https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

Exploring TikTok as an effective platform for geoscience communication

Emily E. Zawacki[1], Wendy Bohon[2], Scott Johnson[3], Donna J. Charlevoix[3]

[1] School of Earth and Space Exploration, Arizona State University, Tempe, AZ, 85287, USA
[2] Incorporated Research Institutions for Seismology, Washington, D.C., 20005, USA
[3] UNAVCO, Boulder, CO, 80301, USA

Correspondence to: Emily E. Zawacki (eezawack@asu.edu)

Abstract. With TikTok emerging as one of the most popular social media platforms, there is significant potential for science communicators to capitalize on this success and share their science with a broad, engaged audience. While videos of chemistry and physics experiments are prominent among educational science content on TikTok, videos related to the geosciences are comparatively lacking, as is an analysis of what types of geoscience videos perform well on TikTok. To increase the visibility of the geosciences and geophysics on TikTok and to determine best strategies for effective geoscience communication on the app, we created a TikTok account called "Terra Explore" (@TerraExplore). The Terra Explore account is a joint effort between science communication specialists at UNAVCO, IRIS, and OpenTopography. We produced 48 educational geoscience videos over a four-month period between October 2021 and February 2022. We evaluated the performance of each video based on its reach, engagement, and viewer retention to determine the qualities of a successful video. Our video topics primarily focused on seismology, earthquakes, topography, lidar (light detection and ranging), and GPS (Global Positioning System), in alignment with our organizational missions. Over this time period, our videos garnered over 2 million total views, and our account gained over 12,000 followers. The videos that received the most views received nearly all (~97%) of their views from the For You page, TikTok's algorithmic recommendation feed. We found that short videos (< 20 s) had a high viewer retention rate, but they often had a low engagement rate, leading to less overall visibility. Lecture-style videos that were between 40 seconds and two minutes in length had more success in both reach and engagement. Our videos that went the most viral featured content that was related to a recent newsworthy event (e.g., an earthquake) or explaining place-based geology of a recognizable area. Our results highlight the algorithm-driven nature of TikTok, which results in a low barrier to entry and success for new science communication creators.

1 Introduction

Given the current popularity and ubiquity of various social media platforms, scientists have a unique opportunity to directly interface with a diverse public audience. Not only can scientists use social media to improve the public perception of science, but they can also work to combat the growing tide of scientific misunderstanding and misinformation (Hilary and Dumebi, 2021; Shu et al., 2020). Over the last decade, scientists have found success using social media, especially Twitter, to

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

share scientific discoveries (Côté & Darling, 2018; Schmitt, & Jäschke, 2017; Smith, 2015) and affect social change (Jahng & Lee, 2018). However, the social media landscape is frequently changing, and scientists must adapt to new changes and trends to effectively reach an audience.

Over the past two years, TikTok has dominated the social media landscape and currently boasts over one billion monthly active users (TikTok, 2021a). On TikTok, users create and interact with short-form video content (~15 seconds to 3 minutes). TikTok is exceptionally popular among the younger generation, with 25% of users being under the age of 19 (Statista, 2022a). With the growing popularity of TikTok among users of all ages, TikTok presents an excellent opportunity to strategically examine how scientists can use social media to broaden their reach and create a more scientifically literate public. On TikTok, science communication is highly personalized, as science practitioners are presented in an approachable and relatable way (Zeng et al., 2020).

Of the STEM (science, technology, engineering, and mathematics) disciplines, the geosciences are especially relatable; essentially everyone has personal experience with geoscience-related information in their daily lives. Effective communication of geoscience topics is important because the geosciences are intrinsically linked to the human and natural world, and it is beneficial for everyone in society to understand the basics of geoscience. Increased awareness and understanding of geohazards like earthquakes, landslides, floods, and global climate change can help to improve personal safety and increase support for public policy. Additionally, geohazards are often the subject of considerable misinformation—persistent rumors that Yellowstone is about to catastrophically erupt serves as a frequent example—so providing high-quality, scientifically accurate information is especially important.

In recognizing the substantial potential for geoscience communication on TikTok, we created a TikTok account called "Terra Explore" (@TerraExplore) to share educational geoscience and geophysics videos. With these videos, we sought to not only enhance the visibility of geoscience and geophysics on TikTok but also to assess the most effective methods for science communication on the platform. We analyzed the reach (how many individuals saw the video), the engagement (the number of interactions with the content, e.g., "likes" or "comments"), and the viewer retention rate (how much of the video is watched on average) of each video we posted to determine the qualities of a successful educational geoscience TikTok. Through this work, we are able to determine the factors of a video that help maximize the reach and potential for geoscience communication on TikTok.

2 Basics of TikTok

TikTok is a short form video app that allows users to create videos using music, filters, text, and camera effects on their mobile phones. The app is free to download on Apple and Google Play stores. While TikTok videos were originally all less than a minute long, TikTok increased the upper limit to three minutes during late summer of 2021 (Kirchhoff, 2021). The COVID-19 global pandemic served as a catalyst for the growth and success of TikTok among different demographics (Feldkamp, 2021). During the first quarter of 2020, TikTok had more than 315 million installs across the Apple and Google

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

Play app stores, which was the most downloads ever for an app in a single quarter (Briskman, 2020). This was a significant increase from the 219 million installs during the fourth quarter of 2019 (Statista, 2022b), and TikTok currently stands as the third largest social media platform behind Facebook and Instagram (Insider Intelligence, 2021).

TikTok provides two feeds on which a user can watch content: *Following* and *For You*. Upon opening the app, videos immediately begin playing on the *For You* page. Users can toggle between the two feeds at the top of the screen. TikTok uses AI algorithmic recommendations to determine what videos are shown on a user's *For You* page, which are often based on the user's profile settings, their location, and their activity on the app (Smith, 2021). In order to help users discover new content categories and creators, as well as to avoid a repetitive experience, TikTok also provides diverse recommendations on the *For You* page (TikTok, 2020). The *For You* page is notable and unique amongst social media feeds, as videos with extremely few views (~10 views) can be recommended, thus guaranteeing a potential audience for every post regardless of the number of account followers. The more engagement a video receives, the more likely it will be shown to other users on the *For You* page. Based on TikTok's internal data, 69% of a user's time on the app is spent on the *For You* page (Stokel-Walker, 2020), making it the primary way users view and discover new content. Only videos from accounts that someone follows are shown on the *Following* feed, although these videos may also be shown on the *For You* page. Videos additionally can be viewed on a creator's profile page or by searching video hashtags or sounds.

3 Educational landscape on TikTok

Despite the common perception that TikTok is a "dance app" for kids, there is an abundance of educational content on the app that is widely consumed. Research shows that youths agree that TikTok serves as a window for online learning and aids in educational development (Azman et al., 2021). This positive educational potential led TikTok to be integrated into various aspects of instruction in higher education (Draganić et al., 2021; Escamilla-Fajardo et al., 2021). As well, studies show that TikTok allows non-expert users to participate in scientific discussions—such as those related to climate change—that oftentimes only take place among expert-level scientists and journalists (Basch et al., 2022; Hautea et al., 2021).

The TikTok leadership has also worked to strengthen and promote educational content on the app. In May of 2020, TikTok launched their "#LearnOnTikTok" campaign, where they partnered with 800 public figures, educational institutions, and professional experts to bring learning material to TikTok (Thoensen, 2020). These partnerships included notable science communicators such as Bill Nye and Neil deGrasse Tyson. While the campaign partnered with specific creators, anyone on TikTok can create videos and use the #LearnOnTikTok hashtag. As of February 2022, videos using the "LearnOnTikTok" hashtag have a collective 240.4 billion views. The success of the #LearnOnTikTok campaign demonstrates the desire for consumption of educational material on the platform and provides an ideal opportunity for science communicators to capitalize on a platform with a large user base. By leveraging this already well-known and popular hashtag, geoscientists can promote their content to a receptive audience, potentially increasing knowledge of and interest in geoscience topics.

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

The manner in which science content is presented on TikTok—lecture style vs. demonstration—influences user engagement. Habibi and Salim (2021) evaluated the engagement of lecture-style and experimental educational science videos on TikTok and found that scientific experiments presented in dynamic ways received the most engagement. Hayes et al. (2020) observed that TikTok videos of at-home chemistry experiments can increase knowledge of and interest in chemistry for viewers. In addition to videos showing chemistry experiments, Hight et al. (2021) found that students enjoyed creating and consuming content on TikTok that featured anthropomorphized chemistry concepts. Based on an analysis of memetic science content on TikTok, Zeng et al. (2020) found that the presence of science on TikTok is dominated by chemistry and physics experiments.

Thus far, the geosciences have largely been excluded from evaluations of science content and science communication on TikTok. Content related to geology and geophysics on TikTok has significantly fewer views than content related to physics, biology, and chemistry (**Table 1**). Unlike chemistry and physics, the geosciences do not as easily lend themselves to experiment-based content, but do allow for unique, hands-on demonstrations as well as the potential for "field trip" style presentations. Additionally, geoscience is a discipline that every person has had some level of interaction with (soil, geohazards, GPS on their phone, etc.) Our aim was to not only enhance the visibility of geoscience and geophysics content on TikTok but also to determine and evaluate the most effective strategies for geoscience communication on TikTok.

Hashtag	View Count
#physics	3.3 billion
#biology	3.2 billion
#chemistry	3.0 billion
#geology	617.6 million
#geophysics	2.7 million

Table 1. Number of total video views on TikTok for different science-related hashtags, as of October 2021 before our project began. Within the app, TikTok denotes the total number of video views per hashtag.

4 Account and video creation

In October 2021, we created an account "Terra Explore" to evaluate the potential of TikTok for geoscience communication (**Fig. 1a**). Between 10/8/2021 and 2/6/2022, we published 48 videos. The "Terra Explore" name is a nod to the many ways scientists explore Earth (Terra) using geoscience tools and techniques. The Terra Explore account is a joint effort led by science communication specialists from UNAVCO, IRIS, and OpenTopography. UNAVCO and IRIS are non-profit university-governed consortiums and manage the GAGE and SAGE facilities (respectively) on behalf of the National Science Foundation (NSF), serving the geophysics community. OpenTopography is co-managed by the San Diego Supercomputer Center at the University of California San Diego, UNAVCO, and Arizona State University and facilitates community access to high-resolution, Earth-science-oriented topography data and related tools and resources, also on behalf of NSF.

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

Our primary aim with the Terra Explore account was to determine effective strategies for geoscience communication on TikTok and increase the presence of geoscience and geophysics content, ideally targeting users aged 19-and-under and female/girl users. Our videos featured three rotating front-facing hosts and were typically done in a "lecture-style" format, where the host explains a geoscience topic while using engaging visuals. Two of the hosts are female and presented the majority of the videos, and one is male. We primarily used TikTok's "green screen" feature to add visual imagery to videos, in addition to image and text overlays (**Fig. 1b**). TikToks were filmed in individual home offices using simple equipment such as iPhone/Android devices, small lights, and low-cost lavalier microphones. We used TikTok's built-in captioning feature to provide captions on all of our videos to increase their accessibility.

We largely produced content related to our organizations' missions. Video topics primarily focused on seismology, earthquakes, topography, lidar (light detection and ranging), and GPS (Global Positioning System). We often used and incorporated existing educational graphics and animations produced by IRIS and UNAVCO. The videos we produced ranged between 9 seconds and 2 minutes 30 seconds in duration, with an average video duration of 57 seconds. Each video post contained a short description and approximately five relevant hashtags. Due to staff time limitations, we did not set a specific video posting schedule, but averaged between one to four videos posted per week, with the most videos posted during the first two months of the project. A number of videos were cross-posted and promoted on UNAVCO, IRIS, and OpenTopography's other social media accounts.

Our video content largely did not include TikTok "memes" or sounds. "Memes" are among the most common videos on TikTok and use viral audio clips that are transformed and applied to different visual imagery, capitalizing on popular culture or shared experiences. Given the educational aspect of our videos, we chose to follow a more traditional video format.

The most common type of video we produced presented ground motion visualizations (GMV) for notable earthquakes magnitude 6 or higher (**Fig. 1c**). These GMV animations were already being produced by IRIS and disseminated through other social media channels. On the Terra Explore TikTok, the front-facing video host explains what is shown in the animation: earthquake waves pass across seismic stations in the United States, and we can see representation of the ground moving up and down (although the movements are too small to feel). Videos were timely in that they were typically posted the day of or the day after the earthquake occurred. As the content and style of these GMV videos were largely identical, they provided a way to more clearly evaluate specific factors that may affect a video's performance.

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

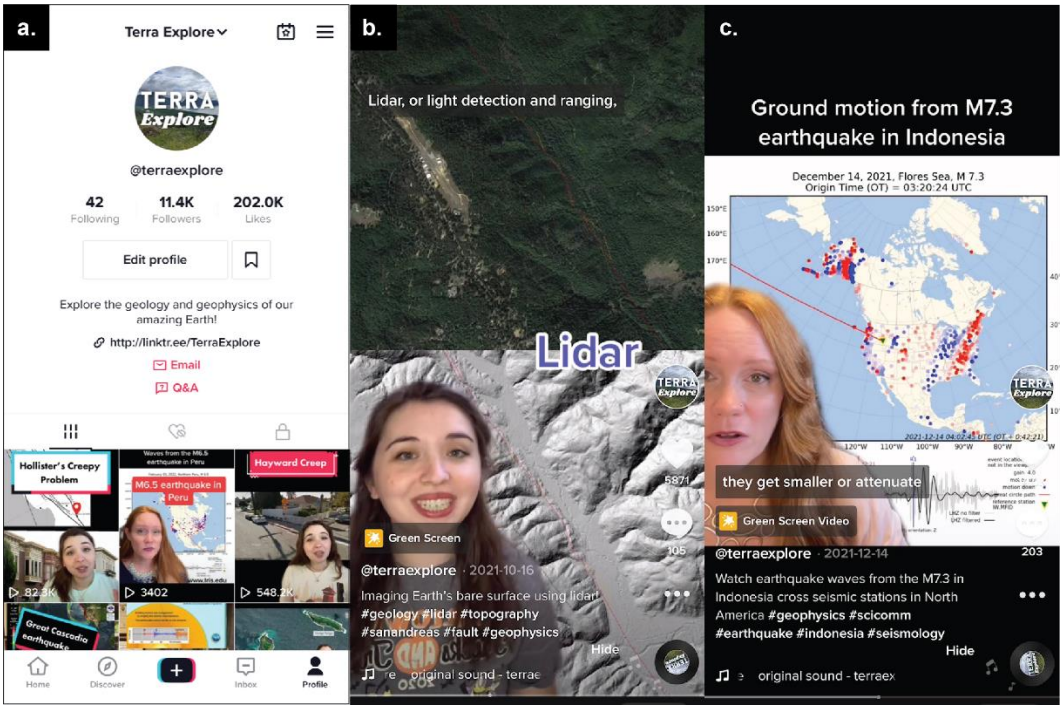


Figure 1. (a) Representative screenshot of the Terra Explore account. Our profile page has a Linktree that provides external links to the UNAVCO, IRIS, and OpenTopography websites. (b) Screenshot of typical video using the "green screen" effect. (c) Example screenshot of a GMV video.

5 Methods

We used TikTok's built-in account analytics to download and record video and account metrics for the period between 10/8/2021 and 2/6/2022. We began collecting data upon video publication and continued until the end of the reporting period, ensuring that there was a minimum of two weeks of available data per video. We found that videos typically received the majority of views and engagement within the first week after publication, and thus this timeframe is generally sufficient to observe video trends.

We collected the following summary data for each individual video: video views, likes, comments, shares, total cumulative play time, average duration the video was watched, percentage of viewers who watched the full video, unique reached audience, and the percentage of video views by section (*For You*, personal profile, *Following*, hashtags). TikTok does not provide information on the gender or the age of users who view a video. We evaluated the "success" of videos based on reach and engagement metrics, as well as viewer retention (how long a video is watched). We used metrics of reach (number of unique users the video was seen by) and engagement (likes, comments, and shares) to calculate the engagement rate of each

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

video. The engagement rate is calculated as the engagement parameter as a percentage of total reach (e.g., Likes / Audience Reached *100).

We also recorded weekly account metrics including total video views, profile views, total account likes, total comments, total shares, total followers, new followers, and gender of followers. The only gender information TikTok readily provides in analytics is the binary percentage of male and female followers. Of these metrics, we most closely evaluated the gender percentage of followers over time to see how well we were able to reach specific demographics.

6 Results

6.1 Video and account metrics

During the four-month test period, the Terra Explore account gained over 12,000 followers, and the 48 videos published garnered 2,106,504 views. The videos had a combined 22,297 hours of watch time. Individual video views ranged between 522 views and 684,100 views, with a median of approximately 2,400 views. Seven videos received over 90,000 views, and 30 videos received less than 3,000 views (**Fig. 2**). Videos were uploaded at various times throughout the day, and the videos that received the most views were uploaded either in the morning or early afternoon Mountain Standard Time (MST) (**Fig. 3**). We did not spread video publication evenly throughout the week, and the greatest number of videos was posted on Tuesdays. Videos that were published on Wednesdays and Thursdays received significantly fewer views than other days of the week, with videos published on Mondays receiving the most cumulative views on average (**Fig. 4**).

Tables 2–3 record the topic and metrics of our ten most viewed and ten least viewed videos. Our highest viewed video described an offset curb in Hayward, California that was famous among geologists for recording the continual slow motion along the Hayward Fault (part of the San Andreas fault system). Our least viewed videos were all published in either October or November 2021 when we first began our account. However, our second most viewed video was also published during this timeframe.

Of the account's over 2.1 million video views, 95% of those views came from videos shown on the *For You* page. Nearly twice as many videos were viewed on the Terra Explore profile page than on the *Following* feed. Videos were rarely discovered by a user directly searching for a specific hashtag (**Table 4**). Our most viewed videos received nearly all (~97%) of their views from the *For You* page. Videos with fewer views were shown to fewer viewers on the *For You* page and received a higher percentage of views from the Terra Explore profile page or the *Following* feed (**Fig. 5**).

As of February 2022, the Terra Explore account had 36.5% female and 63.5% male followers. This percentage remained relatively unchanged over the four-month duration of video posts (**Fig. 6**).

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

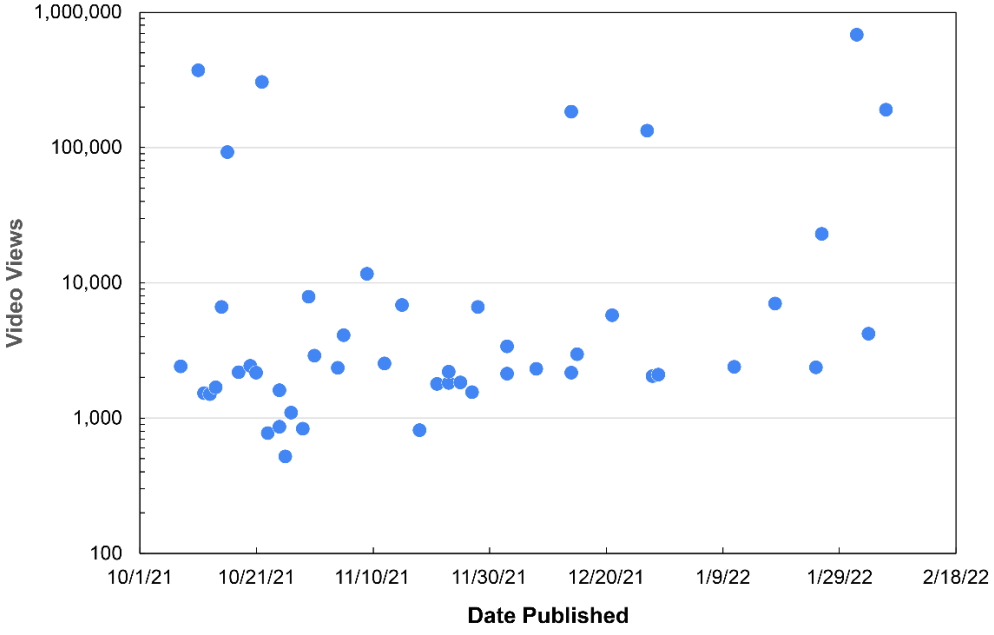
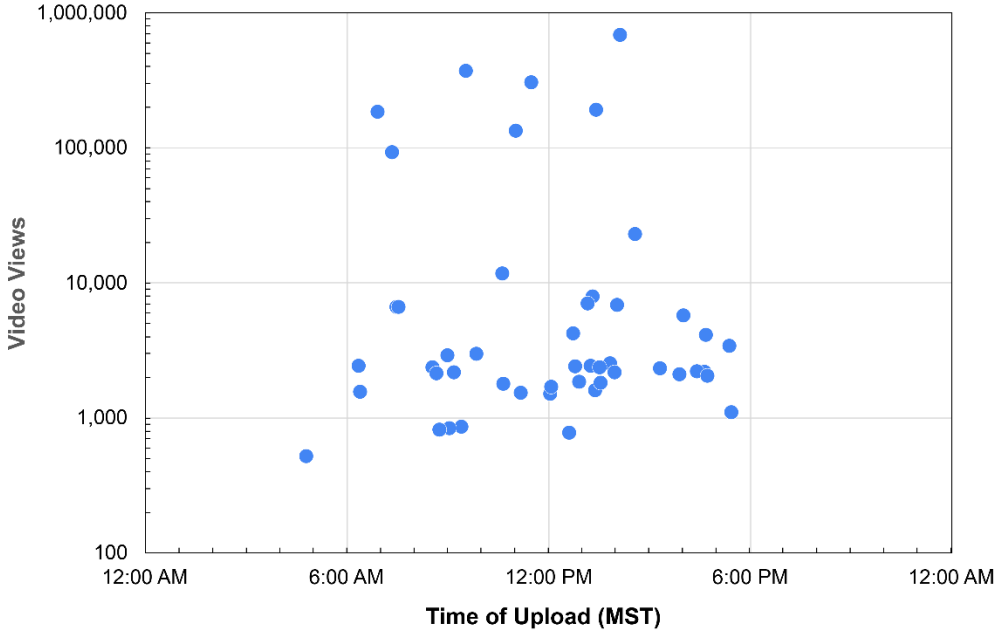


Figure 2. Number of video views each Terra Explore video received and the date that each video was posted on. Note video views are shown on a logarithmic scale.



195 **Figure 3. Time of video upload in Mountain Standard Time (MST) and the number of views the video received (on logarithmic scale). Videos that received the most views (>90,000) were uploaded in the morning or early afternoon.**

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

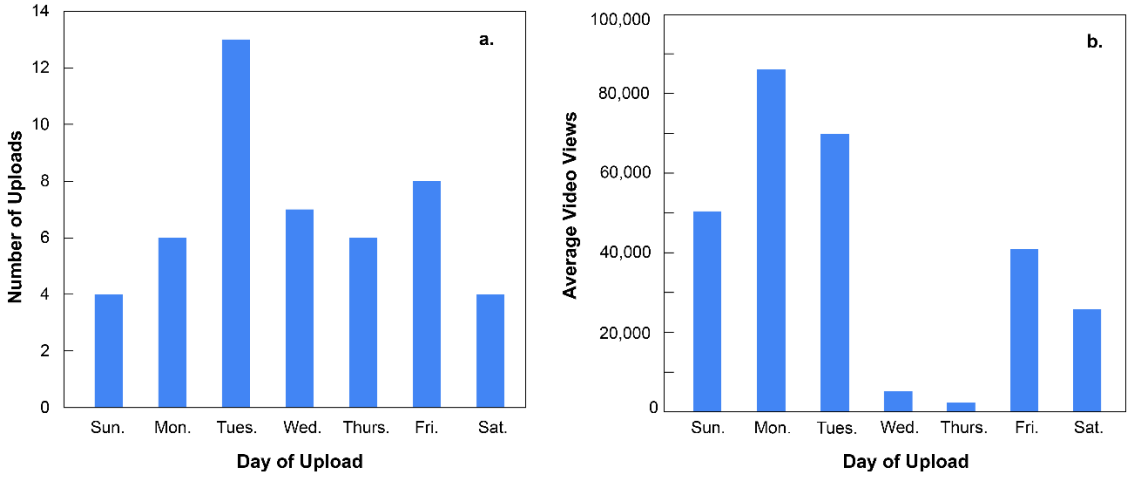


Figure 4. (a) The number of videos uploaded per day of the week. (b) The average total number of video views received based on the day of video upload.

Video Topic	Date Published	Duration (s)	Views	Likes	Comments	Shares	Avg. % Watched
Hayward, CA offset curb (Hayward fault creep)	2/1/2022	108	684,100	104,600	1,209	2,332	51
GMV of M6.2 Hawaii earthquake	10/11/2021	30	372,300	43,900	558	1,066	85
Demonstrating earthquake magnitude with spaghetti	10/22/2021	34	305,500	24,300	444	346	78
GMV of M7.3 Indonesia earthquake	12/14/2021	56	184,600	14,000	205	344	60
Hollister, CA fault creep and impact on infrastructure	2/6/2022	88	190,300	19,600	386	612	41
Wallace Creek (San Andreas Fault) stream offsets	12/27/2021	73	133,500	6,871	128	48	55
Lidar “x-ray vision” of Earth’s bare surface	10/16/2021	48	92,900	5,859	105	49	56
Cascadia 1700 earthquake and tsunami	1/26/2022	147	21,600	1,861	83	71	43.5
GMV of Nicaragua M6.2 earthquake	11/9/2021	39	11,700	1,102	37	29	55

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

Using lidar to uncover ancient Mesoamerican complexes	10/30/2021	47	7,896	1,339	20	13	53

Table 2. Top ten most viewed videos between 10/8/2021 and 2/6/2022 on the Terra Explore and corresponding metrics. GMV = ground motion visualization, M# = earthquake magnitude. All videos had an average viewer retention (how long a person watches the video) of 40% or higher. These videos correspond with #1–10 in Fig. 5.

Video Topic	Date Published	Duration (s)	Views	Likes	Comments	Shares	Avg. % Watched
Difference between earthquake magnitude and intensity	10/25/2021	57	1,606	189	4	6	34
Difference between hazard and risk	11/27/2021	38	1,562	110	1	1	36
Attending a scientific meeting, Geological Society of America 2021 meeting	10/12/2021	60	1,539	87	8	9	25
Earthquake yoga (Types of seismic waves)	10/13/2021	59	1,511	58	6	6	18
Different earthquake waves: P waves and S waves	10/27/2021	56	1,101	135	5	1	34
Call for 'Ask a Geoscientist' questions	10/25/2021	11	863	59	3	1	49
Demonstrating types of faults using candy bars	10/29/2021	59	840	110	6	5	35
Wave refraction explained	11/18/2021	39	815	62	1	0	37
How GPS is used to monitor Earth's systems	10/23/2021	50	775	78	4	1	27
Mandalorian "baby seismometer" meme	10/26/2021	9	522	27	1	0	76

Table 3. The ten least viewed videos and corresponding metrics on the Terra Explore account between 10/8/2021 and 2/6/2022. These videos correspond with #39–48 in Fig. 5.

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

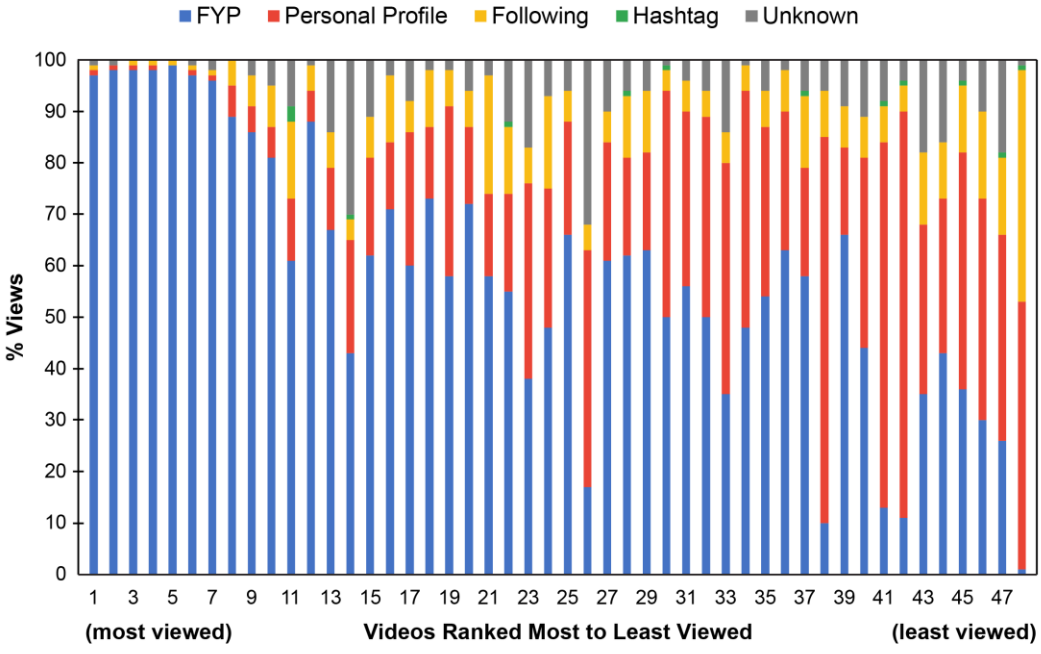


Figure 5. Percentage of video views by section (*For You* page, personal profile, *Following*, hashtag, unknown), with videos ranked from the most (1) to the least (48) viewed (See Tables 2 and 3 for the ten most and ten least viewed videos). The videos with the highest number of views received nearly all (~97%) of their views from the *For You* page. The seven most viewed videos each received over 90,000 views.

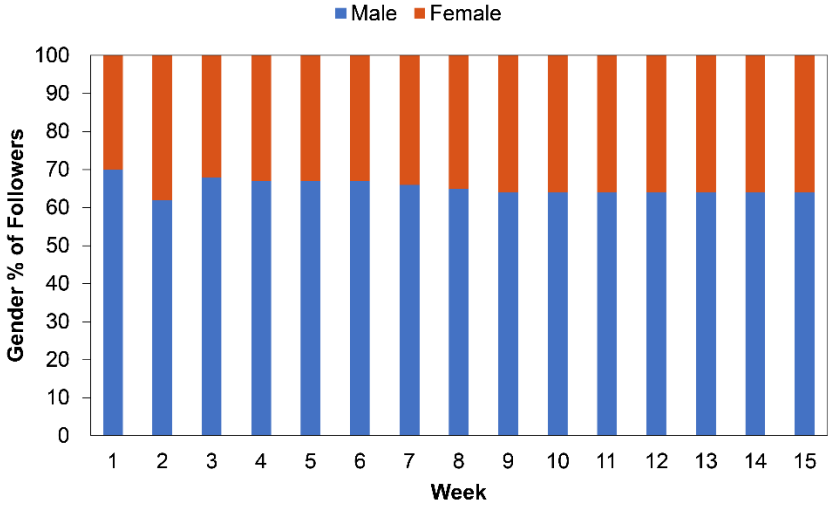


Figure 6. Gender percentage of followers during each week of posting, beginning 10/8/21 (week 1). A gender split of 64% male and 36% female followers remained relatively consistent throughout the period, ending 2/6/2022.

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

6.2 Viewer retention and engagement rate

The average percentage of watch time of a video was 44% of its duration, and on average 19% of users watched the full duration of a video. We evaluated the relationship between the average view duration of a video (viewer retention) and the number of video views based on the length of the video (< 30 seconds, 30 seconds to 1 minute, 1 to 2 minutes, and > 2 minutes in duration) (**Fig. 7**). Videos less than 30 seconds in length had the highest viewer retention, although this high viewer retention did not necessarily equate to higher video views. Videos that were between 30 seconds and 2 minutes in length most frequently received the highest number of views, although there lacks a clear relationship between viewer retention and the number of video views.

Videos had an average engagement rate of 10%, 0.38%, and 0.21% for likes, comments, and shares, respectively. These engagement rates are similar to the engagement rates of other analyzed educational science content on TikTok (Habibi and Salim, 2021). However, videos that received a large number of views (>90,000) did not necessarily have a higher engagement rate than videos with far fewer views (~2,000) (**Fig. 8**). Videos that received the lowest number of views (< 1,000) had engagement rates for likes and comments similar to other videos with more views, but they had among the lowest engagement rates for shares (some at 0%).

The average viewing duration largely did not show any relationship with engagement rate (**Fig. 9**). However, the viewer retention rate is in part linked to the duration of the video itself. Shorter videos (< 20 seconds) are more likely to have a higher viewer retention rate (**Fig. 7**), but these videos received some of the lowest overall engagement rates (**Fig. 10**). In fact, longer videos (>100 seconds) had among the highest engagement rates.

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

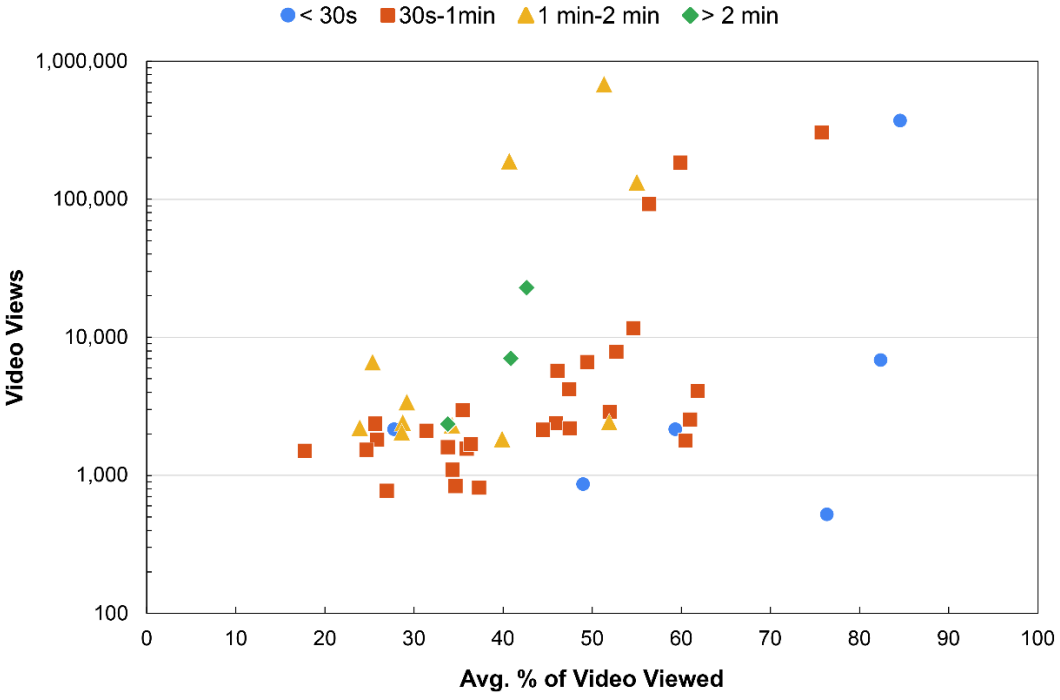
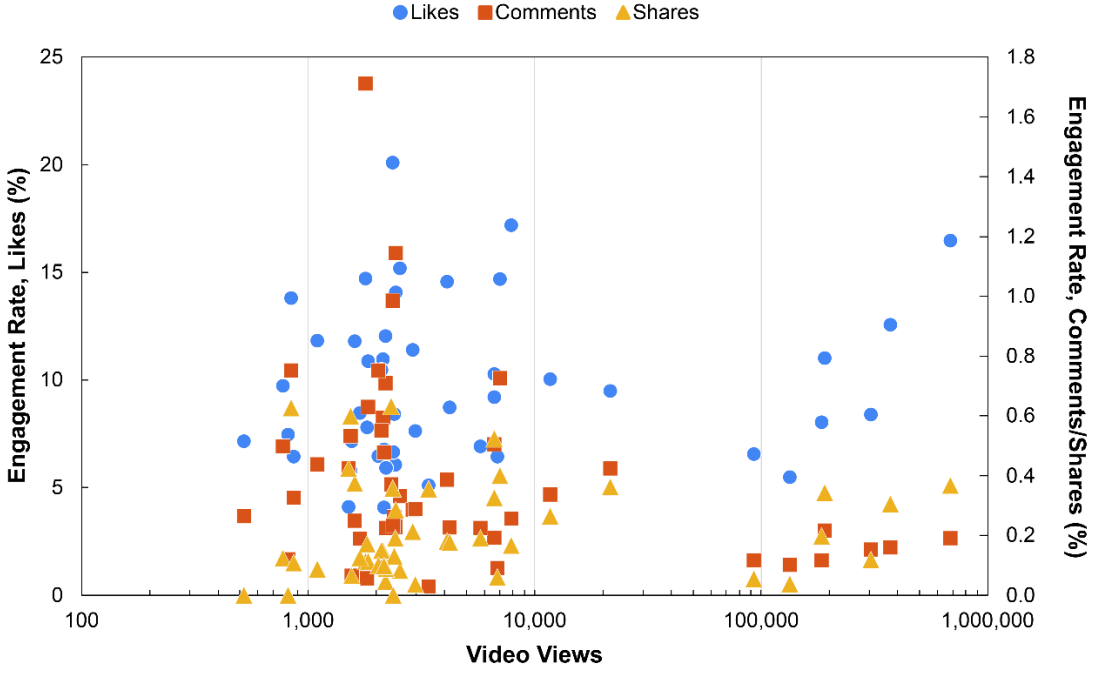
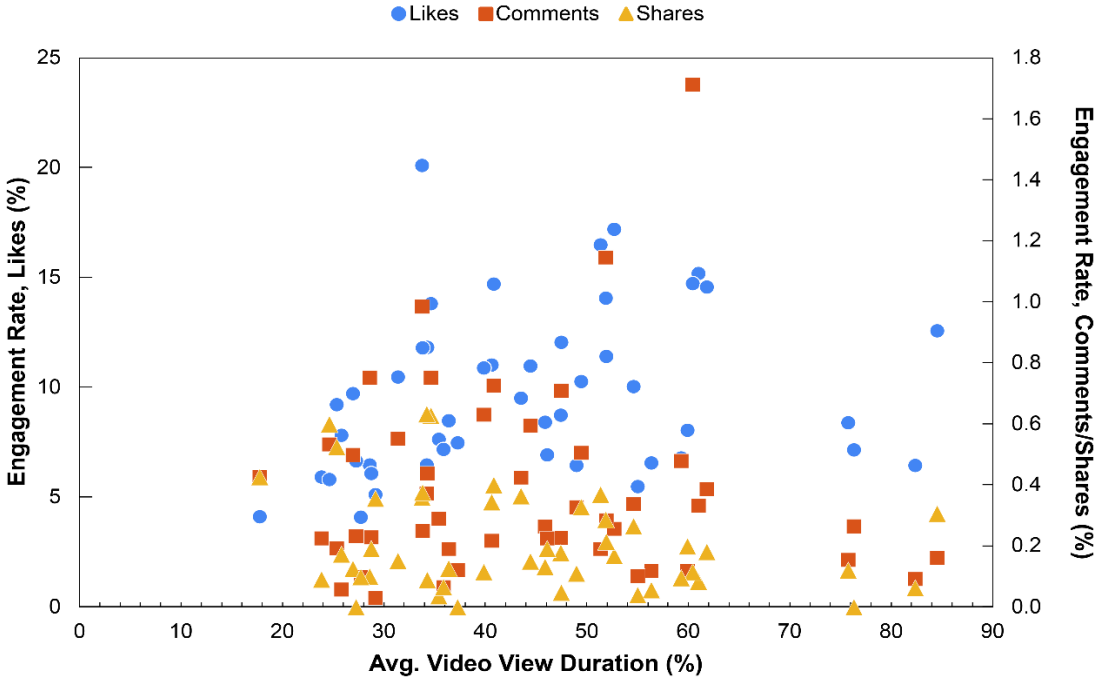


Figure 7. Average percentage of the video viewed (viewer retention) based on the length of the video (< 30 seconds, 30 seconds to 1 minute, 1 to 2 minutes, and > 2 minutes) compared to number of video views. Note that video views are shown on a logarithmic scale.



https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

Figure 8. Engagement rate of likes, comments, and shares from each video compared with video views (plotted on log scale). Videos with a lower number of video views (~2,000) could have engagement rates as high or higher than videos that received hundreds of thousands of views.



240

Figure 9. Engagement rates from each video compared with the average view duration (%) of the video.

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

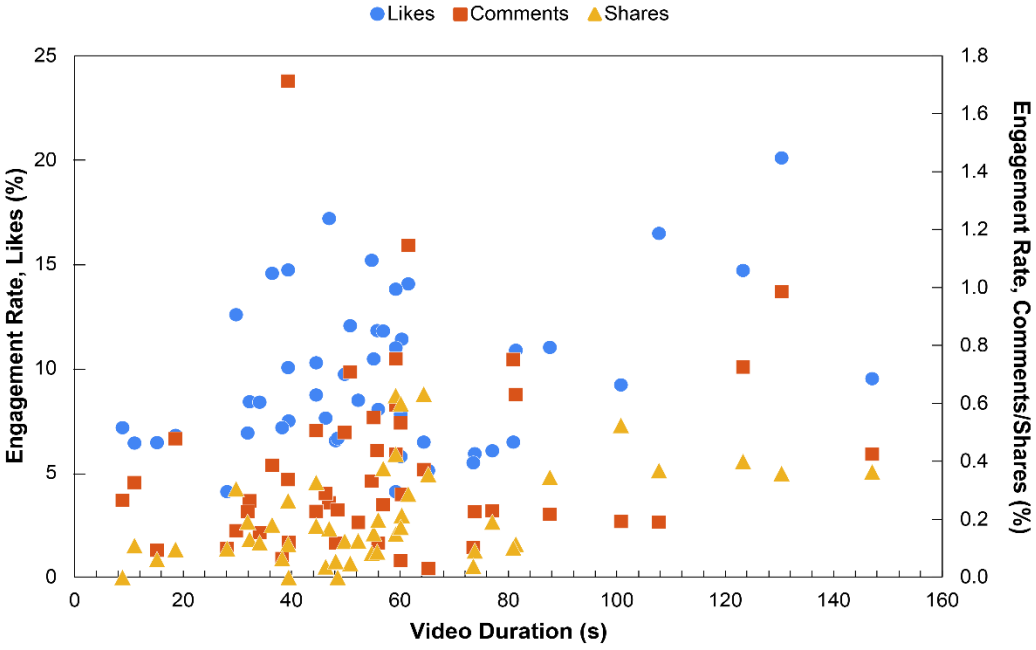


Figure 10. Engagement rates from each video compared with the duration of the video. Short videos under 20 seconds have a lower overall engagement rate than do longer videos.

6.3 Hashtags

Across our 48 published videos, we used a total of 81 unique hashtags. Our videos most commonly used the hashtags "geophysics," "geology," and "earthquake" (**Table 4**). Even though the hashtags "geophysics" and "geology" were used on the most videos, videos that used the hashtag "earthquake" generated the most cumulative views. Hashtags like "SanAndreas" and "California" that were only used in four videos were also associated with a large number of views.

Only one video had higher than 1% of its views come directly from searching for hashtags or clicking on a hashtag to view videos (video ranked number 11 on **Fig. 5**). A video explaining the Hunga Tonga-Hunga Ha'apai volcanic eruption in January 2022 received 3% of its views from direct hashtag searches. This post included the hashtags "HungaTonga" and "Tonga," from which the views were likely derived.

Between October 2021 and February 2022, the cumulative views of all videos using the "geology" hashtag across TikTok increased by 167.5 million views, with Terra Explore videos contributing 9% of those views, and the "geophysics" hashtag increased by 1.2 million views, with Terra Explore videos contributing 89% of those views.

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

Hashtag	# of Videos Used in	Cumulative Views
Geophysics	38	1,073,171
Geology	36	1,511,813
Earthquake	31	1,974,026
Seismology	22	949,459
Science	8	148,978
Lidar	6	110,251
GPS	5	12,190
LearnOnTiktok	5	32,854
SanAndreas	4	418,542
Earthquakes	4	11,651
FYP	4	15,079
California	4	1,013,653
Geoscience	3	4,221
Geodesy	3	5,861
SciComm	3	187,259

Table 4. Top 15 most commonly used hashtags on the Terra Explore videos indicating the number of videos they were used on, and the cumulative views associated with hashtag use. (FYP = "For You Page.")

6.4 GMV videos

Nine of the 48 videos produced featured ground motion visualizations (GMVs) of recent notable earthquakes. All nine of the GMV videos produced highlighted earthquakes that were magnitude 6 or larger. Views for these videos ranged between 2,106 and 372,300 views. All videos were under 60 seconds in length aside from one, which was 100 seconds long, and the videos with the most views had a duration between 30–60 seconds (**Fig. 11a**). The GMV videos that had the highest viewer retention rates received the most views, and videos with lower retention rates generally received fewer views (**Fig. 11b**). GMV videos ended up being posted relatively consistently throughout the period of video production (**Fig. 11c**), and videos were posted at different times during the day, with the videos that received the most views being posted in the morning Mountain Standard Time (MST) (**Fig. 11d**).

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

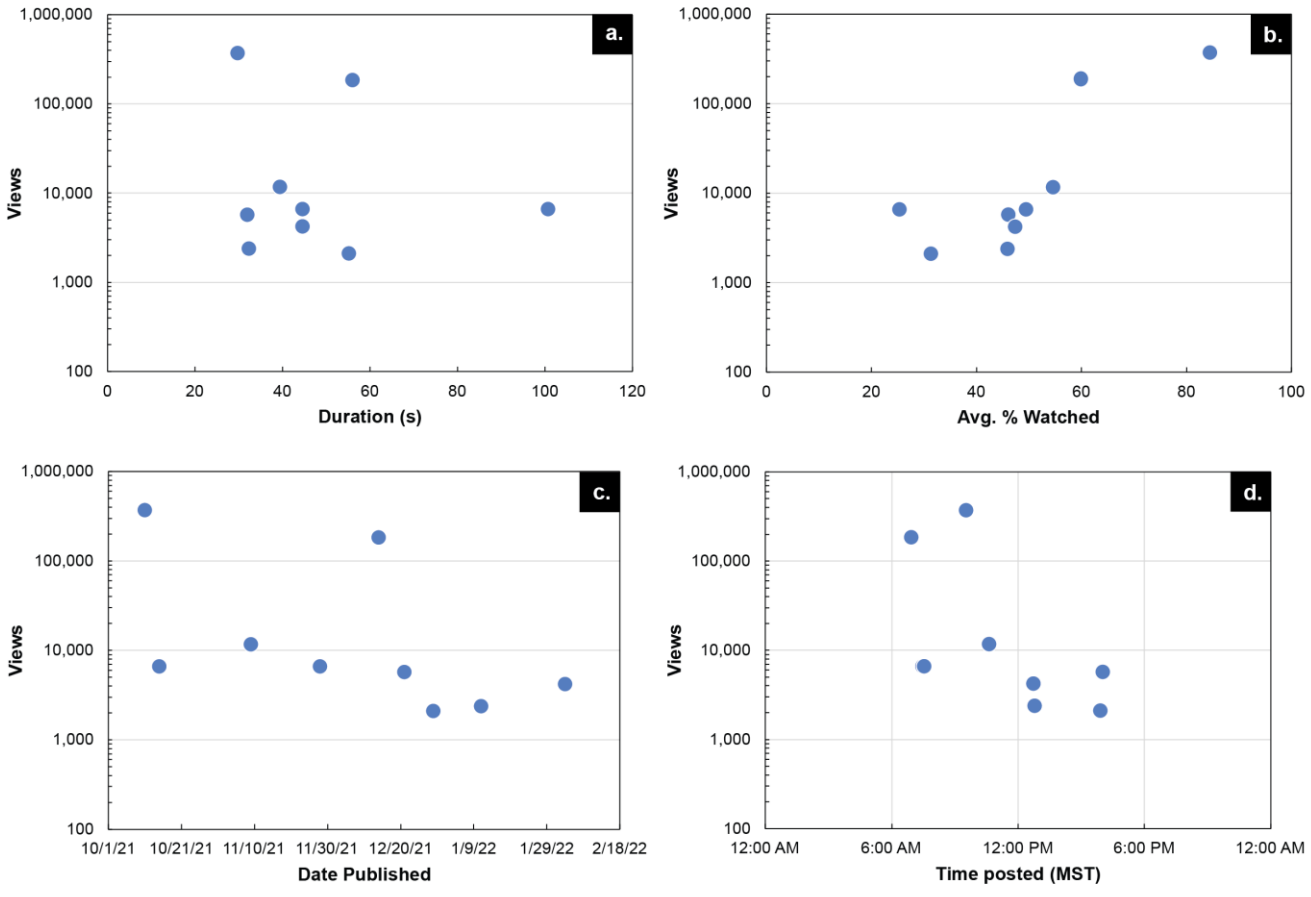


Figure 11. Video views of GMV videos on a log scale compared with (a) the duration of the video, (b) the average duration a video was watched, (c) the date the video was posted on, and (d) the time of day the video was posted (MST).

7 Discussion

7.1 Video views and viewership

Short videos (~20 seconds or less) on TikTok may have a higher potential to accumulate views as they can easily be played in a "loop" like a GIF, but our data does not indicate any clear correlation between video duration and number of video views (**Fig. 7**). Additionally, short (< 20s) videos had lower engagement rates than did longer videos. Videos 40 seconds to 2 minutes in length received the highest engagement rates (**Fig. 10**). Even though some of these videos did not perform exceptionally well in terms of view counts, they still tended to have relatively high engagement rates. Videos < 20 s had an average engagement rate of 6.5% for likes, whereas videos between 40 s and 2 minutes had an average engagement rate of 10% for likes. High engagement rates on videos with lower view counts likely come from people who are following the account

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

and have an express interest in the subject. Based on our findings, post-time optimization such as posting earlier in the day and earlier in the week may aid in having videos reach a wider audience.

The vast number of video views being received from the *For You* page rather than the *Following* feed demonstrates that content on TikTok is primarily consumed from the *For You* page, and that the success of a video largely hinges on whether it will continue to be shown to more users on the *For You* page. Our findings are in accordance with TikTok's internal data that users spend the vast majority of time (nearly 70%) on the *For You* page on the app (Stokel-Walker, 2020). With users spending less time on the *Following* feed, this feed naturally provides a lower overall source of video views. Our findings support other work showing that video views on TikTok are less dependent on the number of followers/subscribers as compared to other platforms like YouTube (Guinaudeau et al., 2021). While the number of followers can support the credibility of an account, a large number of followers is not required to reach a large viewership on TikTok.

Unlike platforms such as Twitter where users may search for a specific hashtag to view content related to a topic (Chang and Iyer, 2012), viewer behavior on TikTok largely does not entail searching for specific hashtags to view content. On average, only 0.02% of our video views came directly from hashtag searches. Thus, hashtags are most useful in categorizing content, which may aid in its algorithmic discovery on the *For You* page—although the factors used in TikTok's algorithm have not been publicly disclosed. The use of a hashtag itself will not necessarily determine the popularity of a video, but rather the hashtag is reflective of the content and subject matter of the video.

7.2 Generating high video reach and engagement

While post optimizations related to video length and posting time can aid in the discovery of a video, the content of the video itself is an equally important consideration when attempting to reach a wide audience and generate high engagement. Based on our most viewed videos (**Table 2**), we found that videos with the highest reach focused on recent newsworthy events (e.g., an earthquake) or discussed specific place-based geology.

Given our organizational missions, a high percentage of our video content focused on earthquakes and seismology, with all notable recent earthquakes being covered in GMV videos. These generated high interest by providing real-time videos about earthquakes in the news, shown in a data visualization format that was likely novel to the public. Additionally, by showing the motion recorded on seismometers across North America, users in those areas were able to view how the ground moved near them, adding a level of personal, place-based interest. We also found high reach and engagement with videos covering other relevant, newsworthy geology topics. For example, we produced videos covering the January 2022 Hunga Tonga-Hunga Ha'apai volcanic eruption and the anniversary of the January 1700 Cascadia earthquake and tsunami. These videos were our eleventh and eighth most viewed videos, respectively. The Hunga Tonga video had the sixth highest engagement rate for comments (0.7%), and the Cascadia 1700 earthquake video had the ninth highest engagement rate for shares (0.4%).

Videos describing geologic processes or features were most successful when they were tied to a specific, recognizable location. Based on user comments, videos that were about a geologic feature in a specific location that were tagged with

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

location indicators (e.g., #Hayward #California; #Hollister #California) were shown to many people who live in those cities. Although these users may not have previously interacted with or shown interest in geoscience content, we hypothesize that location-based information was used to deliver these videos to their *For You* page. Based on these video comments, the high engagement was generated in part by users from those geographic locations. Many commented that they were from the locations being covered; some recognized features in the town they were familiar with, and others learned something new and interesting about the geology of where they live.

In spite of these data, there is still complexity in understanding why certain videos perform better than others. We produced two demonstration videos using food as analogs for geologic concepts. A video using spaghetti strands to demonstrate earthquake magnitude received 305,500 views and was our third most viewed video (**Table 2**), while a video using Halloween candy bars to demonstrate types of faults received only 840 views and was our fourth least viewed video (**Table 3**). Both of these videos presented concepts that were made easy for the viewer to understand by using common food items, and they were both posted on the same day of the week (Friday) and before noon MST. It is possible that for demonstration videos like these—which are more analogous to chemistry or physics content showing experiments—that a shorter video duration is better for achieving high reach and engagement. The earthquake spaghetti video was 34 seconds long, while the candy bar faults video was 59 seconds long. A viewer may be more likely to watch a longer lecture-style video but may prefer shorter, dynamic demonstration videos.

7.3 Gender of viewers and target audiences

Although we used the hashtags #WomenInSTEM and #WomenInScience on a number of videos, the majority of the Terra Explore account's followers remained male (~64% male) (**Fig. 3**). Given the fact that 61% of users on TikTok are female (Statista, 2021), the gender breakdown of our followers is not representative of the demographics of TikTok users. The large percentage (25%) of TikTok users that are under the age of 19 (Statista, 2022a) represents a critical demographic for maintaining interest in STEM. Research has shown that STEM interest begins to decline in middle school, especially for girls (Archer et al., 2010; Riegle-Crumb et al. 2017; Sadler et al., 2012). Additionally, many students have little exposure to the geosciences during their K-12 education (Dodick and Orion, 2003; Lewis and Baker, 2010; Ridky, 2002), which means that young girls are often left without geoscience role models. Through TikTok, we can engage with this critical demographic and hope to inspire young women to continue an interest in pursuing STEM and see themselves as future STEM professionals.

However, the presentation of material by female scientists and the use of hashtags like #WomenInSTEM or #WomenInScience on TikTok may not be enough to gain female followers and viewership; the content itself may also have to focus on gender. Experience from the lead author's personal TikTok account suggests that women and nonbinary individuals may be more likely to receive videos about gender discrimination and gender disparity on their *For You* page than educational science content. On the lead author's personal TikTok account, a video discussing how their follower base had become overwhelmingly male (75% male followers) used the #WomenInSTEM hashtag. The video gained wide female and nonbinary viewership, and the percentage of followers flipped to 86.1% female. The second author also had a similar experience on their

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

personal TikTok after making a series of posts about the IF/THEN organization and International Women's Day, with male following decreasing from 65% to 17%.

As TikTok does not provide information about the age of followers or viewers, we are unable to evaluate the full demographics of who our videos reach. Future work may benefit from the utilization of the paid "Promote" feature, an advertising tool used to gain views and followers. This feature allows the selection of particular viewing demographics, as well as a more granular breakdown of viewers, including enhanced gender reporting.

7.4 Ethics of TikTok data usage

When conducting research on social media platforms, it is necessary to address the ethical issues related to privacy, anonymity, and consent of human subjects (Vitak et al., 2016). Kanthawala et al. (2022) highlights the specific ethical considerations related to research on TikTok given its heavier dependence on algorithmic curation and its younger user base. More so than other social media platforms, TikTok has faced scrutiny over the data that it collects from its users and user security. TikTok has previously paid $92 million to settle dozens of lawsuits that allege that users' personal data was tracked and sold to advertisers in violation of state and federal law (Allyn, 2021). There additionally has been scrutiny over the biometric data including "faceprints" and "voiceprints" that TikTok can now collect from users (McCluskey, 2021).

According to TikTok's privacy policy, TikTok collects information that the user provides when creating an account, such as their name, age, and email, as well as information from other sources, such as linked social media accounts and third-party services, and device information, including the user's approximate location (TikTok, 2021b). By creating a user account and agreeing to the terms and conditions, TikTok users provide their 'consent' to have their information collected. However, many users are unlikely to read the privacy policy when creating an account and will not be aware of what they are consenting to.

Although TikTok provides analytical information about the gender breakdown of an account's followers, users do not provide information on their gender when registering for an account. We hypothesize that TikTok either acquires gender information through connected social media accounts or assumes the gender of an account based on a user's activity on the app. We are therefore unable to determine how accurate the information provided on the gender of followers is and whether users are aware that this information is assumed or collected on their behalf.

The information and data we analyze in this study is essentially restricted to video view duration and engagement metrics and is not related to personal user information that TikTok may collect. We do not evaluate or analyze the individual followers of the Terra Explore account or include specific comments from any users, providing full anonymity. The data on video views, likes, comments, and shares is fully publicly available to all users, and only total cumulative play time, average duration the video was watched, percentage of viewers who watched the full video, and the percentage of video views by section is private to the account user. Therefore, the data used is largely public and there is minimal risk to the individual users from this research. While TikTok as a platform may have larger ethical concerns that are beyond the scope of this study, we argue that the data used in this research is ethical.

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

7.5 Potential for science communication on TikTok

Data collected over this four-month timespan demonstrates that TikTok provides unparalleled potential for reach and growth of science communication. As a brand-new account, the second video we posted gained over 165,000 views within the first few days and now has over 370,000 views. The algorithm-driven (rather than follower-driven) nature of TikTok creates a low barrier of entry for new creators. An account does not have to focus on creating a large following in order to achieve a wide reach. As well, there are no materials required to produce content other than a mobile smartphone with a camera. However, given that views from the *Following* feed constitute a low overall percentage of views, there may be pressure to constantly produce "viral" videos that are shown widely on the *For You* page. Having a large number of followers does not guarantee that a video will be seen by a large number of people.

Despite potential shortcomings, TikTok presents an unquestionable opportunity to deliver educational science videos to wide audiences with relatively little effort. All six Terra Explore videos related to lidar were cross-posted on OpenTopography's YouTube channel as "Shorts," which is YouTube's TikTok-like short-form video category. The OpenTopography YouTube channel had 1,900 subscribers at this time. These videos received an average of only 34 views on YouTube, while the same videos received between 2,422 and 133,500 views on TikTok. The vast discrepancy in views of the exact same videos posted on different platforms highlights the benefits of TikTok's recommendation algorithm in reaching a wide audience.

A potential challenge is that TikTok videos require an engaging, charismatic video presenter: two people could create the same video, but one video might perform significantly better if one host has a more natural, charismatic presentation style. We have not evaluated how this factor impacts video performance. In addition to the content of the video itself, practice in the presentation style of videos (which is beyond the scope of this study) is also an important component for science communicators to consider.

We thus recommend the following for the best chances of high reach and engagement with science communication on TikTok:

- Produce lecture-style videos using greenscreen and image overlay effects that are approximately 60 seconds in duration.
- Produce demonstration or experiment-style videos that are $\leq$ 30 seconds in duration.
- Post videos earlier in the day and earlier in the week and maintain a relatively consistent posting schedule.
- Choose video topics that are related to recent newsworthy events or are tied to a specific place or location.
- Include gender-related topics to reach a wider female audience.
- Select hashtags that are relevant to the video topic, especially ones including locations.
- Pay attention to videos that receive the majority of their views from the *For You* page and work to replicate those qualities.

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

8 Future plans

As we continue to run the Terra Explore account, we plan to expand the scope of the geoscience topics that we cover and to continue analyses of how to best maximize reach and engagement from these videos. While the geoscience content of our videos has been largely focused on earthquakes thus far, we plan to include discussion of other natural hazards like volcanic eruptions, floods, landslides, etc. This expansion naturally segues into an opportunity to produce content related to climate and climate change. Encouraging science curiosity helps to neutralize polarization on topics like climate change (Kahan et al., 2017), and TikTok provides an ideal platform to promote such curiosity.

While all of our videos produced thus far have been created in home offices, we believe producing content from the field could generate high video views and user engagement. Instead of merely showing photos, field-based videos could present and highlight seismic or GPS instruments and their installation and maintenance, geologic features you can see in the field, or how drones are used in geoscience, among many other possibilities. Given the more costly and time-intensive nature of producing videos on location, a full analysis of their metrics would be necessary to see if they have higher reach and engagement than similar videos produced in home offices.

To better reach target audiences like young women and girls and to improve the overall diversity of scientists shown in popular media, we would like to produce a "Meet the Scientist" video series to highlight female and nonbinary geoscientists, sharing both their research and experiences. These types of videos would complement and expand on the IF/THEN "Women in Geoscience" video series available on the IRIS YouTube channel that features women in the geosciences sharing their work and interests. The geosciences remain one of the least racially and ethnically diverse out of all the STEM fields (Bernard and Cooperdock, 2018), and "Meet the Scientist" interviews featuring underrepresented scientists on TikTok will help to increase the visibility of minoritized scientists and show the broad diversity of scientists and careers that exist in geoscience.

9 Conclusions

TikTok offers unparalleled potential for reach and growth of science communication content. TikTok functions primarily on a model of algorithmic recommendations rather than a follower-based model, which provides a low barrier to entry for new creators. Although the exact nature of the TikTok algorithm is unknown and therefore somewhat challenging in reaching target audiences, particular features, such as the "Promote" tool, may provide additional insight into demographics engaging with content. In the assessment of our geoscience content, lecture-style videos that were in the range of 40 seconds to 2 minutes yielded the highest reach and engagement. Video topics that discussed recent newsworthy events (i.e., earthquakes) or discussed specific place-based geology resulted in the highest reach and engagement. Shorter-form content (< 30 seconds) did not perform as well unless it was a demonstration-style video, which would be more analogous to the physics and chemistry experiments that are commonly seen on TikTok. Unlike other platforms, user behavior on TikTok does not entail searching for or browsing specific hashtags to view videos. Rather, videos are predominantly viewed via the *For You* page, and hashtags provide a way to categorize and describe content—information which may or may not be used by TikTok's

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

AI to show the video to audiences. Although this study focuses on the geosciences, we anticipate that our findings will be broadly applicable to other scientific disciplines and will allow science communicators success in reaching broad audiences.

Data availability

The video data analyzed in this study is accessible at https://doi.org/10.6084/m9.figshare.20069333 (Zawacki, 2022).

Author contributions

The Terra Explore videos analyzed here were created by EZ and WB, in addition to SJ. DC provided project administration and coordination. EZ collected and analyzed the data and wrote the primary draft. WB, SJ, and DC contributed to the writing, review, and editing.

Competing interests

The authors declare that they have no conflict of interest.

Acknowledgements

We thank Christopher Crosby for project guidance.

Financial statement

This work was supported by NSF awards #1724794, #1948997, #1948994, and #1948857.

References

Allyn, B. (2021, February 25). "TikTok to Pay $92 Million to Settle Class-Action Suit over 'Theft' of Personal Data." *NPR*. Retrieved June 14, 2022 from, https://www.npr.org/2021/02/25/971460327/tiktok-to-pay-92-million-to-settle-class-action-suit-over-theft-of-personal-data.

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2013). 'Not girly, not sexy, not glamorous': Primary school girls' and parents' constructions of science aspirations. Pedagogy, Culture & Society, 21(1), 171-194. https://doi.org/10.1080/14681366.2012.748676

Azman, A. N., Rezal, N. S. A., Zulkeifli, N. Y., Mat, N. A. S., Saari, I. S., & Ab Hamid, A. S. (2021). Acceptance of TikTok on the Youth towards Education Development. *Borneo International Journal*, eISSN 2636-9826, 4(3), 19-25. Retrieved February 11, 2022 from http://majmuah.com/journal/index.php/bij/article/view/98

Basch, C. H., Yalamanchili, B., & Fera, J. (2022). #Climate Change on TikTok: A Content Analysis of Videos. *Journal of Community Health*, 1-5. https://doi.org/10.1007/s10900-021-01031-x

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

Bernard, R. E., & Cooperdock, E. H. (2018). No progress on diversity in 40 years. *Nature Geoscience*, 11(5), p. 292-295. https://doi.org/10.1038/s41561-018-0116-6

Briskman, J. (2020, April). Sensor Tower's Q1 2020 Data Digest: Exploring COVID-19's Impact on the Global App Ecosystem. *Sensor Tower*. Retrieved February 15, 2022, from https://sensortower.com/blog/q1-2020-data-digest

Chang, H. C., & Iyer, H. (2012). Trends in Twitter hashtag applications: Design features for value-added dimensions to future library catalogues. *Library Trends*, 61(1), 248-258.

Côté, I. M., & Darling, E. S. (2018). Scientists on Twitter: Preaching to the choir or singing from the rooftops?. *Facets*, 3(1), 682-694. https://doi.org/10.1139/facets-2018-0002

Dodick, J., & Orion, N. (2003). Geology as an historical science: Its perception within science and the education system. *Science & Education*, *12*(2), 197-211. https://doi.org/10.1023/A:1023096001250

Draganić, K., Marić, M., & Lukač, D. (2021). An application of TikTok in higher education. *E-Business Technologies Conference Proceedings*, 1(1), 114–119. Retrieved February 11, 2022 from https://ebt.rs/journals/index.php/conf-proc/article/view/75

Escamilla-Fajardo, P., Alguacil, M., & López-Carril, S. (2021). Incorporating TikTok in higher education: Pedagogical perspectives from a corporal expression sport sciences course. *Journal of Hospitality, Leisure, Sport & Tourism Education*, 28, 100302. https://doi.org/10.1016/j.jhlste.2021.100302

Feldkamp, J. (2021). The rise of TikTok: The Evolution of a social media platform during COVID-19. In *Digital Responses to Covid-19* (pp. 73-85). Springer, Cham. https://doi.org/10.1007/978-3-030-66611-8_6

Guinaudeau, B., Vottax, F., & Munger, K. (2021). Fifteen Seconds of Fame: TikTok and the Supply Side of Social Video. https://osf.io/zvq8w/

Hautea, S., Parks, P., Takahashi, B., & Zeng, J. (2021). Showing they care (or don't): Affective publics and ambivalent climate activism on TikTok. *Social Media + Society*, 7(2), 20563051211012344. https://doi.org/10.1177/20563051211012344

Hilary, I. O., & Dumebi, O. O. (2021). Social Media as a Tool for Misinformation and Disinformation Management. *Linguistics and Culture Review*, 5(S1), 496-505. https://doi.org/10.21744/lingcure.v5nS1.1435

Habibi, S. A., & Salim, L. (2021). Static vs. dynamic methods of delivery for science communication: A critical analysis of user engagement with science on social media. *PloS One*, 16(3), e0248507. https://doi.org/10.1371/journal.pone.0248507

Hayes, C., Stott, K., Lamb, K. J., & Hurst, G. A. (2020). "Making every second count": utilizing TikTok and systems thinking to facilitate scientific public engagement and contextualization of chemistry at home. *Journal of Chemical Education*, 97 (10), 3858-3866. https://doi.org/10.1021/acs.jchemed.0c00511

Hight, M. O., Nguyen, N. Q., & Su, T. A. (2021). Chemical anthropomorphism: acting out general chemistry concepts in social media videos facilitates student-centered learning and public engagement. *Journal of Chemical Education*, 98(4), 1283-1289. https://doi.org/10.1021/acs.jchemed.0c01139

Insider Intelligence (2021, December 16). TikTok is the third largest worldwide social network behind Instagram and Facebook. *eMarketer Newsroom.* Retrieved March 16, 2022 from, https://www.emarketer.com/newsroom/index.php/tiktok-is-the-third-largest-worldwide-social-network-behind-instagram-and-facebook/

Jahng, M. R., & Lee, N. (2018). When scientists tweet for social changes: Dialogic communication and collective mobilization strategies by Flint water study scientists on Twitter. *Science Communication*, 40(1), 89-108. https://doi.org/10.1177/1075547017751948

Kanthawala, S., Cotter, K., Foyle, K., & DeCook, J. R. (2022, January). It's the Methodology For Me: A Systematic Review of Early Approaches to Studying TikTok. In HICSS (pp. 1-17). https://hdl.handle.net/10125/79716

Kirchhoff, D. (2021, July 1). More Tok on the Clock: Introducing longer videos on TikTok. *TikTok Newsroom*. Retrieved February 14, 2022, from https://newsroom.tiktok.com/en-us/longer-videos

Kahan, D. M., Landrum, A., Carpenter, K., Helft, L., & Hall Jamieson, K. (2017). Science curiosity and political information processing. *Political Psychology*, 38, 179-199. https://doi.org/10.1111/pops.12396

Lewis, E. B., & Baker, D. R. (2010). A call for a new geoscience education research agenda. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *47*(2), 121-129. https://doi.org/10.1002/tea.20320

https://doi.org/10.5194/egusphere-2022-494
Preprint. Discussion started: 22 June 2022

McCluskey, M. (2021, June 14). TikTok Has Started Collecting Your 'Faceprints' and 'Voiceprints.' Here's What It Could Do With Them. *Time*. Retrieved June 14, 2022 from https://time.com/6071773/tiktok-faceprints-voiceprints-privacy/.

Ridky, R. (2002). Why We Need a Corps of Earth Science Educators. *Geotimes*, *47*(9), 16-19.

Riegle-Crumb, C., & Morton, K. (2017). Gendered expectations: Examining how peers shape female students' intent to pursue STEM fields. *Frontiers in psychology*, *8*, 329. https://doi.org/10.3389/fpsyg.2017.00329

Sadler, P. M., Sonnert, G., Hazari, Z., & Tai, R. (2012). Stability and volatility of STEM career interest in high school: A gender study. *Science Education*, 96(3), 411-427. https://doi.org/10.1002/sce.21007

Schmitt, M., & Jäschke, R. (2017). What do computer scientists tweet? Analyzing the link-sharing practice on Twitter. *PloS One*, 12(6), e0179630. https://doi.org/10.1371/journal.pone.0179630

Shu K., Wang S., Lee D., Liu H. (2020). Mining Disinformation and Fake News: Concepts, Methods, and Recent Advancements. In: Shu K., Wang S., Lee D., Liu H. (eds) *Disinformation, Misinformation, and Fake News in Social Media*. Lecture Notes in Social Networks. Springer, Cham. https://doi.org/10.1007/978-3-030-42699-6_1

Smith, A. (2015). "Wow, I didn't know that before; thank you": How scientists use Twitter for public engagement. *Journal of Promotional Communications*, 3(3), 320-339.

Smith, B. (2021, December 6). How TikTok Reads Your Mind. *The New York Times*. Retrieved March 16, 2022, from https://www.nytimes.com/2021/12/05/business/media/tiktok-algorithm.html

Statista Research Department. (2022a, January). Distribution of TikTok users in the United States as of September 2021, by age group. *Statista*. Retrieved February 14, 2022, from https://www.statista.com/statistics/1095186/tiktok-us-users-age/

Statista Research Department. (2022b, January). Number of first-time TikTok installs from 2nd quarter 2016 to 4th quarter 2021. *Statista*. Retrieved March 16, 2022, from https://www.statista.com/statistics/1078692/china-tiktok-worldwide-downloads-quarterly/

Statista Research Department. (2021, April). Distribution of monthly active TikTok users in the United States as of March 2021, by gender. *Statista*. Retrieved February 14, 2022, from https://www.statista.com/statistics/1095201/tiktok-users-gender-usa/

Stokel-Walker, C. (2020). Inside TikTok's latest big pitch to advertisers with new numbers showing time spent on the app and engagement metrics. *Business Insider*. Retrieved February 8, 2022, from https://www.businessinsider.com/leaked-tiktok-slides-engagement-time-spent-activity-2020-9

TikTok (2021a, September 27). "Thanks a billion!" *TikTok Newsroom*. Retrieved February 8, 2022, from https://newsroom.tiktok.com/en-us/1-billion-people-on-tiktok

TikTok (2021b, June 2). "Privacy Policy." *TikTok Legal*. Retrieved June 14, 2022, from https://www.tiktok.com/legal/privacy-policy-us?lang=en

TikTok (2010, June 18). "How TikTok Recommends Videos #ForYou." *TikTok Newsroom*. Retrieved February 8, 2022, from https://newsroom.tiktok.com/en-us/how-tiktok-recommends-videos-for-you/

Thoensen, B. (2020, May 28). Investing to help our community #LearnOnTikTok. *TikTok Newsroo*m. Retrieved February 8, 2022, from https://newsroom.tiktok.com/en-us/investing-to-help-our-community-learn-on-tiktok

Vitak, J., Shilton, K., & Ashktorab, Z. (2016, February). Beyond the Belmont principles: Ethical challenges, practices, and beliefs in the online data research community. In Proceedings of the *19th ACM conference on computer-supported cooperative work & social computing* (pp. 941-953). https://doi.org/10.1145/2818048.2820078

Zawacki, Emily (2022): TikTokData.xlsx. *figshare*. Dataset. https://doi.org/10.6084/m9.figshare.20069333.v1

Zeng, J., Schäfer, M. S., & Allgaier, J. (2020). Reposting "till Albert Einstein is TikTok famous": The memetic construction of science on TikTok. *International Journal of Communication*, 15, 3216-3247. https://doi.org/10.5167/uzh-205429