process of figuring out which individuals or groups of people are most likely to respond positively to specific advertisements, recommendations, or other information and then making sure those people get that information. Why would a company or organization take the time to know who their customers are? Is the purpose to help customers or to help the company or organization?
 - Ask students to spend a few moments individually thinking about their answer to the following questions and then to write down a list of their ideas.
 - Why would a company or group take the time to know who their customers are?
 - Are companies curious about their customers to help the customers or to help the company or group?
 - Lead a class discussion of their ideas. Record some of their main ideas on the whiteboard or a sheet of chart paper. Tell students that the goal of targeted marketing is to influence people as they decide if they should buy a product or service, watch a video, or click on a suggested link.
2. Tell students they are going to spend a little time focusing on one form of targeted marketing: advertisements.
 - Form groups of 3–4 students and give them a few minutes to share their ideas about the purpose of advertisements with one another. Ask each group to choose the two most important ideas from their discussions and share those with the entire class. (By the end of this step, ensure students understand that advertisements are carefully designed to encourage people of all ages to buy products or services from someone.)
 - Through direct instruction, explain that advertisements have been around for hundreds, even thousands of years. Over time, ways of advertising have changed to reflect how people shared important information with one another. For example, a couple thousand years ago people shared information including ads by painting messages on walls or by etching messages on steel plates placed in places where lots of people would see them. This information could be shared with small groups of people, but everyone got the same message. Members of these groups might be interested in what was being advertised, but maybe they were not.
 - Still in their small groups, students talk about where they most often see or hear online advertisements. Ask them to respond to the following questions:
 - Where do they usually see online advertisements?

- How are these ads presented? Are they text, video, audio?
- Extend the conversation by asking students to talk with one another about how ads make them feel and why they think that might be.
- Ask the small groups to share their ideas about online advertisements. Record common ideas shared by the students on a new sheet of chart paper.
- Point out to students that they have just thought about where they see ads and how those ads make them feel. Remind them that until recently most ads were seen by a limited number of people, but that things are different today because it's possible that advertisements, especially those that are online will be seen by hundreds of thousands of people from around the world.
- Ask students if they knew that people who see advertising on a laptop, tablet, phone, or other device are probably seeing ads chosen especially for them? Explain that they and a friend might decide to stream the same video online but see a completely different ad at the beginning of that video. Ask if they have any idea why that happens?
- Direct students to pay attention to advertisements they see or hear the rest of the day. Specifically ask them to notice where and when they see them. Do they pay attention to the ads or ignore them? How do they feel when they see or hear an ad?
- Ask students to be prepared to share their observations during the next class day.

TAKE A CLOSER LOOK

Activity 2: Exploring How Machine Learning Algorithms Make Predictions About Us Using Targeted Marketing

In this activity, students are introduced to basic concepts related to targeted distribution of ads and other information based on use of machine learning algorithms and data. In Activity 1 students were asked to think about targeted marketing, and advertisements in particular: what they are, their purpose, and where or when they usually see or hear them. In this activity, students learn a little more about how advertising has been distributed in the past and then look at how AI and machine learning algorithms are used today to ensure that online information, including advertisements, is seen and heard by the people most likely to be interested in that specific information.

1. Introduce this activity by explaining the following concepts:
 - Explain to students that throughout much of history, people had limited access to any kind of information. As technologies have developed—the printing press, for example—the ability to share information with people expanded greatly. Before information was mass printed using presses, very few people could read. Partly that was because few people had opportunities to be educated, but it was also because all books at that time had to be copied by hand, making them fairly rare.
 - Thanks to the printing press it was possible to make copies of books and other writings easily and cheaply. Just as the printing press made it easier to create and share books and other written information, it also made it easier to create advertisements to let people know about products and services they could

purchase. The ability to share this information with larger groups of people than had been possible before helped local businesses grow.

- But just being able to print and distribute information did not mean that the right people always saw it. Maybe someone who wanted an advertised product or service or other information would come across it, but maybe not. By the 1700s and 1800s in the United States, businesspeople tried to get information out to possible customers using newspaper ads, billboards, and postcards. When radio and television were invented in the first half of the twentieth century, and people were able to listen to or watch programs, advertisements became an important part of programming. But it was difficult to know if the information was getting to the right people.
- The invention of the internet changed that, making it possible to reach thousands of people around the world with ads and other information and to program computers using **artificial intelligence** and something called **machine learning algorithms**. Artificial intelligence is the science, engineering, and creation of computer programs that can imitate human intelligence. A machine learning algorithm is a process or set of rules used by a computer to find patterns in data. These processes enable computer programs to use data to recognize the people most likely to be interested in a product, service, or other information, and then make sure they see or hear it.

2. Make the connection between information found on line and it being directed to a specific audience by exploring the following concepts:

- Explain that for a machine learning algorithm to be effective, it needs a tremendous amount of accurate, relevant training data.
- Training data consists of examples used to teach a machine learning model. How is **training data** collected? One way is by tracking what people do when they are online.
- Ask students to work in pairs or trios to brainstorm a list of the apps, websites, and other tools they use online. Examples might include: search engines, streaming sites for video or music, games, etc.
- Mention that every time anyone goes online, they leave a **data trail**. A data trail is a collection of personal information tracked through a person's actions online, such as what sites or apps they used, for how long, what they did there, or who they are (if they logged into an account). All of this information is stored and used to tell companies what you as an individual do online, and is also added to **datasets** that store what people like you do—for example, elementary students in grades 3–5, kids who live in your state, or kids who are 8 to 10 years old who like to play games. Without realizing it, people are adding to datasets every time they go online.
- Ask students to talk with their partners or trios about what kind of data trail they might be leaving behind. Then create a class mind map organizing what might be in these data trails by category.
- Have students share their answers with the whole class, and create a class mind map organizing what might be in these data trails by category.
- Tell students that machine learning algorithms are programmed to find patterns in collected data. For example, the algorithm may determine that more fourth graders spend time playing online game A than

playing online game B or that fewer girls than boys click on videos about poisonous snakes. In these cases, the algorithm might predict that all fourth graders prefer game A or that all girls do not like videos about poisonous snakes, even though neither prediction is true. As a result, an online game site might not show a link to game B to users identified as fourth graders, or a video streaming site might not show users who identified as girls any links to videos about poisonous snakes.

- Ask students to consider the pros and cons of targeted advertising that uses machine learning algorithms like the ones just described. On the one hand, most people would rather see a majority of ads that tell them about products that they would likely be interested in instead of seeing ads for things they wouldn't like. On the other hand, this means people might not know that there are choices they could be making, if they knew they existed. Here are a few questions to reflect on in their pairs or trios:
 - Should people's choices be directed or limited by a computer program?
 - Are these ads helpful when it points people to products, news, or events they want to know about?
 - How might it be harmful to people if targeted ads keep them from hearing about important products, news, or events because the algorithm doesn't think they will be interested?
- Conclude this activity with a whole-class debriefing discussion.

Activity 3: Exploring How Machine Learning Algorithms Make Predictions about Us Using Recommender Systems

In this activity, students explore how predictions made by recommender systems using a machine learning algorithm may impact people's decisions.

1. Introduce this activity by explaining the following concepts:
 - Another application of machine learning algorithms is something called a **recommender system**.
 - Explain that this is a computer program that makes suggestions about products, services, or other information that users might like based upon data collected about the individual person, or about groups of people who are similar to the person getting the recommendation. Again, the idea is to make it easier for someone to find what they want, but based on its programming, the algorithm also limits a person's choices. Familiar examples of recommender systems include those used by Netflix, YouTube, Spotify, Disney+, and even online stores.
 - Ask students if they or their parents use video streaming services or shop online. If so, do they pay attention to the suggestions made to them? Why or why not?
 - Demonstrate this technology by projecting your laptop screen to illustrate for students the points you are making (or, instead of a live display, walk through the three examples described below and take screenshots to share those images with students instead of a live display). Following are three examples of what you might show (try these out yourself prior to sharing with students to ensure suitability):
 - **Netflix or similar sites featuring series and movies.** Sites like this make suggestions about what videos subscribers might want to view next. Streaming accounts allow users to create a limited

number of profiles for individual viewers. Each profile typically offers a category called Trending Now, or something similar. The phrase Trending Now might imply that this is what everyone using that site is watching now. However, when viewing Trending Now suggestions in different profiles, even in the same account, are they the same? Why do multiple profiles on the same streaming account have such different suggestions for what to watch next? Can students guess anything about the person who uses each profile based on the recommendations? What are they basing those guesses on?

- **YouTube or similar sites featuring short videos.** Begin a search using keywords like grade 4 math. How well do the initial suggestions relate to various grade 4 math concepts? Select one video.

Pause the video and look at the suggestions to the right. Are they all related to math? If not, what happens if you click on a non-math related title? Now what kinds of recommendations do they see?

The keywords for the original search remain, but the results have nothing to do with math. How does a search for videos that help with a school topic get so quickly off the track?

- **Any online bookstore.** Tell students that a friend said you might want to read a book called *The Lemonade War*. When you went online to order it, you were given a list of seven other books you might want to purchase. Why does a search for one specific book title lead to a suggested reading list? How do they think these recommendations are being made?

2. Have students meet in their pairs or trios to talk about what they think happened. Have them discuss the following questions:

- Are these examples of machine learning algorithms making decisions for people?
- What are the benefits of seeing these recommendations?
- What are the drawbacks of relying on recommendations?
- Based on what they have seen, are these recommendations always accurate? Why or why not?

3. Ask students to choose one of the three examples and develop an explanation of how they think the recommendations were made. Ask them to address the following questions in their pairs or trios:

- What data were collected and used?
- How accurate were the predictions made?
- Were the predictions this helpful? Why or why not?

4. Make the connection to ethical use of artificial intelligence by sharing the following concepts with students:

- In addition to the pros and cons just discussed, some people are concerned that recommender systems do such a great job at giving people what they want that it can lead to wasted time or addiction to our digital devices.
- Ask students: Have you had the experience of watching one video or episode of a show, but then realized that because the service kept autoplaying things that you liked, you had watched many videos or shows without choosing them or thinking about whether you wanted to keep watching? Give students a few minutes to discuss this question.

- Point out to students that the algorithms that select video and show recommendations for individual users are designed to make the company money by recommending relevant content. It might keep users watching as long as possible to generate revenue on advertising sales. Alternatively, the company might sell more subscriptions if the algorithm recommends additional videos or shows that customers want to see. The more often they give users media that will keep their attention, the longer they'll use the site or the app, and the more money the service makes.
- Explain that the sites do not judge the quality of the content of the videos, just whether or not people continue watching them. Ask students to discuss the following questions in their pairs or trios:
 - What might be the effect of keeping people watching for long periods of time without thinking about it?
 - What might be the impact of showing people videos that will keep their attention without the algorithm considering whether the content of the videos will be good or bad for the viewer?

Activity 4: Exploring How Machine Learning Algorithms Make Predictions about Us Using Search Engines

In this activity, students explore how predictions made by search engines using a machine learning algorithm may impact people's beliefs and decisions.

1. Introduce this activity by asking students to identify what they have learned about how machine learning algorithms can impact the information they see when they are online.
 - If they need prompting, remind them about the discussions the class had during Activities 2 and 3.
 - Mention to students that even when they don't sign in to an account, there are ways to track the device being used online and gather information about websites visited, searches conducted, etc. Tell students that although companies often say that machine learning algorithms are intended to make it easier for people to find information that will be of interest to them, these algorithms can also limit the choices people have by including links just to what the algorithm predicts the person will want.
2. Tell students that they are going to experiment using two different search engines to see how results vary from one person to another. The search engines they will use are Google and DuckDuckGo. Each student should have an internet-connected device and a partner.

NOTE: Ideally, each student needs to have an internet connected device and a partner for this activity. If that is not possible, students can do this activity in their pairs or trios or the teacher can demonstrate the activity to the entire class using a laptop and projection device.

- Ask students what they know about how search engines work. Allow them to share their ideas.
- Explain that search engines are designed to help people find online resources that will be most useful for them out of the millions of possible choices. Most search engines do this by using machine learning algorithms that make predictions based on the search terms you use, where the computer you are using is located, the privacy and other settings on the device you are using, and even personal information about you if you are using a search engine within a web browser you can log into, such as Google Chrome.

- Begin the activity by having all students open the web browser they normally use at school. What search engine do they use by default? (You may need to help identify the search engine they are using, most likely Google, Bing, or Yahoo—but it could be something else.) Write the following list on the whiteboard or a piece of chart paper:
 - Bicycles
 - Online games for kids
 - UFOs
 - Ask the student duos to choose one of these topics to search for, using the default search engine. Or, allow them to choose a topic of their own, as long as they both agree to use the same topic. Students should type in the topic they chose on each of their own devices and press Enter. Ask them to compare the results they get with their partner. What kinds of resources do they see (e.g., images, websites, files, ads). Are the lists identical on each device or not?
 - Now ask them to open a new browser window and navigate to [DuckDuckGo](#). Explain that DuckDuckGo does not use machine learning algorithms to decide which results individual users will see because it does not collect tracking data to create profiles for individuals or groups. Ask students to conduct another search using the same topic. What results do they get this time? Are they the same as their partners' results? Are they the same as their first search results? Why do they think that is?
3. After providing a little time for students to try several side-by-side searches, lead a whole-class discussion during which students reflect on this experience. How is it similar to results they got in Activities 2 and 3? How is it different?

CULMINATING PERFORMANCES

Activity 5: Using Data Trails to Profile Someone

In this culminating performance, students will create a data profile for themselves based on the kinds of data trails people regularly leave behind when they are online.

1. Tell students they are going to use what they have learned about data trails to create a data profile for themselves using a format you will share with them. Be sure to tell students not to include their names because after they turn in their profiles, the papers will be shuffled and each student will be given someone else's profile to analyze.
2. Give each student a piece of 8.5" x 11" blank, unlined paper. Ask them to fold the paper in half so it makes a rectangle about 8.5" x 5.5" and then fold that in half again to make a rectangle about 4.25" x 5.5." Unfold the paper and label the sections created by the creases as follows:
 - Top left box: Two keywords I have used for online searches
 - Top right box: Three websites I have visited (name of each site)
 - Bottom left box: Three online videos I have watched
 - Bottom right box: Two online games I play regularly

Now have students take a few minutes to add the information needed in each box. Collect the completed profiles, mix them up and give a profile to each student (not their own).

3. Tell students they are going to use these bits of information to try to learn about the person who created the profile they now have. On a separate sheet of lined paper they should write the following:
 - Describe the kind of person they think would have created this profile, such as athletic, musical, outgoing, or studious. Why?
 - Design an ad for a product they think this person would like.
4. Each student briefly shares with the class the description they were assigned, the ad they created, and what bits of information they used from the profile to select the product for the ad. The creator of the profile should then claim it and reveal if they would or would not like the product in the ad created for their profile.
5. Make a table with two columns on the board. Label one "Would Buy" and one "Would Not Buy" and keep a tally as students state their preferences. At the end of this activity ask the class to use the tally to help them decide how effective the profile was in identifying what each person might like. If there were more incorrect than correct guesses, what additional information could be collected to improve the results? If there were more correct than incorrect guesses, what bits of information were most helpful?
6. Help students conclude that bits of information about someone can be gathered, analyzed, and then used to make predictions about something that person might like or dislike. While in this case each person had access to only a small amount of data about each user, AI that uses machine learning algorithms can quickly gather and analyze massive amounts of data about us. With that much data, the machine learning algorithm can have very high accuracy in proposing targeted ads, recommender systems, and search engine results that will get and keep the user's attention.

Activity 6: Reflect

In this activity, students should discuss the following questions to reflect on the societal impact of targeted marketing.

Ask students to think about the following questions and then write a reflection. When finished, allow volunteers to share some of their thoughts.

- Should we be concerned about the influence of machine learning algorithms on our lives? Why or why not?
- Whose best interests are served when we allow ourselves to be influenced in this way?
- How might these algorithms impact schoolwork or activities at home?
- What strategies can we use to make sure that the impact algorithms might have on decisions we make is a good one?
- What does this have to do with data privacy, and why should we care?

Extensions

Following are three ways to expand students' exploration of ways people may be influenced by targeted marketing based on personal and group profiles.

1. Use the data profiles students created for the Culminating Activity to extend the conversation. Ask students to retrieve their own profiles. Challenge them to think about the kinds of information that might be discovered about them based on their own online activity by writing brief responses to the following questions:
 - What were some similarities and differences between the profiles that were shared during the culminating activity?
 - Which of the data pieces helped identify individual classmates?
 - Were there ways to combine the information to help guess who created the profile?
 - How could you be more mindful of your data trail?
 - Is it your responsibility to monitor your data trail? Why?
2. In the Culminating Activity, students provided information about online activities they engage in which was then used to create a profile about them and then to make a prediction about who they are and a product they might like. Here is another approach to helping students see how a data trail can lead to personally identifiable profiles. Try this modified version of an activity originally called Privacy in the Information Age.

NOTE: To model protecting their own personally identifiable information, ask students to each use a fake name and birth date for this activity.

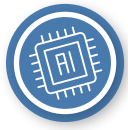
- As a class, create a three-column table on the board. Label the first column Fake Name, the second column Birth Dates (month/day/year), and the third column Favorite Food. Ask students to make up a name and birthdate and add this information to a row in the table on the board. Be sure to tell them that a person's name and birth date are considered personally identifiable information.
- Give each student a slip of paper and ask them to write down the fake birthdate they added to the list on the board and a favorite food. Collect the paper slips in a small box or other container.
- Ask a student to draw one slip out of the container and read the birthdate and food out loud. Ask the following questions:
 - Can they guess which fake name is associated with the favorite food written on the slip of paper simply by comparing the birth date written on the paper with the list of birthdays on the board? Why or why not?
 - What would happen if they knew just the birth month and year?
 - What would happen if they knew just the year?
 - What would happen if they did not have the birth date at all?

- Add the favorite food to the table in the row that students identify as being the best match with the birth date and fake name already there. Repeat this process several times.
 - Ask the students whose slips were drawn and recorded to confirm if the favorite food was listed in the proper row of the table.
 - Ask the class to respond to the following questions:
 - Which level of information—no birth date, year only, month and year only, full birth date—made it easiest to correctly guess the fake name associated with the birth date? Which level of information—no birth date, year only, month and year only, full birth date—made it most difficult to correctly guess the fake name associated with the birth date, thus offering the most privacy? Why do they think that is? What does this tell them about personally identifiable information?
 - Would it have been easier to assign the favorite food to a row if students had also been asked to write on the slip of paper the first and last initials for the fake name they added to the table? Why or why not? Help students understand that initials and birthdate would have provided two data points to compare, making it much easier to identify the proper row for each food. But that would have meant giving up more personal information. Is that something that they would want to do? Why or why not?
 - Would there be a way to figure out where to record each favorite food without giving up any personal information? How?
3. Explain that the more bits of personal information collected, the more likely it is that a personally identifiable profile can be created. For example, what if each person's address was known, or the name of their school? Should companies be permitted to gather data and create profiles that actually identify individual people? Why or why not?
4. Extend students' thinking about machine learning algorithms and their impact by teaching the "Training Data and Machine Learning" project found in *Hands-on AI Projects for the Classroom: A Guide for Elementary Teachers*



This project introduces targeted marketing as a concept and does so in a way that is approachable for elementary and middle school students. I also appreciate the connection to media literacy and thinking about our digital presence (even beyond creating profiles on social media or other websites). I'm also excited about the culminating activity, because I think it is a strong active learning experience that clearly teaches students about data trails and how machine learning algorithms can influence our digital lives. One suggestion I would give to teachers who use this project is to consider using examples that are most relevant to their students, which will increase motivation in learning about the topic.

—Caitlin McLemore, Educational Consultant, Blank Crayon



PROJECT 3

The Trade-offs of AI Technology

Artificial intelligence technologies are becoming more prevalent across different fields and industries, transforming the way everyday tasks are completed and, in many cases, doing them faster and with fewer errors than humans. Yet, the use of AI technologies doesn't always go as planned. Sometimes it leads to unintended consequences; biases; and loss of jobs, privacy, or freedoms.



The more I think about it, all of technology has been a series of trade-offs. A sword is better than a pointy stick, but you have to be stronger to lift it and it requires forging, sharpening, cleaning, etc. Too often we just see the benefit, but rarely stop to think of what we are either giving up or passing over when we make those choices, especially in technology fields. Making that a very personal and deliberate choice makes a lot of these AI discussions much more thoughtful and meaningful.

—Mark Gerl, Technology Teacher, The Galloway School

Project Overview

In this project, students explore the opportunities and shortcomings of a variety of AI technologies. In the process, they consider the stakeholders affected by AI technologies, examine the trade-offs involved in AI design and use, and consider ways that they can personally impact the ethical use of AI technologies in their own life and in the lives of others.

SUBJECT

Technology, Computer Science,
English Language Arts, Civics, Government

ESTIMATED DURATION

3–8 hours

TARGET GRADES

6–12

VOCABULARY

active data collection
artificial intelligence
call to action
ethical
ethics

model card
passive data collection
stakeholder
trade-off

OBJECTIVES

At the end of this project, students will be able to:

- Understand that all decisions, including those made by artificial intelligence, involve trade-offs.
- Describe the pros and cons of using or implementing various AI technologies.
- Make more informed decisions about the data they share and the AI technologies they use.
- Articulate a personal position related to the use of AI technologies.

STANDARDS

ISTE Standards for Students

1. Empowered Learner

- d. Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.

2. Digital Citizen

- d. Students manage their personal data to maintain digital privacy and security and are aware of data-collection technology used to track their navigation online.

3. Knowledge Constructor

- d. Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.

4. Innovative Designer

- d. Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.

6. Creative Communicator

- c. Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations.
- d. Students publish or present content that customizes the message and medium for their intended audiences.

7. Global Collaborator

- c. Students contribute constructively to project teams, assuming various roles and responsibilities to work effectively toward a common goal.

ISTE Computational Thinking Competencies

1. Computational Thinking

- e. Recognize how computing and society interact to create opportunities, inequities, responsibilities and threats for individuals and organizations.

2. Equity Leader

- e. Communicate with students, parents and leaders about the impacts of computing in our world and across diverse roles and professional life, and why these skills are essential for all students.

4. Creativity & Design

- c. Guide students on the importance of diverse perspectives and human-centered design in developing computational artifacts with broad accessibility and usability.

AI4K12 Five Big Ideas in AI

1. Perception

Computers perceive the world using sensors.

2. Representation and Reasoning

Agents maintain representations of the world and use them for reasoning.

3. Learning

Computers can learn from data.

4. Natural Interaction

Intelligent agents require many kinds of knowledge to interact naturally with humans.

5. Societal Impact

AI can impact society in both positive and negative ways.

CSTA K-12 Computer Science Standards

2-IC-20: Compare trade-offs associated with computing technologies that affect people's everyday activities and career options.

2-IC-23: Describe trade-offs between allowing information to be public and keeping information private and secure.

3A-IC-24: Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.

3A-IC-29: Explain the privacy concerns related to the collection and generation of data through automated processes that may not be evident to users.

3B-AP-08: Describe how artificial intelligence drives many software and physical systems.

3B-IC-28: Debate laws and regulations that impact the development and use of software.

Common Core State Standards for English Language Arts

CCSS.ELA-LITERACY.W.6.1 through 11-12.1: Write arguments to support claims with clear reasons and relevant evidence.

CCSS.ELA-LITERACY.WHST.6-8.7: Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

CCSS.ELA-LITERACY.WHST.9-10.7/11-12.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Preparation

MATERIALS

- Computer(s) or tablet(s) with internet connection for accessing tools and resources online
- Writing materials such as paper, pens, pencils
- Online articles, tools, and resources listed below
- Optional: A digital copy of The Trade-offs of AI Technology: Activity 3 **graphic organizer** for each student or student group
- Optional: Headphones for watching videos during Activity 3

SUPPORTING RESOURCES FOR EDUCATORS

- Article: "[Ethical Concerns of AI](#)"
- Article: "[Top 9 ethical issues in Artificial Intelligence](#)"
- Article: "[1st Party Data, 2nd Party Data, 3rd Party Data: What Does It All Mean?](#)"
- Video: "[There's No Anonymity](#)"
- Website: [DigCitCommit](#)
- Book: *[Blown to Bits: Your Life, Liberty, and Happiness after the Digital Explosion](#)* by Hal Abelson, Ken Leedon, and Harry Lewis

ADVANCED PREPARATION

This project can be facilitated in several different ways, depending on the time you have available in your course. Before beginning the project, determine which of the following implementations you will likely use.

- If your class time is limited to 3–4 hours of project time, focus your attention on Activities 1–3, use a jigsaw instructional strategy for Activity 3, and have students conclude the project with their Activity 3 class presentations and discussion.
- If you have 4–8 hours of project time, complete the provided project activities as written. Use the time you have allotted to determine the depth to which students will work on their group presentations in Activity 3 or culminating performance options A or B.
- If you have 8 hours or more, this project could provide a framework for a full unit on AI and ethics. For Activity 3, instead of using a jigsaw instructional strategy, have all students explore each of the seven categories of AI technologies listed. For the culminating performance, students can complete options A and B, and even work as individuals, in groups, or as a class to develop presentations about their calls to action to share what they have learned about AI, ethics, and trade-offs with an audience of students, educators, parents, or the community.
- Alternatively, this project can also be used cross-curricularly in a combination of technology, computer science, English Language Arts, civics, and government classes. For example, a middle school technology teacher might teach Activities 1–3, while the English Language Arts or civics teacher subsequently teaches Activities 4–6.

There are many links to media resources shared throughout this project, including videos to show to the whole class and resources for students to explore independently or in small groups. Prior to class, review the materials and decide how you will distribute them to your students. For example, if you choose to use *The Trade-offs of AI Technology: Activity 3* [graphic organizer](#), it is provided in Google Doc format. As you prepare for this activity, make your own editable copy, edit or update the questions or resources if desired, and distribute to your students in your preferred format.

Instructions

GETTING STARTED

Activity 1: Artificial Intelligence and Trade-Offs

In this activity, students will develop contextual knowledge around artificial intelligence, ethics, and the idea of trade-offs.

1. Introduce this project with a definition and description of **artificial intelligence**.
 - According to John McCarthy, who first coined the term, artificial intelligence is “the science and engineering of making intelligent machines, especially intelligent computer programs” (McCarthy, 2007).

A technology powered by AI is capable of such things as using sensors to meaningfully perceive the world around it, of analyzing and organizing the data it perceives, and of autonomously using those data to make predictions and decisions.

2. Have students watch the video “[What Is Artificial Intelligence? #1](#)”
3. Say, “In the video, you heard about many different applications of AI technologies. Jabril mentioned that some people are excited about the impact of AI, while others might be afraid of it. As with any new technology, there are **trade-offs**—pros, and cons of using it. A trade-off is a balance or compromise between two or more desirable, but competing or incompatible options.”
4. To help reinforce the concept of trade-offs, play a “would you rather” style game with your students. For each of the trade-off examples below (or others you create based on your students’ interests), read the prompt aloud and then have the students vote for their choices. Briefly discuss the consequences of choosing either action in relation to the other before moving on to the next scenario.

Trade-off examples:

- You have a 20-minute ride home on the school bus. Do you read a book or play a video game?
 - You accidentally sleep through your alarm and wake up right before it’s time to go to school. Do you take time to do your hair before leaving the house even if it means being late, or leave it as it is to get to school on time?
 - On Friday night, your family is holding a family dinner to celebrate a parent’s birthday, but your friends want you to go with them to a school event. What would you do?
 - You have only two hours of free time on Wednesday afternoon. Do you finish the two hours of homework you need to do for school the next day or hang out with your friends at the local coffee shop?
 - You are at a theme park and there are two rides you’ve been really wanting to try: a roller coaster and a water ride, but the lines are so long that you can only ride one before the park closes. Which would you pick?
 - It’s Saturday night and you are hanging out at home. Do you stay up late catching up on a television series everyone else has been watching or go to bed early to get a full night’s sleep?
 - Your teacher is giving a review for a big test coming up, but you feel your phone buzzing repeatedly in your pocket. Do you ignore it to focus on the review, or check your phone and risk missing something important?
5. Conclude this activity by framing trade-off decisions in the context of ethics, including the following key points:
 - You probably noticed from this activity that we don’t always all agree on what the best decision is in any given situation. Each of us made our choices based on our personal priorities and value systems at the time. Those values are determined by our experiences, cultures, backgrounds, interests, and other factors.

- **Ethics** is the study of the moral principles and systems that govern a person's behavior. It is the study of the systems people use to determine what is right and wrong. When people say that something is the **ethical** thing to do, they typically mean that they believe it is the morally right thing to do.
- As with the decisions we just explored, various metrics or values might be used to determine the ethical impact of an AI technology, such as whether it is legal, fair, beneficial, or harmful.
- In this project, we will explore various AI technologies, examine the trade-offs involved in their design and use, and consider ways that you can personally impact the ethical use of AI technologies.

TAKE A CLOSER LOOK

Activity 2: AI Data Collection and Applications

In this activity, students think about the trade-off of sharing data in return for the benefits or conveniences they receive from the AI-powered technologies people use in their daily lives. Then, they consider the potential risks and unintended consequences of sharing that data.

1. Introduce this small group activity with the following:

- Say, "In the video we watched earlier, we saw that—just as with a human baby—an AI that uses machine learning needs a lot of data in order to learn. It also needs data from users or its environment in order to apply what it has learned, communicate, generate new data, predict outcomes, or make decisions. The better the dataset an AI has, the better job it will do at performing tasks. As an individual or society, we have decided to give up some of our privacy or freedom in return for the benefits that AI technologies provide, such as convenience, personalization, or automation. This is an example of a trade-off.
- Have students watch the TED Talk video "[Your social media 'likes' expose more than you think](#)" by Jennifer Golbeck.
- Say, "As you saw from this video, there are good reasons for us to consider this trade-off more closely. Whenever there are data being collected, there are also data use and privacy concerns that should be taken into consideration."
- Say, "In the book *Blown to Bits: Your Life, Liberty, and Happiness after the Digital Explosion* by Hal Abelson, Ken Leedon, and Harry Lewis, the authors describe two types of data collected by technologies: footprints and fingerprints.
- Footprints—sometimes referred to as **active data collection**—are data you know you are leaving behind and may expect to be seen or used by others. For example, if you create a new account on a website, you might give them your name, email, location, or birthday.
- Fingerprints—sometimes referred to **passive data collection**—are data that you probably don't think about or expect to leave behind, but are being collected or tracked by the application. For example, tracking what links you click on, whose profiles you view, or even a video you didn't select, but didn't stop from autoplaying.

2. For this activity, have students work in groups of three to four to consider each of the AI-powered technology tools listed below and name what data are being collected as footprints, what data are being collected as fingerprints, and what the user gets out of sharing that data. Go over the first one together as a class, then assign each group two or three technologies from the list. After students have 10–15 minutes to brainstorm and write down their ideas in their groups, discuss each technology as a whole class. Record the students' answers on a whiteboard or in a digital table. To support your facilitation of this activity, possible answers for each technology can be found in the following table.

Technology	Footprints / Active Data Collection	Fingerprints / Passive Data Collection	User Benefit
Social Media Platform (e.g., Facebook, Instagram, or TikTok)	Likes, posts, friends/followers, tagged locations, photos, videos, messages, user tags, hashtags used, which groups you belong to, content of private messages, answers about favorites in personality quizzes	Profiles you view, ads you view, links you click on, amount of time spent in the app, what time of day you use the app, where you use the app.	Connecting with friends, good feelings from people liking your content, discovering new things
Search Engines/ Web Browsing	Search history of websites visited	Ads you view or click, links you click, time spent browsing, your physical location, your language, location where the search was made, type of device used while searching	Discovering new things; access to sites you like; personalized search results; targeted ads or product recommendations based on your predicted age, gender, interests, or location
Music and Video Apps (e.g., Spotify or YouTube)	What you 'like,' which accounts you follow or subscribe to, playlist contents, listening or viewing history	How many times you play a particular artist, song, or video; genres you prefer; topics or tags you prefer; what time of day you listen or watch; how long you listen or watch	Enjoying your favorite songs and videos; discovering new media; easily organizing your entire music library in one place; saving and sharing playlists; sharing media with friends
GPS/Map Apps	Locations you are trying to get to, locations you search, your current location	Where you live, your routine, frequently visited locations, how fast you are driving, location-based interests (food, entertainment, etc.), when you arrive at and leave locations, who you are with (from having location data from you and whomever you're with)	Easily getting to where you are going, getting real-time information about traffic

PROJECT 3

The Trade-Offs of AI Technology

Technology	Footprints / Active Data Collection	Fingerprints / Passive Data Collection	User Benefit
Adaptive Educational Apps (e.g., Khan Academy)	Name, teacher, school, grade, which lessons you are working on, your answers to practice problems, your performance in different school subjects, what classes you are taking	How long it takes for you to master a topic	Lessons to help you learn, information about mastery and progress, moving through material as soon as a topic is learned instead of completing all the questions
Online Shopping	What you buy, what you save for later, your birthday (for promotions)	What you look at, what you have in your cart, your or your parents' credit card information, your address, how much time you spend on their site or app	Home delivery, convenience, personalized recommendations
SMART home devices (e.g., Ring doorbells, SMART thermostats, Echo, or Google Home)	Who is at your door; what commands or prompts you give it; what temperature you prefer	When you come or go from your home; what you talk about in the privacy of your own home	Convenience, home security, energy efficiency
Wearable Technologies (e.g., Apple Watch, Fitbit, sleep trackers, smart eyewear, smart medical devices)	Steps in a day, heartrate, glucose levels, REM cycles	Sensor fusion data like heart BPM while at work (heart rate monitor + GPS)	Real-time access to health data, convenience of heads-up displays.

3. Extend the students' thinking about the data they share online by considering possible risks or unintended consequences of sharing the data they listed.

- Say, "When we share data online, we don't always know if, how, or why any of the data that we shared—as footprints or fingerprints—are being used by that computer program or that company—or even if it's being sold to a government or a third party to be used for a different purpose entirely. Sometimes we share what we think is harmless information, but on its own or when combined with other information, it might lead to unintended consequences or uses."
- Project the infographic "[What Information Are You Driving Around?](#)" for the class to see. Read through the information that each of the bumper stickers reveals and the potential unintended ways that people might interpret, use, or misuse that data.
- Review the footprints and fingerprints that your students listed about the technologies in the table above, or others that they think of. Ask, "In addition to using data to provide the user benefits you listed before, how else might people, companies, or the government use or misuse the data you said each of these technologies collected? What might they be able to know or do when they aggregate or combine data shared across these apps to create a digital profile of you? What might happen if they give or sell this data

to another company or the government?" For example, when students post their photos and a list of their favorite things, someone might use that information to guess their passwords, figure out their security question answers, or impersonate them. Or a company might evaluate the medical or mental health of its users based on their behaviors or the topics of the media they consume.

- Tell students that terms and conditions are one way of knowing how an app or company might use their data, and whether the app or company is saving, deleting, sharing, or even selling their data. Ask students whether they ever read the terms and conditions of apps they download. Discuss why or why not, as well as the benefits of being selective about which applications they use and what data they share.
- Conclude the activity by revealing that trade-offs exist in the design and use of all AI technologies. While you and your students were able to name many pros and user benefits for each of the technologies, there are also potential cons and unintended negative consequences of using these same technologies. When we choose to use an AI technology, we make a decision about the related trade-offs, such as having the convenience of using a map app, but giving up our privacy about where we are and where we go.

Activity 3: The Good, the Bad, and the Trade-Offs

In the last activity, students explored the trade-offs between sharing personal data and the benefits of using AI tools. In this activity, students will explore ways that AI is currently being used; the impact each of these uses may have on people, society, or the environment; and the trade-offs these technologies represent.

1. Introduce this activity with the following key concepts:
 - In the last activity, you thought about the trade-offs between sharing personal data and benefiting from using AI tools in your daily life. Now, let's think about other AI applications and some ways that AI might impact not only the user, but also society and the environment.
 - One way of measuring the ethical impact of AI is to determine whether it aligns with the social good. **Social good** is typically thought of as something that benefits the largest number of people in the largest possible way. In other words, something that isn't just good for one person or a small group of people, but that is good for the community or society as a whole. AI holds a lot of potential for effecting social good via applications that solve humanitarian, social, and environmental problems around the world.
 - As we considered in the last activity, the impact of using an AI technology can be positive, negative, or some combination of both. Those who have an interest in, who can affect, or who are affected by an AI technology are called **stakeholders**. Stakeholders include not only the users, but also the developers, salespeople, owners of the company, the environment, the government, or anyone else who is impacted by its use. And sometimes what is positive for one group of stakeholders might be negative for another.
2. Using a **jigsaw instructional strategy**, assign one or more of the categories of AI technologies in the table below to each individual or small group. Using the provided graphic organizer or another method of your choice, have students research their assigned technology using the questions and resources provided, and record their findings. Once students have completed their research, have them report their findings to the whole class. Ideally, students will take notes during other students' presentations as well, so that they ultimately develop a rich understanding of how various AI technologies are used and affect various stakeholders.

Note: The provided [The Trade-offs of AI Technology: Activity 3 graphic organizer](#) is in Google Doc format. As you prepare for this activity, make your own editable copy, edit or update the questions or resources if desired, and distribute to your students in your preferred format.

Questions for students to answer:

- What is the purpose of this type of technology? Give specific examples.
- What do you know about how this technology works?
- What data are being collected about the user?
- Who are the stakeholders of this technology (i.e., who are the users, the creators, and others affected by it)?
- Which stakeholders benefit from this technology, and how?
- Which stakeholders might be harmed by this technology, and how?
- In addition to the purpose you described, how else might this technology or this data be used for good?
- How else might this technology or this data be misused?
- How would you describe the trade-offs people must accept to use this technology? (Ex: People get _____ by giving up _____.)

Select any or all of the following categories and resources, or provide additional categories and resources based on current events and relevant student interests. Note that these categories are not comprehensive and sometimes overlap, but should provide a variety of entry points to connect with students cultures, experiences, and interests.

CATEGORIES OF AI TECHNOLOGIES

Category	Learn	Explore	Think
<p>AI Chatbots and Companions</p> <p>A chatbot is a software program that simulates conversation with a human. Chatbots come in the form of virtual assistants, conversational agents, companions, and even AI social media influencers.</p>	<p>Video: "What are Chatbots?"</p> <p>Video: "Google Duplex"</p> <p>Video: "This robotic therapy seal is revolutionizing elderly care"</p> <p>Article: "Why Are Brands Using CGI Influencers to Promote Skin Care and Fashion?"</p> <p>Article: "What future for humanoid robots?"</p>	<p>ALICE: An award-winning conversational agent.</p>	<p>Are there ways that an AI chatbot or companion should or should not be used (e.g., for friendship, as a romantic partner, or posing as a human customer service agent)? Why?</p> <p>What are the ethical issues around recreating the voice or appearance of deceased people as chatbots?</p>

PROJECT 3

The Trade-Offs of AI Technology

Category	Learn	Explore	Think
<p>AI-Generated Media</p> <p>AI technologies are being used to generate voices, images, deepfake videos, and even news.</p>	<p>Video: "Sway Launches #CoolRanchDance in Partnership with Doritos: Join the AI Dance Challenge!"</p> <p>Video: "Behind the Scenes: Dali Lives"</p> <p>Interactive Game: Choose Your Own Fake News</p> <p>Article: "What are Deepfakes?"</p> <p>Article: "Should AI Bring Dead Voices To Life?"</p>	<p>This Person Does Not Exist: Refresh to see AI-generated human faces.</p> <p>This Cat Does Not Exist: Refresh to see AI-generated cats.</p>	<p>Some people think that fake content can be as harmful or malicious as cybersecurity breaches, and that corporations and governments should act accordingly. In what ways is this true or untrue? How does fake media affect our ability to know what is real?</p> <p>Does it matter who owns voice and image data on you? Would it matter if it was the government vs a corporation? A local vs a foreign company? For profit or not-for-profit?</p>
<p>AI Personalization</p> <p>Machine learning allows AI technologies to use data about you and people like you in order to personalize things like educational intelligent tutoring systems, targeted advertisements, media recommendations, and search engine results.</p>	<p>Video: "Recommender Systems: How YouTube Knows What You Should Watch"</p> <p>Article: "What is Targeted Advertising?"</p> <p>Article: "How 'Intelligent' Tutors Could Transform Teaching"</p>	<p>Google Ads Settings: If you log-in to a Google account, you can see how the company is personalizing the ads you are shown.</p> <p>Flexi: See ways the Flexi intelligent digital math tutor not only provides hints, reminders, and support, but also adapts the practice with harder or easier follow-up questions based on how you answer the previous problems. Learn more about how it works here.</p>	<p>What are the ethical impacts of personalized results that manipulate human behavior through recommendations or nudges?</p> <p>Should people be worried about the amount of time spent watching the videos or consuming other media recommended to us by AI algorithms?</p>
<p>AI-Generated Art</p> <p>Using AI tools, people can create visual art, music, poetry, choreography, or other works of art—even in the style of other artists.</p>	<p>Article: "Would You Buy This AI Painting?"</p> <p>Article: "Computers are Changing How Art is Made"</p> <p>Article: "What is AI Generated Art?"</p> <p>Article: "AI can make music. But will it replace your favorite musician?"</p> <p>Article & Videos: "12 Songs Created by AI"</p>	<p>Demo: MuseNet</p> <p>Demo: AI Duet</p> <p>Demo: Doodles to Pictures</p>	<p>Does AI-generated art count as art?</p> <p>Who should own or get credit for the AI-generated artwork?</p>

PROJECT 3

The Trade-Offs of AI Technology

Category	Learn	Explore	Think
<p>AI Automation</p> <p>AI technologies are automating tasks that were previously performed by living, intelligent beings like humans and animals.</p>	<p>Video: "Microsoft is accelerating the journey from automated to autonomous systems"</p> <p>Article: "How Will Automation Impact Our Lives?"</p> <p>Article: "A robot referee can really keep its 'eye' on the ball"</p> <p>Article: "How to fight online hate before it leads to violence"</p> <p>Article: "Moral dilemma could limit appeal of driverless cars"</p> <p>Webpage: Automated Vehicles for Safety</p>	<p>Moral Machine: Try making ethical decisions for an autonomous vehicle</p>	<p>In what situations might it be an ethical problem to have automated AI technologies perform tasks previously completed by human workers, and why?</p> <p>How should people decide when automated technology should be used (e.g., if the AI does it faster, with less errors, performs a task that is dangerous to humans, works without bias, etc.)?</p>
<p>AI Assistive Technologies</p> <p>AI can be used to power technologies that help people with diverse needs and abilities.</p>	<p>Video: "Seeing AI: Making the visual world more accessible"</p> <p>Video: "How to Translate Spoken Word into Sign Language on Your Phone"</p> <p>Article: "Computers can translate languages, but first they have to learn"</p> <p>Webpage: Microsoft.com AI for Accessibility</p>	<p>Present Slides with Captions: Follow these directions to have machine learning generate captions while presenting Google Slides</p> <p>Using Microsoft Translator in a presentation: Follow the directions to have machine learning generate subtitles in a language of your choice while presenting PowerPoint slides</p>	<p>Do you think assistive technologies will help or hinder human intelligence in the long run?</p> <p>Should machines decide who to help and who to harm?</p>

Category	Learn	Explore	Think
<p>AI Recognition</p> <p>When we talk about AI recognition, we are talking about AI algorithms that use patterns to correctly identify and label images, sounds, or text.</p>	<p>Video: "Gender Shades"</p> <p>Article and Video: "New device tells smiles from frowns—even through a mask"</p> <p>Article: "Researchers Are Using Facial Recognition Software To Save Lions"</p> <p>Article: "Artificial Intelligence: From Croissants to Cancer"</p> <p>Article: "Facial recognition technology: The need for public regulation and corporate responsibility"</p>	<p>Google Lens or Google Search by Image</p> <p>Erase Your Face</p>	<p>Since greater surveillance leads to more data collection, which leads to more accurate AI, how should we find a balance between data privacy and technological advancement?</p> <p>Should people be worried about a few companies or governments owning or accessing tremendous amounts of data about people?</p>

NOTE: Following student presentations, if time does not permit you to do Activity 4 and 5, skip to the class discussion in Activity 6: Reflect.

Activity 4: AI Policymaking

In the last activity, students explored the pros and cons of various AI technologies, revealing how those technologies are able to help people, but also how they might cause harm or ethical dilemmas. In this activity, students will consider whether policies or regulations might help ensure that AI technologies are only used for good.

1. Summarize what students learned in the last activity, sharing that AI can be beneficial if it helps people in a society and aligns with their values, but it can be dangerous if it is programmed to do something harmful or if it is destructive in how it achieves something good.
2. Tell students that many industry, government, and civic organizations are advocating for or establishing guidelines, policies, regulations, and laws to ensure the ethical design and use of AI. While violating some of these regulations, like the United States Federal Trade Commission (FTC) regulations, might come with legal consequences for a company; others policies, such as a company's code of ethics, are simply goals the company internally strives to abide by, and there may not always be consequences for violations. Share the list of resources below (or other policy resources) and give students some time to explore them. Tell them to select two to explore more closely.
 - [USA Federal Trade Commission Guidance](#)
 - [European Union's Ethics Guidelines for Trustworthy AI—Press Release](#)

- [Hong Kong's Ethical Accountability Framework](#)
 - [Artificial Intelligence at Google: Our Principles](#)
 - [Microsoft's Responsible AI page](#)
 - [IBM: Everyday Ethics for Artificial Intelligence](#)
 - [Partnership on AI's Goals and Thematic Pillars](#)
 - [USA Children's Online Privacy Protection Act \(COPPA\): FAQs on COPPA and Schools](#)
 - [The Institute for Ethical AI in Education's The Ethical Framework for AI in Education](#)
3. Using a Venn diagram, have students compare and contrast the two examples they selected. They do not need to read the resources in their entirety, but should instead try to find main ideas about how their examples address topics like bias, fairness, transparency, explainability, accountability, or values. Once students have completed their diagrams, have them share some of the common themes they found throughout the ethical guidelines they examined.
 4. Tell students that one recent innovation proposed by Google to help address these issues is called model cards. **Model cards** provide a holistic framework for sharing information about machine learning model, such as its purpose and audience, design and training data, implementation limitations, and trade-offs. Google suggests these model cards can be created by many developers and will improve transparency about an AI for various stakeholders. Take a closer look at two examples of Google's model cards [here](#).
 5. Conclude this activity with a class discussion about ethical responsibility with AI, using the questions below. Help students to understand that all stakeholders, even users, share responsibility for ethical AI design and use. All stakeholders have a role to play in determining how AI will be used in the future.
 - Which do you think would be more effective: private companies regulating themselves, or the government enacting laws to regulate the design and development of AI? Why?
 - Who is responsible for making sure that AI is designed and implemented ethically? Who should be responsible? Why?

CULMINATING PERFORMANCES

Activity 5: Getting Engaged in AI Policymaking

In this culminating performance, students will synthesize what they learned in this project to articulate and support a position on an AI policy. Depending on your personal teaching style and your students' interests, you could do one or both of the listed activity options. Both activities reinforce the importance of digital citizenship and advocacy in an AI-infused world.

1. Kick off the final section of this project by introducing students to the concept of digital citizenship. According to the ISTE Standards for Students, a good digital citizen is someone who "recognize[s] the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and

they act and model in ways that are safe, legal and ethical.” This is a critical skill, especially in an increasingly AI-powered world.

2. The DigCitCommit Coalition defines five digital citizenship competencies: inclusive, informed, engaged, balanced, and alert. Have students watch the 30-second video “Commit to Digital Citizenship!” to introduce these concepts. Display the list of five competencies on the board and ask students to share how they see these concepts relating to what they have learned about AI in this project.
3. Tell students that they will have a chance to put all five competencies into action during the remainder of the project activities, especially the “engaged” competency, defined as “the ability to use technology and digital channels for civic engagement, to solve problems and be a force for good in both physical and virtual communities.” In both options, they will think about various **calls to action**—statements telling someone what next step they should take—that stakeholders might ask policymakers to take.

Option A: Mock AI Regulatory Council Meeting

In Culminating Performance Option A, students will apply what they learned from the last activity as they consider policy and regulation around the development and use of AI technologies. Students will role play stakeholder advocates and policymakers during a critical meeting of a fictional global agency—the World AI Regulatory Organization (WAIRO). This activity can be as straightforward or elaborate as your time and learning environment allow.

1. Introduce this activity by letting students know that they will be applying the research they gathered in the last activity as they role play in a mock global regulatory council meeting of the fictitious, but potentially very influential WAIRO. Explain that this activity mirrors what it might look like for a stakeholder representative to advocate for their constituents in front of a school board, city commission, or legislature.
2. Establish the roles of the WAIRO meeting.
 - **3-5 Council Members.** These students will sit at the front of the room, listen to comments shared by various stakeholders, and attempt to work together to create a unifying AI regulatory policy for the world. (For an interesting alternative implementation of this activity, school leaders or community members could serve as the council members.)
 - **3-7 Stakeholder Representatives.** These students will present three-minute arguments to the council members regarding exactly how a particular stakeholder group would like them to decide about AI regulation. Possible stakeholder groups include: children under 13, middle and high school students, consumers, large AI software corporations, small AI-powered start-ups, humanitarian organizations, environmental activists, government organizations, or any other stakeholders that came up during Activity 3.
 - **Stakeholders.** The remainder of the students should form partnerships or groups with the stakeholder representatives to help them prepare their comments for the council.

3. Give students time to prepare for the mock meeting. Encourage students to draw from the resources they explored in previous activities for concrete examples and supporting evidence as they determine how someone in their role would think about the types of policies or regulations to be addressed.
4. During the mock meeting:
 - Allow each stakeholder representative three minutes to present their argument to the council. Optionally, also give the council members time to ask follow-up questions of the stakeholder.
 - Give the council members 10–15 minutes to deliberate and create a policy resolution on AI use, rights, or restrictions. This list might include dos and don'ts, as well as indications of whether violations would be considered civil or criminal violations or incur any type of punishment. The rest of the class should serve as an audience to these discussions. The final policy resolution should only include what the council members can agree on during the given amount of time.
5. Following the mock meeting, debrief using the following questions:
 - Based on the policies or regulations the WAIRO council passed, how might each of the stakeholder groups be impacted?
 - If the council could not agree on certain policies or regulations that were requested by the stakeholder representatives, how might this lack of action impact the stakeholder groups?
 - Looking at the names and descriptions of the five digital citizenship competencies, how do you see these skills playing a role in the development of AI policy?

Option B: An AI Call to Action

In Culminating Performance Option A, students considered multiple stakeholder viewpoints and how they might be affected by various AI policies or regulations. In option B, students will take a personal AI policy position and communicate it through a media artifact.

1. Have students work as individuals, with partners, or in small groups to create an artifact that advocates for a specific AI-related call to action. The artifact might be a letter, a persuasive essay, a blog, a video, a podcast, or other medium of their choice. The artifact should include:
 - **Who:** A specific policymaker audience, such as parents, school leaders, state leaders, company or business leaders, or government officials.
 - **What:** An audience-specific call to action, such as: developing a specific policy or regulation; learning more about particular AI topics; bringing in a guest speaker or consultant; adding AI education to the school curriculum; training teachers and students about AI data privacy; or, using an AI in a specific way to help people.

- **When:** A suggested timeline for executing this action.
- **Why:** At least two examples of supporting evidence that explain why this call to action is needed, why it will benefit people, and why the benefits of this policy will outweigh the potential risks or harms.

NOTE: It is likely that some students will advocate for positions that seem unethical in some way. When evaluating this assignment, consider whether they met the assignment criteria, whether their supporting evidence aligns with their call to action, and whether they establish an argument for the way the harms in their trade-off are outweighed by the benefits of their call to action.

2. Once students have created their artifacts, have them share them with the class using a gallery walk or class presentation format. Optionally, students may choose to share their artifact with the audience they selected.

Activity 6: Reflect

In this activity, students discuss the following questions.

- Is the ethical thing to do always obvious or self-evident? How might different stakeholders perceive the same decision about fair and ethical AI design or use differently?
- What happens if policymakers can't agree on or choose not to act on regulations regarding how AI should be used? What might be the consequences of not creating policies or regulations to govern ethical AI design and use?
- How will you continue to learn about and advocate for ethical design and uses of AI?

Extensions

Following are three ways to expand students' exploration of AI and the ethical considerations raised in this project:

1. Extend students' thinking about the ethics and societal impact of using AI technologies by teaching projects from other guides in the *Hands-on AI Projects for the Classroom* series. Depending on which topic you'd like to explore next, here are several projects to explore:
 - Boost students' media literacy skills by further exploring how AI is used to create and disseminate information, misinformation, and disinformation in the "Developing a Critical Eye" project found in *Hands-on AI Projects for the Classroom: A Guide for Secondary Teachers*
 - Learn about ways that AI can solve real world problems and foster social good in the "Using AI to Solve Environmental Problems" project found in *Hands-on AI Projects for the Classroom: A Guide for Secondary Teachers*.
 - Further consider ethical AI business practices and overarching principles for AI policy through the "Laws of AI" project found in *Hands-on AI Projects for the Classroom: A Guide for Secondary Teachers*.

- Consider several ethical questions around the use of automation and robotics in the “Using AI for Robotic Motion Planning” project found in *Hands-on AI Projects for the Classroom: A Guide for Computer Science Teachers*.
2. Continue the conversation about various aspects of digital data privacy with resources from the International Computer Science Institute at teachingprivacy.org.
 3. Further explore how AI technologies express the creator’s values and affect various stakeholders through the following student curriculum developed at MIT: [“An Ethics of Artificial Intelligence Curriculum for Middle School Students.”](#)



I love that the advanced preparation section provides teachers with options depending on how much time they have to teach the topic and specifically lays out which activities should be completed based on time available. It can also be used as a full unit. I also love the suggestion of how to use this as a cross-curricular project, which can really help teachers envision how they can incorporate AI into their classrooms. It’s a wide range of options, which I think is great to provide these ideas to teachers to help them plan as they integrate this project into their curriculum. It’s a great project that hits so many areas of AI and the resources provided are excellent!

—Coral Zayas, Dual Language Teacher (K-12), Leander ISD



One suggestion I would give to teachers who use this project is to go through the resources yourself first and pick the ones that your students will connect with most. Also, don’t be afraid to remix the activities and allow your students to explore this topic. It will be a time of great learning for you and the students.

—Brandie Wright, Middle School Technology Education Teacher, Dozier Middle School



PROJECT 4

AI and the 21st Century Worker

In “The Future of Jobs Report 2020,” over 80% of the companies surveyed indicated they will be using AI technologies by 2025. Furthermore, the report estimates that by 2025, “85 million jobs may be displaced by a shift in the division of labour between humans and machines, while 97 million new roles may emerge that are more adapted to the new division of labour between humans, machines and algorithms.” Applications of AI technologies in this evolving workforce environment raise a variety of ethical questions that today’s students should explore.



I’m excited about this project because it gets students to think about their future in a practical way and gives them the resources and mindset to make predictions about the changing world around them. One suggestion I would give to teachers who use this project is to experiment with how they run the discussions. There are so many great discussion questions throughout this activity, and it is a great way to see how students engage when presented with different formats like small groups, whole class, or online forums.

—Eamon Marchant, teacher and site tech coordinator, Whitney High School

Project Overview

The “AI and the 21st Century Worker” project provides students with a series of learning activities that build on their prior knowledge of AI applications to explore how AI technologies might impact school and work life, now and in the future. Through videos, simulations, class discussions, research, and a little imagination, students will learn that all applications of artificial intelligence come with trade-offs and that it will take diversity, inclusion, and unbiased decision-making to foster a positive and ethical impact of AI on society.

SUBJECT

Technology, Computer Science,
English Language Arts, or Career Exploration

ESTIMATED DURATION

6–13 hours

TARGET GRADES

8–12

VOCABULARY

bias
ethics
ethical
futurist

machine learning algorithm
stakeholder
training data

OBJECTIVES

At the end of this project, students will be able to:

- Describe ways that artificial intelligence is positively and negatively changing schools and industries.
- Explain the roles of bias, equity, diversity, and inclusion in the development of ethical AI.
- Predict ways that AI might impact the workforce of the future.

STANDARDS

ISTE Standards for Students

2. Digital Citizen

- d. Students manage their personal data to maintain digital privacy and security and are aware of data-collection technology used to track their navigation online.

4. Innovative Designer

- a. Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.

5. Computational Thinker

- d. Students understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.

ISTE Computational Thinking Competencies

1. Computational Thinking

- e. Recognize how computing and society interact to create opportunities, inequities, responsibilities and threats for individuals and organizations.

2. Equity Leader

- b. Construct and implement culturally relevant learning activities that address a diverse range of ethical, social and cultural perspectives on computing and highlight computing achievements from diverse role models and teams.
- e. Communicate with students, parents and leaders about the impacts of computing in our world and across diverse roles and professional life, and why these skills are essential for all students.

4. Creativity & Design

- b. Design authentic learning activities that ask students to leverage a design process to solve problems with awareness of technical and human constraints and defend their design choices.

5. Integrating Computational Thinking

- b. Empower students to select personally meaningful computational projects.

AI4K12 Five Big Ideas in AI

3. Learning

Computers can learn from data.

5. Societal Impact

AI can impact society in both positive and negative ways.

CSTA K-12 Computer Science Standards

2-DA-09: Refine computational models based on the data they have generated.

2-IC-20: Compare trade-offs associated with computing technologies that affect people's everyday activities and career options.

2-IC-21: Discuss issues of bias and accessibility in the design of existing technologies.

3A-IC-24: Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.

3A-IC-25: Test and refine computational artifacts to reduce bias and equity deficits.

3B-AP-08: Describe how artificial intelligence drives many software and physical systems.

3B-IC-25: Evaluate computational artifacts to maximize their beneficial effects and minimize harmful effects on society.

3B-IC-27: Predict how computational innovations that have revolutionized aspects of our culture might evolve.

Common Core State Standards for English Language Arts

CCSS.ELA-LITERACY.W.6.1 through 11-12.1: Write arguments to support claims with clear reasons and relevant evidence.

CCSS.ELA-LITERACY.WHST.6-8.7: Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

CCSS.ELA-LITERACY.WHST.9-10.7/11-12.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Preparation

MATERIALS

- Computer(s) or tablet(s) with internet connection for accessing tools and resources online
- Writing materials such as paper, pens, pencils
- Online articles, tools, and resources listed below
- Sticky notes
- Optional: Printing capabilities for student work in Activity 3

SUPPORTING RESOURCES FOR EDUCATORS

- Article: [“Top 9 ethical issues in Artificial Intelligence”](#)
- Article: [“Design Thinking for Educators”](#)

ADVANCED PREPARATION

- Complete the [Most Likely Machine](#) interactive to understand how the user’s decisions affect the outcomes in the simulation.
- Complete the [Survival of the Best Fit](#) interactive simulation to see how students will explore the concept of bias as they train an AI to review resumes and make hiring decisions.

Instructions

GETTING STARTED

Activity 1: AI in Schools

In this activity, students will activate their prior knowledge about the impact of AI by considering how artificial intelligence tools affect how students go about their daily life and work as middle or high school students.

1. If students are unfamiliar with AI technologies, you should begin this activity by explaining what artificial intelligence is and how it works. Supporting resources can be found in Appendix A: Unpacking Artificial Intelligence.
2. Display this list of real examples of AI technologies that impact students during the modern school day. Ask the class, “How many of these real-world examples of AI technologies are already in use during your school day?” Make a tally of how many are in use.
 - GPS or map apps to check traffic on the way to school
 - Self-driving car taking staff or students to or from school
 - Intelligent tutoring software like Khan Academy or iReady

- Chatbots to provide tech support or answer frequently asked questions on the school website
 - Autocorrect or spellcheck
 - Auto-completion of text in emails or class writing assignments
 - Search engine to do class research
 - Recommender systems on YouTube or TikTok to find videos explaining concepts for school
 - Retinal scans to take attendance
 - Facial recognition to measure if students are paying attention in class
 - Translation software to understand a word or phrase in another language
 - Cognitive assistants (like Siri or Alexa) to make a calculation or give you a fact for class
 - A writing helper like Grammarly for proofreading and making suggestions to improve student essays
 - Digital filters to edit photos or art for projects
 - Teachers using Turnitin or another AI-powered program to check if student submissions include plagiarism
 - Sensors to monitor usage of class materials or students' traffic patterns in hallways
 - Smart watches to measure your fitness or steps during the school day
 - Smart devices used for school safety
 - Algorithms in LinkedIn or other software to help match a student with a compatible employer for a high school job
3. Hold a class discussion to explore how the AI technologies examined are impacting education. Ask the following question:
- How many of these technologies do you want to be used in schools? Are there any that you don't want to be used? Why or why not?
 - How did these tasks get done in the past? How else might AI affect the school day of preteens and teenagers in the future?
 - How is AI affecting how you go about your daily life and work as a middle or high schooler?
4. Tell students that another way that AI is being used is to screen applications for colleges, universities, and technical schools. An algorithm is developed to decide which applications represent the best candidates for their institution. Ask students, "Do you think an AI or a person would make a more accurate decision about which students will be the most successful, and why?"
5. Have students complete the Most Likely Machine simulation individually or with a partner. In this activity, students build their own **machine learning algorithm** for determining which historical figures (here called "students") are the best fit for certain superlative titles, such as "most likely to go to a top university." A machine learning algorithm is a process or set of rules used by an artificial intelligence to find and apply

patterns in data. Following their experience, ask students to indicate whether they think it is right or wrong (or beneficial vs. dangerous) to have an AI make decisions about students' futures. It is likely that students will collectively have mixed feelings about this. Tell them there is not one correct answer to that question, and it's okay if they disagree with each other about it.

6. Tell students that in this project they will continue to explore the ways that AI technologies are shifting the way people work, not just in schools, but in the workforce as well. In the process, they will often stop to ask themselves questions about whether these impacts seem good or bad, and why. These are considered ethical questions. **Ethics** is the study of the moral principles and systems that govern a person's behavior. It is the study of the systems people use to determine what is right and wrong. When people say that something is the **ethical** thing to do, they typically mean that they believe it is the morally right thing to do. In this project, students explore the impact of AI technologies on society and decide for themselves whether they think these changes are ethical—or good—for our society.

TAKE A CLOSER LOOK

Activity 2: The Changing Workforce

In this activity, students will consider how AI is impacting the modern-day workforce as they watch videos, hold class discussions, and complete an **affinity diagramming activity**.

1. Display the question "How is AI impacting the workforce?" on a whiteboard, bulletin board, or wall.
2. Give five or six sticky notes to each student. After students experience the resources listed below, have them write down facts or ideas on the sticky notes about what AI can do or how AI is impacting jobs. Each sticky note should list only one fact or idea.
 - Play the videos "**Humans Need Not Apply**" and "**Humans and AI Working Together**," or other video clips that provide an overview of how AI is being applied in ways that affect today's workforce.
 - Share the following facts from "The Future of Jobs Report 2020" (**full report**; **list of key findings**).
 - Over 80% of companies surveyed for the report believe they will be using artificial intelligence technologies by 2025. And nearly 50% of the companies surveyed in the automotive, education, financial services, and healthcare sectors say they will be using humanoid robots by 2025.
 - "Forty-three percent of businesses surveyed indicate that they are set to reduce their workforce due to technology integration, 41% plan to expand their use of contractors for task-specialized work, and 34% plan to expand their workforce due to technology integration. By 2025, the time spent on current tasks at work by humans and machines will be equal."
 - "We estimate that by 2025, 85 million jobs may be displaced by a shift in the division of labour between humans and machines, while 97 million new roles may emerge that are more adapted to the new division of labour between humans, machines and algorithms."
 - "For those workers set to remain in their roles, the share of core skills that will change in the next five years is 40%. 50% of all employees will need reskilling (up 4%)."

- “94% of business leaders report that they expect employees to pick up new skills on the job.”
 - “The top skills and skill groups which employers see as rising in prominence in the lead up to 2025 include groups such as critical thinking and analysis as well as problem-solving, and skills in self-management such as active learning, resilience, stress tolerance and flexibility.”
3. After writing down their ideas, have students place the sticky notes under the posted question. Work with students to organize the notes into categories by discussing how they might label different types of impacts. Then cluster their ideas using the categories they identify. Discuss the major themes that arise, including questions such as:
- What types of jobs might be eliminated over time by automation or AI technologies?
 - What would be the pros and cons of a society where so much work is automated that many people are not needed to fill jobs?
 - Why might people want to keep doing tasks that can be done by automation or AI? (Does anyone still hand wash dishes even though they have a dishwasher? Or choose to checkout with a cashier even when there is an available self-checkout lane? Why?)
 - What are some of the new types of jobs that are being created because of automation and AI technologies?
 - What might be the benefits of humans and AI agents working together?
4. Tell students to look at the categories and sticky notes again, this time through an ethical lens. Explain that sometimes the same AI technology, application, or change might be beneficial to some people and detrimental to others. The people who have an interest in, who can affect, or who are affected by an AI technology are called **stakeholders**. Stakeholders include not just the users, but also the developers, salespeople, owners of the company, the environment, the government, or anyone else impacted by its use.
- Draw a line across the top of the board. On one end, write “positive impact.” On the other, write “negative impact.” Explain to students that this line represents a spectrum that the ideas they wrote down might fall on. The two ends represent the extremes, while something in the middle might be balanced or have equally strong tradeoffs on both sides.
 - For each sticky note, ask, “How does this impact reflect positive changes that are benefiting one or more stakeholders? How does this impact reflect negative changes that are detrimental to one or more stakeholders? Do you think the overall effect of this impact is positive (benefits outweigh the harms), negative (harms outweigh the benefits), or neutral?”
 - Have the students work as a class to place the sticky notes on the spectrum, justifying the position by explaining how they took various stakeholders’ perspectives into account.
5. Keep the sticky notes displayed (or take a photo of the display), and let students know they will return to this activity at the end of the project.

Activity 3: Careers Working with AI

In the previous activity, students discussed how some jobs will be eliminated by AI technologies, while new jobs will emerge. In this activity, students explore why diversity in the people who hold AI-related jobs is important, then learn about people from diverse backgrounds who are making a positive impact through their work with AI technologies.

1. Have students watch the video "[Ethics & AI: Equal Access and Algorithmic Bias](#)." Following the video, ask students to share their takeaways. Highlight the following key points:
 - AI technologies can sometimes negatively affect those who are the most vulnerable or the most marginalized. To limit the harm of these technologies, we must consider those most likely to be hurt by the system.
 - When nearly everyone has a computer in their pocket, it's possible to imagine a world where AI technologies could be benefiting everyone. To achieve that, we need to give a greater voice to those being impacted, so that their input impacts AI development.
 - AI development jobs need to be filled by people with diverse perspectives, such as more women and more people of color. This not only provides an opportunity for them to apply new lenses to approaching the world's problems, but also makes sure that AI solutions are designed with them in mind. (Note: While the video specifically mentions women and people of color, this would be a great time to mention increasing diversity by including people from other traditionally underrepresented populations in STEM fields, such as persons with disabilities, who identify as LGBTQ+, or who come from lower socioeconomic backgrounds.)
2. Have students work independently or with a partner to read an article about someone who has contributed to or succeeded in the field of AI, such as those listed on the [AI4All Role Models in AI](#) webpage. Students should learn a little about the person, as well as what they have accomplished in the AI field. This is also an opportunity to showcase the successes of AI contributors from diverse backgrounds. Students can take notes in a graphic organizer, or they could create a set of AI Role Model trading cards using a digital tool like the [ReadWriteThink Trading Card Creator](#). Students can print and display the cards, or share them in a digital gallery for other students to explore.
3. Tell students that because of available AI tools, models, and datasets, they don't have to wait until they are in a career to create AI applications that can help solve a problem in their life, school, or community. In fact, children and teenagers around the world have already begun to develop their own programs and apps that integrate AI to solve real world problems. (If time permits, consider sharing examples like high school student [Michelle Hua's Coach AI](#) or high school students [Owen Scott, Drew Kinner, Arya Karnik, and Sabarish Mogallapalli's ChestML](#). Both of these projects were recognized as winners in the annual [Congressional App Challenge](#).)

Activity 4: AI Decision-Making

In this activity, students will explore ethical considerations about how AI is being used to automate decisions about hiring and firing in the workforce.

1. Tell students that in addition to automating tasks and ushering in new types of jobs, AI is also changing the workforce by making decisions about schooling and job placement. Artificial intelligence technologies are currently being used by many organizations to automate high school course placement, screen college applications, and make hiring and firing decisions.
2. Have students complete the **Survival of the Best Fit** simulation game about hiring bias in AI. In this simulation, students step into the hiring role of a new start-up. At first, they make hiring decisions themselves, but as the business grows, they train and implement an AI algorithm to make the decisions for them.
3. Following the simulation, explain to students that **bias** is a preference for or against an idea or thing. We all have biases—preferences towards everyday things like cats or dogs, sweet or salty, sun or rain, as well as about harder trade-offs such as whether it is better for a woman to be a stay-at-home mom or be part of the workforce. While we are aware of some of our biases, others are **unconscious biases**—opinions or decisions that are formed about people or things without consciously learning or thinking about them. Whenever we use an artificial intelligence to make decisions, the decisions reflect any biases found in the **training data** (examples used to teach the machine learning model) that humans collected, selected, and used.
4. Further explore the idea of bias in AI decision-making by sharing historical or current event articles that reveal the applications and outcomes of real world organizations using AI for hiring or firing. Resources to support this discussion might include:
 - Article: "[AI programs exhibit racial and gender biases, research reveals](#)"
 - Article: "[AI at work: Staff 'hired and fired by algorithm'](#)"
 - Article: "[Amazon scraps secret AI recruiting tool that showed bias against women](#)"
 - Article: "[The Key Role Evolving AI Will Play In Tech Hiring And Firing](#)"
 - Article: "[How AI Can Remove Bias From The Hiring Process And Promote Diversity And Inclusion](#)"
5. Hold a class discussion, exploring the following questions:
 - How does the use of AI for making hiring and firing decisions impact stakeholders? Who does or does not benefit, and why?
 - How do AI machine learning algorithms inherit the biases of the humans who create them?
 - How might the use of machine learning algorithms reinforce inequities that already exist in the world?
 - How might knowing that an AI could be screening a resume or application change how you or others fill out applications?
 - If people better understand how machine learning algorithms are trained, how might we use machine learning algorithms more ethically for decision-making? How might we use them to overcome biases in the world? How might we create accountability for those who develop and use them?

CULMINATING PERFORMANCES

Activity 5: Jobs of the Future

In this culminating performance, students will step into the job role of a futurist. They will combine research with imagination to describe the evolving knowledge, skills, and credentials they believe will be needed for jobs of the future.

1. Introduce this activity, letting students know that they will be stepping into the role of a **futurist**: someone who uses research on current trends to make predictions about the future. This task will require both research and a lot of imagination.
2. Have students work individually, with a partner, or in a small group to complete the following steps:
 - Select a job or field of your choice.
 - Based on the assumption that AI will affect every job and field, use a **design thinking framework** like the one outlined below to research and develop your ideas.
 - **Discovery.** Research the selected job or field, using resources like the [U.S. Department of Labor's Career One Stop, My Next Move](#), or [Project STEM's Real-World Career Connections](#). What core tasks do these workers do day-to-day? How is AI currently being used in this job or field? Do they use, train, and/or develop AI tools? What is the current pathway for getting into this career? What knowledge, skills, or credentials are needed?
 - **Interpretation.** Based on what you learned, what trends do you notice? What changes are already occurring because of AI technologies?
 - **Ideation.** Generate ideas about how this job or field might look in 10 or 25 years. What will be the core tasks performed and how will AI be involved? How might the pathway to this career change? What knowledge, skills, or credentials will be needed? In your opinion, how might these changes positively and/or negatively impact various stakeholders or society as a whole?
 - **Experimentation.** Share ideas with a classmate and get their feedback. Do your ideas seem possible? Are they an effective combination of the research and your own ideas? What other suggestions do they have for improving your predictions?
 - **Evolution.** Consider the peer feedback and improve your predictions by revisiting any of the previous design thinking steps.
 - Select the best way to advertise a future job in the field you selected, such as an online job listing or a video. Develop an advertisement that includes, at a minimum, the future job description as well as the knowledge, skills, and credentials needed to be qualified for the job.
 - Have students present their future job advertisements to the class. After each presentation, discuss as a class whether they think the specific predicted changes would be beneficial or detrimental to various stakeholders or to society, and why.

Activity 6: Reflect

In this activity, students should discuss the following questions to reflect on the societal impact of AI technologies on work in the digital age.

- Looking at how the class placed the sticky notes on the positive and negative impact spectrum at the beginning of the project, are there any ideas that you would move now that you know more? Why?
- Why is having a diverse workforce in AI development important to the development of ethical AI design and application?
- How might society be negatively impacted by the ways AI technologies are changing today's workforce? How might society be positively impacted?
- Just because an AI *can* be used to do something, does that mean an AI *should* be used to do it?
- What next steps will you take to continue learning about the ethical impact of AI technologies on life and work?

Extensions

Following are four ways to expand students' exploration of AI and ethics topics raised in this project:

1. If time permits, consider sharing the PBS documentary "[CyberWork and the American Dream](#)" during Activity 2, or following the completion of the project. This documentary offers one way to explore the history of industrial development in the United States, examine ways that robotics and AI are currently impacting the future of work; debate presented perspectives and how these trends might affect jobs of the future; and consider what might be done to prepare for the challenges these potential shifts present.
2. Further students' understanding of machine learning and bias by teaching the "Programming with Machine Learning" project found in the *Hands-on AI Projects for the Classroom: A Guide for Computer Science Teachers*. In "Programming with Machine Learning," students create and select data, train a model, test for bias, and iterate to improve their program. Its activities could be inserted at the end of Activity 3 during this project to add an interactive programming element, or used as a follow-up.
3. Extend students' thinking about ethics and using AI technologies to make a positive societal impact by teaching projects from other editions of *Hands-on AI Projects for the Classroom*. Depending on which topic you'd like to explore next, here are several projects to explore:
 - Discover ways that AI capabilities can be harnessed to solve practical problems in the "Design an AI Agent" project found in *Hands-on AI Projects for the Classroom: A Guide for Electives Teachers*.
 - Consider how chatbots, like virtual assistants and conversational agents, can automate tasks traditionally performed by humans in the "AI Chatbots" project found in *Hands-on AI Projects for the Classroom: A Guide for Secondary Teachers*.

- Explore ways that AI can solve real-world problems and make a positive environmental impact in the “Using AI to Solve Environmental Problems” project found in *Hands-on AI Projects for the Classroom: A Guide for Secondary Teachers*.
4. Inspire students to further explore careers in computer science and AI by inviting a guest speaker, using connections with local businesses or an online program such as [Amazon Future Engineer Class Chats](#).



I teach computer science and career preparation 9–12 and I can clearly see how beneficial this project will be for students. The activities are very engaging and the content is relevant and easy to understand. I feel that the two interactive simulations are great to help students understand the possible scenarios and have a better picture of the context where this is applicable.

—Betzabé Orenos, High School Innovation Teacher and Instructional Coach, Colegio Decroly Americano



Glossary

active data collection: data you know you are leaving behind and may expect to be seen or used by others (also called footprints).

artificial intelligence (AI): the science and engineering of creating computer programs that can imitate human intelligence.

bias: preference for or against an idea or thing.

call to action: statements telling someone what next step they should take.

data: information

dataset: collection of data.

data trail: a dataset of personal information tracked through a person's actions online

ethical: morally right.

ethics: the study of the moral principles and systems that govern a person's behavior.

feature: unique measurable property.

futurist: someone who uses research on current trends to make predictions about the future.

machine learning algorithm: a process or set of rules used by a computer to find and apply patterns in data.

model card: a holistic framework for sharing information about machine learning model.

passive data collection: data that you probably don't think about or expect to leave behind, but is nevertheless being collected or tracked by the application (also called fingerprints).

recommender system: a computer program that makes suggestions about products, services, or other information users might like based upon data collected

about the individual person or groups of people who are similar to the person getting the recommendation.

social good: something that benefits the largest number of people in the largest possible way.

stakeholder: those who have an interest in, who can affect, or who are affected by something

stereotype: a fixed general idea or image of someone or something.

survey: a way to collect information by asking people what they think or know about something, and using that information to make decisions or predictions using that information.

targeted marketing: the process of identifying people who are most likely to respond positively to advertisements, recommendations, and other information expressing specific points of view and then identifying the most likely strategies for reaching those people (e.g., print, radio, television, online).

trade-off: a balance or compromise between two or more desirable, but competing or incompatible options.

training data: examples used to teach a machine learning model.

unconscious bias: opinions or decisions about people or things that are formed without consciously learning or thinking about them.



APPENDIX A

Unpacking Artificial Intelligence

This section provides basic explanations of fundamental AI concepts referenced in the *Hands-On AI Projects for the Classroom* series of guides, along with resources for supporting instruction.

What Is AI?

According to John McCarthy, who first coined the term, artificial intelligence is “the science and engineering of making intelligent machines, especially intelligent computer programs” (McCarthy, 2007). A technology powered by AI is capable of such things as using sensors to meaningfully perceive the world around it, of analyzing and organizing the data it perceives, and of autonomously using those data to make predictions and decisions.

AI technologies are sometimes classified as narrow and general AI. Narrow AI makes decisions about a specialized task, sometimes even based on a specific dataset of preprogrammed actions. The DeepBlue chess program that beat a human world champion in 1996, Apple’s Siri, and self-driving cars are all examples of narrow AI. In contrast, general AI could hypothetically learn and adapt to perform any task and solve any problem that a human being can. General AI does not currently exist, but there are many examples of it in fiction, such as “WALL-E” and “Big Hero 6”’s Baymax.

Learn More

Video: “[What is AI \(or Machine Learning\)?](#)”

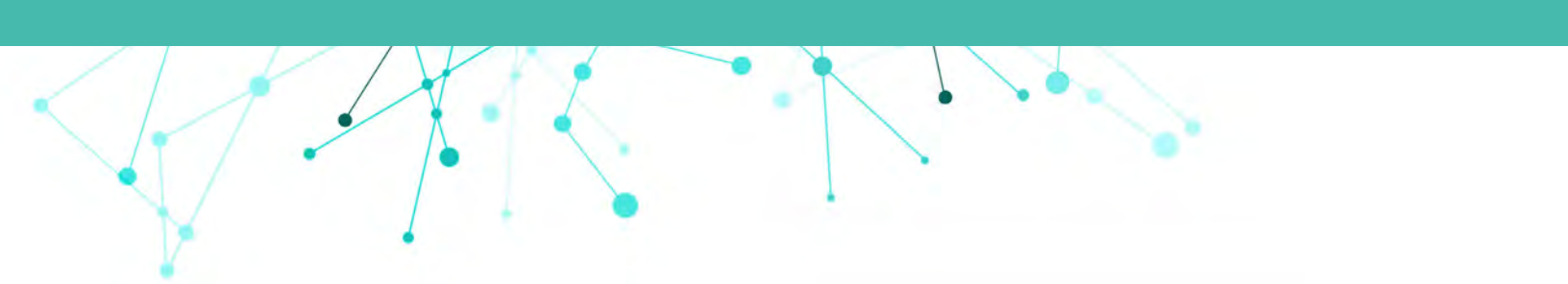
Video: “[What’s intelligent about artificial intelligence](#)”

Article: “[What Is Artificial Intelligence?](#)” by John McCarthy

Curriculum: “[AI4ALL’s Open Learning Curriculum](#)”. This free curriculum provides activities to teach students what AI is, what types of AI exist, and how to identify AI in the world around them.

How Do I Know If a Robot or Other Technology Has Artificial Intelligence?

Some robots and computer programs have AI, while others do not. A robot or software solution that has AI capabilities can do things such as recognize specific objects or faces, navigate around objects or complex maps on its own, classify or distinguish between objects, interact naturally with humans, understand or speak in a human



language, recognize or express emotions, or improvise when encountering something unexpected. In these ways, the autonomous decisions made by AI are more advanced than simple automation of a task (performed a prescribed sequence of steps), which even non-AI robots and software are frequently used for. As the cost of technology decreases and the capabilities of AI technologies increase, we will likely see increased AI use across most devices and software.

Learn More

Article: [“What’s the Difference Between Robotics and Artificial Intelligence”](#)

Article: [“How Robots Work: Robots and Artificial Intelligence”](#)

What Is Machine Learning?

Machine learning, a subset of AI, is the study of algorithms and models that machines use to perform a task without explicit instructions. Machine learning algorithms improve with experience. Advanced machine learning algorithms use neural networks to build a mathematical model based on patterns in sample “training” data. Machine learning algorithms are best used for tasks that cannot be completed with discrete steps, such as natural language processing or facial recognition.

Learn More

Video: [“Intro to Machine Learning \(ML Zero to Hero—Part 1\)”](#)

Video: [“How Does Machine Learning Work? Simply Explained”](#)

How Do Neural Networks Work?

Artificial neural networks are currently modeled after the human brain. While a brain uses neurons and synapses to process data, neural networks use layers of nodes with directed connections. Some of these connections are more important than others, so they have more weight in determining the outcome. Just like people, machines with neural networks learn through experience. As a machine processes a set of data, it recognizes patterns, assigns more weight to the most important information, learns to process inputs in order to develop the most accurate outputs, and creates a model from which to make future predictions or decisions. There are many types of neural networks, each with different design, strengths, and purposes.

Learn More

Video: [“Neural Networks and Deep Learning #3”](#)

Playlist: [“Neural Networks”](#)

Article: [“What Is Deep Learning?”](#)



What Is Natural Language Processing?

Natural language processing is the AI technology used to understand and interact with humans' natural language. Natural language processing powers technologies such as voice experiences and assistants, text predictors, grammar checks, text analyzers (such as spam filters), and language translators.

Learn More

Video: "[Natural Language Processing #7](#)"

Article: "[A Simple Introduction to Natural Language Processing](#)"

Video: "[How Do Chatbots Work? Simply Explained](#)"

Article and video: "[What Are Chatbots?](#)"

What Types of Ethical Considerations Surround AI?

All AI technologies are developed by humans. Whether they have been preprogrammed with a set of rules, or use training data to learn, they will have bias based on human input and decision making. It is important that students understand that AI decisions are not objective, as well as to understand which stakeholders might benefit from certain biases in the technologies. Moreover, many AI technologies collect, store, and apply personally identifiable information about users. Students should be aware of privacy concerns related to these technologies.

Learn More

Curriculum: "[An Ethics of Artificial Intelligence Curriculum for Middle School Students](#)"

Video: "[Algorithmic Bias and Fairness #18](#)"

Article: "[Ethical Concerns of AI](#)"

Article: "[Top 9 ethical issues in Artificial Intelligence](#)"

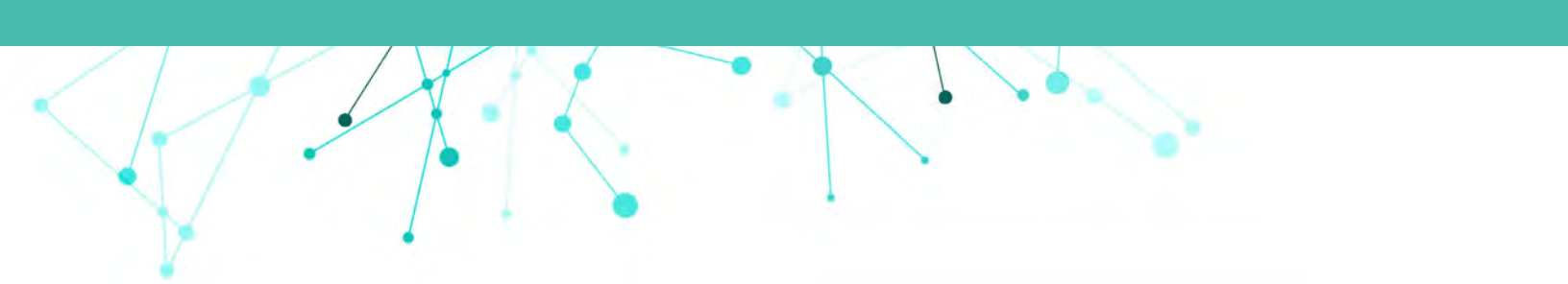
Video: "[The ethical dilemma of self-driving cars—Patrick Lin](#)"

APPENDIX B

Alignment to ISTE Standards and AI4K12 Five Big Ideas in AI

The following tables provide a big-picture view of how the projects in each guide align with the ISTE Standards and AI4K12 Five Big Ideas in AI.

Guide	Elementary				Secondary				Electives				Computer Science				Ethics			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
ISTE STANDARDS																				
1.1 Empowered Learner	x	x					x			x	x	x	x		x	x		x	x	
1.2 Digital Citizen					x			x			x			x			x	x	x	x
1.3 Knowledge Constructor	x		x	x		x	x	x			x		x				x	x	x	x
1.4 Innovative Designer		x	x				x		x	x				x	x				x	x
1.5 Computational Thinker			x	x	x		x		x		x		x	x	x	x	x			x
1.6 Creative Communicator					x	x		x			x			x						x
1.7 Global Collaborator							x					x	x							x
5.1 Computational Thinking				x	x	x	x		x	x	x	x	x		x	x	x	x	x	x
5.2 Equity Leader					x	x	x	x							x	x	x	x	x	x
5.3 Collaborating Around Computing	x			x			x					x	x							
5.4 Creativity & Design	x	x	x	x				x	x	x	x			x	x		x		x	x
5.5 Integrating Computational Thinking		x	x				x		x	x				x						x



Guide	Elementary				Secondary				Electives				Computer Science				Ethics			
Project	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
AI4K12 FIVE BIG IDEAS IN AI																				
Perception	x	x			x					x		x			x					x
Representation & Reasoning	x		x	x			x		x			x	x	x	x					x
Learning	x			x		x	x				x	x	x	x	x	x	x	x	x	x
Natural Interaction	x				x	x				x		x		x	x					x
Societal Impact	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

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