Understanding Algorithms

Age: 9th – 12th
Duration: 90 minutes
Standards:
CC.1.2.9–10.A Determine a central idea of a text and analyze its development over the course of the text, including how it emerges and is shaped and refined by specific details; provide an objective summary of the text.
CC.1.2.9–10.B Cite strong and thorough textual evidence to support analysis of what the text says explicitly, as well as inferences and conclusions based on an author's explicit assumptions and beliefs about a subject.
CC.1.2.9–10.J Acquire and use accurately general academic and domain specific words and phrases, sufficient for reading, writing, speaking, and listening at the college- and career-readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

CC.1.2.11–12.A Determine and analyze the relationship between two or more central ideas of a text, including the development and interaction of the central ideas; provide an objective summary of the text.
CC.1.2.11–12.B Cite strong and thorough textual evidence to support analysis of what the text says explicitly, as well as inferences and conclusions based on and related to an author's implicit and explicit assumptions and beliefs.
CC.1.2.11–12.J Acquire and use accurately general academic and domain specific words and phrases, sufficient for reading, writing, speaking, and listening at the college- and career-readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Objectives:
Students will be able to:
- Define algorithms
- Analyze key features of algorithms, including their functions, goals, and the information about users that these collect
- Compare and contrast algorithms used by popular websites, like Google and YouTube, to rank and recommend content
- Evaluate the benefits and drawbacks of algorithms
- Apply common algorithm features to design a less of their own

Lesson Overview:
In this lesson, students will:
1. Brainstorm, as a class, rules for how content is ranked or recommended on social media. *(Opening)* **<10 min**
2. Learn the definition of an algorithm **10 min**
3. Read about the algorithms used by popular websites (i.e., Google, YouTube, Instagram) and/or what a video about these (i.e., TikTok). Students will complete accompanying reading/viewing guides. This can be completed individually, as a whole class, or using the jigsaw method. Students can learn about all four algorithms or a subset. **15 – 30 min**
4. Compare features of different algorithms, using a graphic organizer. Discuss these comparisons as a class. **20 min**
5. Analyze the benefits and drawbacks of algorithms, using a graphic organizer. **20 min**
6. Create their own algorithm (*Exit Ticket*) **<10 min**

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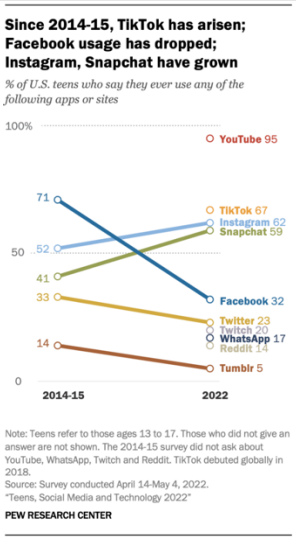
Student Handouts:
1. Google's Algorithm Description: Reading Guide
2. YouTube's Algorithm Description: Reading Guide
3. Instagram's Algorithm Description: Reading Guide
4. TikTok's Algorithm Description: Viewing Guide
5. Algorithm Comparison Graphic Organizer
6. Algorithm Comparison Discussion Questions
7. Algorithm Evaluation Graphic Organizer
8. Design an Algorithm Exit Ticket

Opening Brainstorm

1. Ask students which social media sites they use most often.

This can be done with a show of hands. List each website (e.g., Twitter, Instagram, What's App, YouTube) or show students a logo of each website, and have students raise their hands of they use each site.

Alternately, show students a Pew graph of U.S. teens' social media use. First, ask students what is represented on the x-axis; then ask students what is represented on the y-axis; then ask students what each color represents. Ask several audience volunteer to share one fact that is demonstrated by this graph.



Pew graph drawn from:
https://www.pewresearch.org/internet/2022/08/10/teens-social-media-and-technology-2022/

2. Brainstorm: Ask students *why* they prefer some social media sites over others, in other words ask, "What makes a social media site good?"

Write down students' responses on the board.
If students do not supply this information, prompt: "how often do you see posts from your friends?" "how often do you see posts that are relevant and interesting to you?"

Ask students "what determines or who decides what information you see on social media?" Students may not have an answer to this; this is a segue to introducing algorithms.

Introduce the Concept of Algorithms

1. Define the word **algorithm** for students**.**

In math, an algorithm is a step-by-step procedure. For example, if we have the problem, 23 + 13 * 2, what is the step-by step process or *algorithm* that would be followed.

Today, the definition for algorithms used is the: “the set of rules a machine (and especially a computer) follows to achieve a particular goal” (Merriam Webster).

As applied to social media, this means the set of rules that websites (like Instagram or YouTube) follow to decide which content to show you, in which order.

Emphasize that when we say a website’s “algorithm,” we mean a website’s rules for how that website presents content to users.

Explain that there are many “rules,” that can be used to order content. For example, content can be arranged chronologically or in alphabetical order, but often websites have more complex algorithms or more complicated rules for ordering content, which students will be learning about.

2. **Brainstorm** with students a list of rules that websites may follow (i.e., algorithm features) to decide which content to show you.

Ask students, “which factors might websites consider in deciding whether or not to boost you particular content in your feed or show it to you first?” If students are having trouble brainstorming, ask them to choose a specific website (e.g., Instagram, YouTube) and ask, “If I open my Instagram/if I’m done watching a YouTube video, what is the first image/next video that I would be likely to see? How does Instagram/YouTube decide this?”

Algorithm features or rules to prompt students to generate include: (a) relevance, (b) content popularity, (c) creator features (e.g., within a creator is in an individuals’ network/someone they follow).

Algorithm Jigsaw – Initial Reading

1. Ask students to read websites’ explanations of their algorithms and complete corresponding reading guides/viewing guides.

Facilitator Information: This part of the lesson will ask students to read and compare descriptions of Google’s, YouTube’s, and Instagram’s algorithms. Although TikTok does not publish information about its algorithm, a Wall Street Journal video about TikTok’s algorithm is also included, as a possible source. (Any social media website’s algorithm description can be added as a source and any of these sources can be removed).

Resources:

- **Google:** https://www.google.com/search/howsearchworks/how-search-works/ranking-results/
- **YouTube:** https://blog.youtube/inside-youtube/on-youtubes-recommendation-system/

- **Instragram:** https://about.instagram.com/blog/announcements/shedding-more-light-on-how-instagram-works
- **TikTok:** https://www.wsj.com/video/series/inside-tiktoks-highly-secretive-algorithm/investigation-how-tiktok-algorithm-figures-out-your-deepest-desires/6C0C2040-FF25-4827-8528-2BD6612E3796?

Facilitator information: Resources can be accessed on their original websites or as (lightly edited and abridged) excerpts included in the student materials. Reading guides and viewing guides for each resource are included in the student materials.

Variations: There are a number of ways to introduce these materials to students, depending on considerations like class size and reading level. These are some options:

A. Read each of these algorithm descriptions as **a whole class.**
Have students complete post-reading questions as a class or individually/in pairs and then share out as a class.
It may help to frontload vocabulary bolded in the student-versions of texts (e.g., weighing, chronological order)

B. Ask students to read each algorithm description and complete the reading/viewing guides **independently** or with a partner.

C. Use the **jigsaw method**: Students are assigned (or choose) one algorithm to focus on. After students learn about their individually assigned algorithm, they are grouped with other students, so that each algorithm is represented within the group and each group member is responsible for introducing *their* assigned algorithm to others in their group.

D. Overlapping jigsaw: Students are assigned (or choose) two algorithms to focus on. Students are then grouped together so that each algorithm has two students who are able to explain this to group members.

E. Base Video + Independent Work: The Wall Street Journal video about TikTok's algorithm is a strong foundation for understanding algorithms. Watch the video and complete the video guide as a whole class. Once students have a foundational understanding of algorithms, ask them to read one (or more) textual algorithm descriptions independently, in small groups, or using a jigsaw format.

Facilitator Information: I recommend C-E as options for most classes. The texts are rather challenging, so asking students to read more than one text may be overly demanding.

Algorithm Jigsaw – Comparing Algorithm Descriptions

1. Ask students to compare algorithm features to one another using the Algorithm Comparison Handout provided

Facilitator Information: If limited for time, focus on considering the function and goals of each algorithm and the information about users that each algorithm collects.

Facilitator Information: This graphic organizer can be completed individually/in small groups and then discussed as a class or completed as a whole class right away.

Algorithm Website	**Function:** What does the algorithm do?	What information about **you as a user** does the algorithm consider?	What information about **other people** does the algorithm consider?	How does the algorithm consider information quality?	**Goals:** What are the goals of the algorithm? How do you think the algorithm is improved or evaluated?
Google	Rank websites	Context and settings: location, search history	N/A	Prominent websites – if other websites refer to this	Present more useful content, as quickly as possible: "to present the most relevant, useful results in a fraction of a second."
YouTube	Recommends videos to see next	What you find satisfying: Clicks, watch time, survey responses, shares/likes/dislikes	What videos other people, like you, watch	Decide if video is "authoritative" or "borderline" for conspiracy theories and misinformation; use certified experts	Individuals watch more videos that give them "value"
Instagram	Ranks/orders feed and stories	Activity – how many posts you've liked; History of **interactions** with other people/posts	Post popularity, How much you interact with person who posted the image	If misinformation, use third-party fact-checkers and apply a label. Do not take post down.	Unclear – individuals viewing more interesting posts. "get better at surfacing what you're interested in."

					so that you'll spend more time on the site
TikTok	Recommends video	View time; Rewatches	Popularity of the video	N/A (for harmful content: Computer analysis + human moderator + videos reported)	"Engagement" – people spend more time on TikTok

2. After completing the graphic organizer, ask students to identify any patterns of similarities and differences that they notice within each column or between algorithms.

Facilitator Information: Discuss patterns and their implications as a class. There is also an Algorithm Comparison Handout with some of these discussion questions. Students can complete this handout not at all, independently, to prepare for a class discussion, during the class discussion, or after the discussion to summarize what they learned.

Below are some possible prompts for discussion.

Prompt: Column 2: What is the function or the main job of algorithms?
Explain: Ordering, sorting, prioritizing content

Prompt: Why is this an important function for algorithms?
Explain: Sorting and ordering content is important because of mass of information on the internet. Individuals cannot read/watch all of the information available or relevant to them, so algorithms dictate what information individuals interact with. In this way algorithms fundamentally change individuals' experiences on websites and the information that individuals have access to.

Prompt: Column 3: Why do algorithms collect all of this information about users? What are companies' goals in designing algorithms?
Explain: Algorithms are used both to increase engagement, for example time on a website and, in doing so, to increase advertising revenue.

Prompt: Column 5: Why do all of the algorithms we reviewed discuss the issue of misinformation? Instagram (and other platforms) only label misinformation but do not remove this information (i.e., de-platform). What are the benefits and drawbacks of this?

Prompt: Column 6: What are the goals of different algorithms? What is common about these goals?

Additional points of discussion:

Prompt: Why do companies share information about their algorithms and why might they not want to? Why are their descriptions somewhat vague?

Explain: The goal of algorithms are to keep you on a website for as long as possible. Some people may feel manipulated by algorithms or government officials may feel that people are being manipulated. For companies, providing information is a way to pre-empt or counteract individuals' and regulators' mistrust of algorithms. Notice that they're providing only general information rather than the specific algorithm that they use.

Explain: There are also many people who work in "search engine optimization." This means they work with companies to ensure that their websites appear, for example, at the top of search results. They do this by trying to game or figure out, for example, what features Google's algorithm considers to be most important. Keeping the algorithm secret is like a company's "special sauce." It prevents companies from "gaming the system," or promoting the things they want to sell, even if these are not relevant to individuals' searches.

One reason that Google doesn't want companies to figure out how to have their website at the top of search results is because they want companies to pay for advertising.

Facilitator Information: Can introduce the concepts of algorithm transparency and black box algorithms here.

Prompt: Google, in describing their algorithm writes: *"These systems are designed to match your interests, but they are not designed to* ***infer sensitive characteristics*** *like your race, religion, or political party."* Explain what this means in your own words. What are the dangers of algorithms predicting individuals' race or religion?

Facilitator Information: Possible to introduce concept of algorithm bias here; however this requires a separate lesson.

Benefits and Drawbacks of Algorithms

Transition question to benefits and drawbacks of algorithms:

Prompt: YouTube writes that their algorithm is like a librarian: *"Think about how hard it would be to navigate all of the books in a massive library without the help of librarians. Recommendations drive a significant amount of the overall viewership on YouTube"*

Prompt: Instagram suggests that before its algorithm users were missing the majority of the content they cared about: "*When we first launched in 2010, Instagram was a single stream of photos in* ***chronological order****. But as more people joined and more was shared, it became impossible for most people to see everything, let alone all the posts they cared about. By 2016, people were missing 70% of all their posts in Feed, including almost half of posts from their close*

connections. So we developed and introduced a Feed that ranked posts based on what you care about most.

Prompt: Think about the difference in what information you would see if YouTube only showed you the most popular videos, instead of recommending videos to you specifically through their algorithm. Or if Instagram organized content in your feed chronologically, rather than using its algorithm.

1. Ask students to identify one benefit and one limitation of algorithms for companies and for users.

Facilitator Information: The Algorithm Evaluation graphic organizer can be completed by students individually or in pairs/small groups and then reviewed as a class or completed as a whole class right away.

	Benefits	**Drawbacks**
Companies (e.g., Google, TikTok)	Allow companies to create a "better" experience for their users or to provide users with more content that they want to see. Allow companies to attract and keep users for longer and longer periods of time (so that users see more ads). Companies learn about their users. Allows companies to sell more targeted ads, increasing profits. Allow companies to change and improve the user experience over time, by tweaking the algorithm to prioritize different features in different ways.	Algorithms are complex and difficult to develop. This makes changing or optimizing algorithms difficult; and the outcomes of changing the algorithm difficult to predict. Algorithms are dependent on user data. However, user data collected may be imprecise, incomplete, and needs to be cleaned. For example, on YouTube, videos may be playing in the background while no one is really watching, or individuals may never like/dislike videos, or may not complete surveys after the video they viewed. There is a lot of misinformation, conspiracy theories, and otherwise dangerous content on the internet. Developing methods to deal with this bad information is challenging and often requires human raters to process a lot of difficult material.
	Introduced to content that, based on their interests/who they follow, they are interested in seeing	A lot of information about users (e.g., view length, likes location) is collected. Users may not even be aware that this

Individual Users	Can find very specific or niche interests Introduced to content that they may not have encountered otherwise Content on the internet is vast; content is sorted for users (ideally) to align with their interests, be popular, and free from misinformation	information is being collected. It can be used to target viewers for ads or sold to other companies. Because algorithms match their interests so well, users can just passively consumer content and spend more time on each website than they intend to. Because so much content, particularly on YouTube and TikTok is based on algorithm recommendations, users may lose some freedom of choice and may "rabbit tunnel," into watching the same type of content more than they intend to. This content may become more and more extreme over time. (Use example of "sad," videos on TikTok).

Exit Ticket

1. Ask students to complete an Exit Ticket (Optimize the Algorithm).