

REAL-WORLD TAKEAWAYS

- Social media apps like TikTok, Instagram, and others use powerful algorithms to tailor content based on each user's preferences.
- When a user initially starts using a particular app, they may receive a wide variety of content; over time, though, the algorithm will begin to learn the user's preferences and tailor content to match; eventually, a user's feed will consist primarily of content that they're interested in or agree with.
- Personalization algorithms have upsides and downsides. When it comes to entertainment, they're effective and engaging. But when it comes to science and current events, algorithms can perpetuate misinformation and create dangerous informational silos.

MATHEMATICAL OBJECTIVES

- Write a ratio in the form $a:b$ to compare two real-world quantities
- Analyze how a certain ratio of quantities changes over time and discuss its meaning and significance
- Observe a ratio presented in the form of a bar chart; discuss its meaning in a real-world context

LESSON AT A GLANCE

70 MIN.

LESSON AT A GLANCE			70 MIN.
LAUNCH		Watch a commercial for the social media app, TikTok; discuss students' experience with social media apps (and TikTok specifically), including possible upsides and downsides.	5 min.
PART ONE	1	Watch a screen recording showing the first 20 posts seen by three new TikTok users, each of whom has a different favorite topic (animals, dancing, and sports); for each user, write a ratio comparing the number of posts that included their favorite topic to the number of posts that didn't.	15 min.
	2	For each user, watch screen recordings showing the next 30 posts (posts 21-50); write a new ratio comparing the number of posts that included their favorite topic to the number of posts that didn't, and discuss whether the TikTok algorithm seemed to get better at predicting users' interests.	10 min.
	3	For each user, watch screen recordings showing the next 50 posts (posts 51-100); write a final ratio and discuss what it suggests about the algorithm's ability to tailor content to users' interests; discuss whether personalizing <i>entertainment</i> content based on personal preferences is a good or bad thing.	15 min.
PART TWO	4	Watch screen recordings showing the types of posts that two different users receive about a topic in science: whether the Earth is flat or a sphere; analyze various <i>flat-sphere</i> ratios and discuss which is the most likely from an algorithm that tailors content to personal preference.	15 min.
	5	Discuss the benefits and dangers of personalization algorithms and the most responsible ways to use (or avoid) products that employ them.	10 min.

- L Students watch a commercial for the social media app, TikTok. The title of the commercial is “Now You Know.” In it, TikTok users are thrilled to discover new life-hacks, such as the fact that you can use milk to clean a pan or an onion to clean a grill. Students discuss their experience with TikTok and other social media apps, including what they use them for, how the apps decide which content to place in users’ feeds, and possible benefits and dangers.

DISCUSSIONS QUESTIONS

1. What is the title of the commercial? What do you think TikTok means by “Now You Know?”
2. Do you know anyone who uses TikTok, or have you used it yourself? If so, what do they/you primarily use it for?
3. When two different people use TikTok, do they each see the same posts in their feed, or do they see different posts?
4. How do the apps decide which content to place in each user’s feeds? How do they learn what topics users like?
5. What are the benefits of showing users content based on their individual preferences? Can you think of any downsides to this?

KEY TAKEAWAYS

- People use social media for different reasons. These may include keeping up with friends, being entertained, learning new skills and life-hacks, and learning about the world.
- Social media apps like TikTok include millions (perhaps billions) of pieces of content. Rather than showing every user the same content, these apps tailor content to each user’s preferences. Over time, these apps analyze a user’s behavior to learn their preferences.
- By tailoring content to user preferences, apps like TikTok are engaging (even addictive). However, the individualization of content also means that users receive very different information, which may result in people believing very different things.

- 1 Every day, billions of people around the world use social media apps like Instagram, Snapchat, YouTube, and TikTok. These apps use powerful computer programs called “personalization algorithms” to determine which posts each user will see in their feeds.

Watch the screen recordings of three new TikTok users watching their first 20 posts. For each user, write a ratio comparing how many posts involve their favorite topic to how many that don't. Does the algorithm seem good at providing users with content they like?

FAVORITE TOPIC : OTHER TOPIC (POSTS 1-20)		
ANIMALZZZZZ 🐕 🐓 🐶	DANCE-O-MATIC 🎭 🕺 🎵	GOOOOOOOL 🏈 ⚽ 🏉
Posts w/ Animals : Posts w/o Animals 2:18	Posts w/ Dancing : Posts w/o Dancing 1:19	Posts w/ Sports : Posts w/o Sports 2:18

For each user, very few of the first 20 posts included the topic that they're interested in. For the user who's interested in animals, 2 posts involved animals and 18 posts involved something else. For the user who's interested in dancing, 1 post involved dancing and 19 posts involved something else. For the user who's interested in sports, 2 posts involved sports and 18 posts involved something else.

Based on this, the TikTok algorithm doesn't seem to be very good at providing users with content that they're interested in.

TEACHING TIP

Students with friends or family members who use TikTok (or who have accounts themselves) will know that when a user wants to advance to the next video, they swipe up. In the screen recordings, some of the videos cut from one to the next without the upward swipe. If students point this out and ask whether the sequences are true, you can assure them that they are; we didn't manipulate the order in which videos appeared. In some cases, we had to edit clips in order to remove inappropriate content (e.g. profanity in the dance videos), which required us to edit out the swipe animation.

- 2 Now watch the next 30 posts that each user sees, and write the *favorite:other* ratio for posts 31-50. Compared to posts 1-20, would you say that the TikTok algorithm got better at providing each user with content that they're interested in? Explain.

FAVORITE TOPIC : OTHER TOPIC (POSTS 21-50)		
ANIMALZZZZZ	DANCE-O-MATIC	GOOOOOOOL
12:18	13:17	3:27

METHOD 1: REASON ABOUT CHANGE IN RATIOS USING VARIOUS STRATEGIES

Posts 1-20	Posts 21-50
2:18	12:18

In each case (posts 1-20 and 21-50), 18 of the posts involved something *other than animals*. But in the second case, there were 12 animal posts compared to only 2 in the first.

Between posts 1-20 and posts 21-50, the TikTok algorithm got much better at providing videos of animals.

Posts 1-20	Posts 21-50
1:19	13:17

Between posts 1-20 and posts 21-50, the number of dance-related posts increased by 13x (from 1 to 13), while the number of non-dance-related posts went down (from 19 to 17).

Between posts 1-20 and posts 21-50, the TikTok algorithm got much better at providing videos of dancing.

Posts 1-20	Posts 21-50
2:18	3:27

In each case (posts 1-20 and 21-50), there were many more non-sports posts than sports-posts. Even though the second case included more sports posts (3 versus 2), it also included more non-sports posts (27 versus 18).

In each case, only 1 out of every 9 posts involved sports. Between posts 1-20 and posts 21-50, the performance of the TikTok algorithm stayed the same.

METHOD 2: CALCULATE PERCENT (BEYOND GRADE-LEVEL)

Posts 1-20	Posts 21-50
2:18	12:18
$\frac{\text{animal posts}}{\text{total posts}}$	
$\frac{2}{20} = 10\%$	$\frac{12}{30} = 40\%$

Between posts 1-20 and posts 21-50, the TikTok algorithm got much better at providing videos of animals.

Posts 1-20	Posts 21-50
1:19	13:17
$\frac{\text{dancing posts}}{\text{total posts}}$	
$\frac{1}{20} = 5\%$	$\frac{13}{30} = 43\%$

Between posts 1-20 and posts 21-50, the TikTok algorithm got much better at providing videos of dancing.

Posts 1-20	Posts 21-50
2:18	3:27
$\frac{\text{sports posts}}{\text{total posts}}$	
$\frac{2}{20} = 10\%$	$\frac{3}{30} = 10\%$

Between posts 1-20 and posts 21-50, the performance of the TikTok algorithm stayed the same.

TEACHING TIP

Unlike the screen recordings in the previous question (which were played at regular speed), the screen recordings in this question are played at 3x speed. This is to avoid allocating too much class time to watching TikTok videos. While the faster speed means that students will have to pay closer attention to whether a post involves animals/dancing/sports, it has a huge upside: it offers a clear demonstration of *how the TikTok algorithm works*. Even in the sped-up recordings, the on-topic videos clearly play for much longer than do the off-topic videos. This is how the algorithm learns which types of videos users are interested in; they're the videos that users allow to play the longest!

Before moving on to the next question, consider asking students what they notice about the videos that involve animals/dancing/sports...and how they think the TikTok algorithm is learning which types of videos each user prefers.

- 3 Watch the final screen recording for each user, and write the *favorite:other* ratio for posts 51-100. Based on this, what do you expect the user's next 100 posts will look like, and do you think this is a good thing? Why or why not?

FAVORITE TOPIC : OTHER TOPIC (POSTS 51-100)		
ANIMALZZZZZ	DANCE-O-MATIC	GOOOOOOOL
36:14	37:13	33:17

METHOD 1: REASON ABOUT CHANGE IN RATIOS USING VARIOUS STRATEGIES

1-20	21-50	51-100
2:18	12:18	36:14

In posts 51-100, there were more than 2x as many posts that involved animals as posts that didn't. This suggests that the TikTok algorithm got a lot better at learning what kind of content the user was interested in.

Based on this, I expect the next 100 videos (101-200) will focus mostly – or even entirely – on animals.

1-20	21-50	51-100
1:19	13:17	37:13

In posts 51-100, there were more than 2x as many posts that involved animals as posts that didn't. This suggests that the TikTok algorithm got a lot better at learning what kind of content the user was interested in.

Based on this, I expect the next 100 videos (101-200) will focus mostly – or even entirely – on dancing.

1-20	21-50	51-100
2:18	3:27	33:17

In posts 51-100, there were almost 2x as many posts that involved sports as posts that didn't. This suggests that the TikTok algorithm got a lot better at learning what kind of content the user was interested in.

Based on this, I expect the next 100 videos (101-200) will focus mostly – or even entirely – on sports.

METHOD 2: CALCULATE PERCENT (BEYOND GRADE-LEVEL)

1-20	21-50	51-100
2:18	12:18	36:14
$\frac{\text{animal posts}}{\text{total posts}}$		
$\frac{2}{20} = 10\%$	$\frac{12}{30} = 40\%$	$\frac{36}{50} = 72\%$

From this trend, I expect the next 100 videos (101-200) will focus mostly – or even entirely – on animals.

1-20	21-50	51-100
1:19	13:17	37:13
$\frac{\text{dancing posts}}{\text{total posts}}$		
$\frac{1}{20} = 5\%$	$\frac{13}{30} = 43\%$	$\frac{37}{50} = 74\%$

From this trend, I expect the next 100 videos (101-200) will focus mostly – or even entirely – on dancing.

1-20	21-50	51-100
2:18	3:27	33:17
$\frac{\text{sports posts}}{\text{total posts}}$		
$\frac{2}{20} = 10\%$	$\frac{3}{30} = 10\%$	$\frac{33}{50} = 66\%$

From this trend, I expect the next 100 videos (101-200) will focus mostly – or even entirely – on sports.

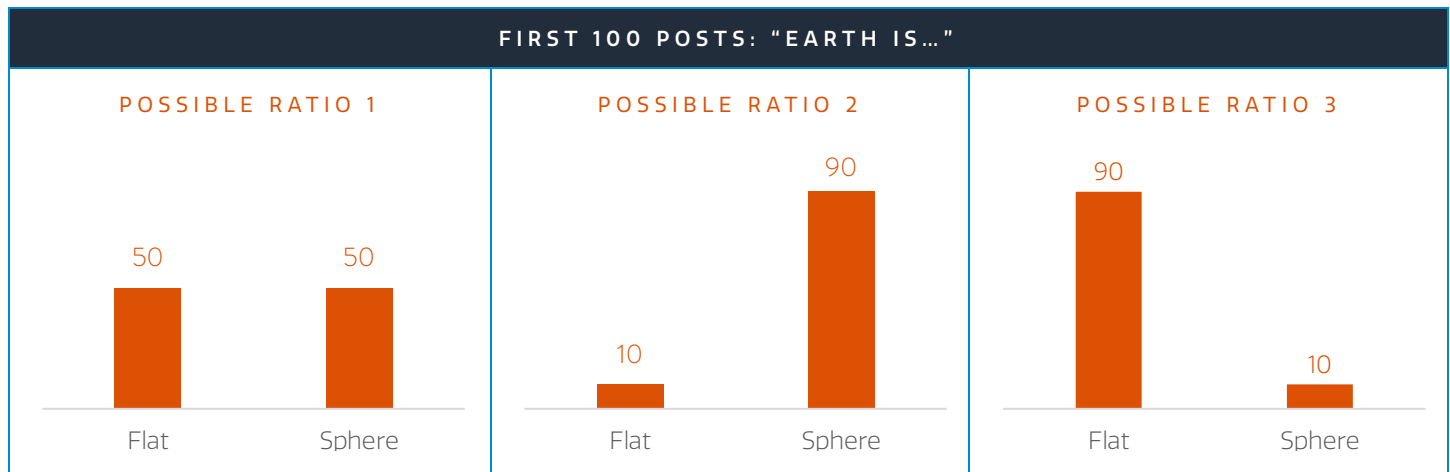
Students' answers will vary about whether the increasing accuracy of the algorithm is a good or bad thing. Sample response:

For each user – Animalzzzzz, Dance-o-Matic, and Goooooooool – TikTok got much better over time at providing them with videos that they're interested in. As all three users continue to use TikTok, I expect that their feeds will consist mostly (if not entirely) of videos that involve animals/dancing/sports. On one hand, this is great. If those are the topics that each person is interested in, then it's great that they'll have such easy access to them. After all, if someone loves dancing and doesn't care about sports, why waste their time showing them sports videos??

On the other hand, there could be a downside to only providing users with content that they're already interested in: It means they won't be exposed to *new* topics that they don't know about yet. (When it comes to entertainment, this may not be so bad. But when it comes to topics other than animals, dancing, and sports, it could be more problematic. For instance, if someone doesn't care about science or current events, it would be irresponsible for the TikTok algorithm to say, "If you don't care about science or current events, I won't show you anything about science or current events!")

- 4 When TikTok launched, users used it mainly as a source of entertainment: a place to watch videos about animals, dancing, and sports. Today, though, more and more users are using TikTok as something else: a place to get information about science and current events. Watch the screen recordings of the different types of videos that two experienced TikTok users receive about the shape of the Earth.

Then, imagine a new user signs up for an account and watches 100 videos about this topic. *Without knowing anything about this user*, which of the following video distributions do you think is the most realistic and why...and what might be some consequences of this?



Students' responses will vary. Sample response:

As we saw earlier, the longer someone uses TikTok, the more the algorithm learns about what kinds of topics they're interested in, and the more of those topics it places in their feeds. However, this probably isn't limited to what people *like*. It probably also applies to what people *believe*. In the screen recordings that show two different users watching videos about the shape of the Earth, one only gets videos claiming that the Earth is flat, while the other only gets videos saying that the Earth is a sphere. This is likely a result of how the TikTok algorithm works. If the algorithm detects that the first user tends to watch videos that are skeptical of science and scientists, it will serve up more and more of them. Meanwhile, if the algorithm detects that the second user tends to watch videos that trust science and scientists' expertise, it will serve up more and more of these.

Based on this, if a third user joined TikTok and watched 100 videos about the shape of the Earth, I expect their video results would look like Ratio 2 or Ratio 3, depending on whether they were initially skeptical of science or not. However, I don't think their results would ever look like Ratio 1. Because the TikTok algorithm tends to prioritize content that leans in a single direction, it doesn't seem realistic that TikTok would provide a user with 50 videos that claimed that the Earth was flat and 50 that said that it was a sphere. Instead, it's more likely that it would provide them with most of one and few of the other (if any).

The consequences of this are dramatic. When a user starts using TikTok, they may not know much or have strong opinions about a certain topic. However, if they happen to watch a video that claims that the Earth is flat, the algorithm will detect this and provide them with more of these videos. As a result, the person may eventually come to believe the Earth is flat...which will result in them seeing even more videos about this...which will result in them believing even more strongly in the idea. Meanwhile, someone who trusts science will get completely different videos and come to the exact opposite conclusion. In the end, both people will end up living in separate realities. Of course, this doesn't just apply to the shape of the Earth. It also applies to other important issues, from politics to climate change to...everything. Once this happens – once everyone comes to occupy their own separate reality – will humans be able to live together anymore??

- 5 Technology companies use personalization algorithms to engage their users and increase their profits. However, many people think these algorithms are dangerous; some even think they should be illegal. Watch the video from NBC's *Today* about this.

Try to name at least five products (other than TikTok) that use algorithms to personalize the content that users see. In your experience, do you think these algorithms are helpful or harmful, and does knowing how they work influence your willingness to use them?

Examples of products that use personalization algorithms to tailor content to users:

<u>Social Media</u>	<u>Entertainment</u>	<u>Current Events</u>	<u>Commerce</u>
TikTok Instagram Facebook Snapchat	YouTube Netflix Amazon Prime Video HBO/MAX Spotify Apple Music Pandora Amazon Kindle	Google News Apple News (+ Social Media)	Amazon Wal-Mart.com Target.com

Students' responses will vary about whether personalization algorithms are helpful or harmful and how they plan to use them. Sample response:

In some situations, personalization algorithms are beneficial. When it comes to music, they can play a helpful role in providing users with music that they like and even introducing fans to other similar artists. When it comes to movies, they can help film lovers discover movies with actors that they like. Of course, the downside of this is that music and movie fans might not be exposed to other *genres*, but I'm not sure how much of a problem this is. How likely is it that a fan of rap will suddenly become a fan of country, or that a fan of rom-coms will fall in love with horror movies? I don't know.

In other situations, though, personalization algorithms can be harmful. When it comes to issues like science and current events, it would be destructive to society if everyone believed something different and couldn't be convinced otherwise; at that point, conversation and compromise would no longer be possible, and expertise would become meaningless. When it comes to commerce, personalization algorithms may end up prompting people to purchase things that they don't really need, which could result in them going into debt and never feeling satisfied.

Now that I better understand how personalization algorithms work – by detecting what we like/believe *and then providing us with even more of that* – I might change how I use products that rely on them. When it comes to entertainment like movies and music, I might intentionally browse genres I've never watched or listened to before. When it comes to current events, if I find that I'm getting the same perspective on a certain issue over and over, I might seek out stories that offer a different perspective. When it comes to commerce, I might unsubscribe from retailers' email lists that recommend products based on ones I've already bought. And when it comes to social media...I might just cancel my accounts altogether. In other areas, there are actions that I can take to minimize the effects of personalization. But on social media, personalization may be all that there is!