Revista Latina de Comunicación Social
ISSN 1138-5820 / No. 82, 01-18.
https://doi.org/10.4185/rlcs-2024-2232

Video features that favor the engagement of science communicators on TikTok

Características de los videos que favorecen el engagement de losdivulgadores científicos en TikTok

Davis Velarde-Camaqui
Tecnológico de Monterrey (Monterrey Institute of Technology), Mexico.
a00832505@tec.mx

Cristina Viehmann
Tecnológico de Monterrey (Monterrey Institute of Technology), Mexico.
a00807496@tec.mx

Rosa Diaz
Tecnológico de Monterrey (Monterrey Institute of Technology), Mexico.
a00832504@tec.mx

Gabriel Valerio-Ureña
Tecnológico de Monterrey (Monterrey Institute of Technology), Mexico
gvalerio@tec.mx

How to cite this article / Standardized reference:

Velarde-Camaqui, Davis; Viehmann, Cristina, & Valerio-Ureña, Gabriel (2024). Video features that favor the engagement of science communicators on TikTok [Características de los videos que favorecen el engagement de los divulgadores científicos en TikTok]. *Revista Latina de Comunicación Social*, 82, 01-18. https://www.doi.org/10.4185/RLCS-2024-2232

Receipt Date: 10/09/2023
Acceptance Date: 31/01/2023
Publication Date: 28/02/2024

ABSTRACT

Introduction: Science dissemination seeks to involve the public in science and stimulate discussion on scientific topics. This practice has extended in recent years thanks to the boom in social networks. Among these networks, TikTok has become a medium for science literacy, particularly among a young audience.

Methodology: For the methodological approach, a mixed stance was used. The objective of this research was to describe the features of the content associated with engagement in Spanish-speaking science communicators through TikTok. The contents (videos) of 10 broadcasters who use a TikTok account to disseminate their contents were analyzed. The format, type and content of 94 videos shared by these broadcasters between August and December 2022 were analyzed. **Results:** It was found that some of the features related to higher engagement were: video length (>60 seconds), number of hashtags (between 5 and 10), use of animated infographics, news presentation, adherence to the stated mission (typically disseminating science) and not making videos for advertising purposes. **Discussion:** Although the study of digital engagement in social networks is not new, the particular case of science communicators in social networks is still a new field. **Conclusions:** The results of this study can be important inputs to help science communicators improve their level of engagement.

Keywords: Science dissemination; Science outreach; Digital engagement; TikTok; Engagement; Science communication.

RESUMEN

Introducción: La divulgación científica busca involucrar al público en la ciencia y estimular la discusión sobre temas científicos. Esta práctica se ha extendido en los últimos años gracias al auge de las redes sociales. Entre estas redes, TikTok se ha convertido en un medio para alfabetizar en temas de ciencia, particularmente ante una audiencia joven. **Metodología:** El acercamiento metodológico se hizo a través de una postura mixta. El objetivo de esta investigación fue describir las características que tiene el contenido que se asocia con el *engagement* en los divulgadores científicos de habla hispana a través de TikTok. Se analizaron los contenidos (videos) de 10 divulgadores que utilizan una cuenta de TikTok para difundir sus contenidos. Se analizó el formato, tipo y contenido de 94 videos que compartieron dichos divulgadores entre agosto y diciembre de 2022. **Resultados:** Se encontró que algunas de las características relacionadas con un mayor *engagement* fueron: la longitud del video (>60 segundos), el número de *hashtags* (entre 5 y 10), el uso de infografías animadas, la presentación de noticias, el apego a la misión declarada (típicamente divulgar ciencia) y el no hacer videos con fines publicitarios. **Discusión:** Aunque el estudio del *engagement* digital en las redes sociales no es nuevo, el caso particular de los divulgadores científicos en redes sociales es aún un campo novel. **Conclusiones:** Los resultados de este estudio pueden ser insumos importantes para ayudar a los divulgadores de ciencia a mejorar su nivel de *engagement*.

Palabras clave: Divulgación científica; *Engagement* digital; TikTok; Interacción.

1. Introduction

Science dissemination has existed since the 19th century, with the purpose of making science more accessible to the general public (Weingart and Guenther, 2016). Habibi and Salim (2021) describe science outreach as "the practice of engaging the public in science and stimulating discussion and speech of scientific issues." Currently, science communication is divided into three categories (Hodson, 2020):

a) communication among scientists, through research journals and conference papers;

b) dissemination and outreach of knowledge generated by the scientific community, through newspapers, journals, television and Internet websites and;

c) formal education, through textbooks and other educational materials.

This research focuses on the second category, specifically on the dissemination and outreach of knowledge through social networks, in this case TikTok. There are two main reasons for this approach. First, in recent years, traditional media, such as newspapers and television, have lost popularity, and people, especially young people, have moved to alternative media such as the Internet and social networks to obtain scientific news gaining even more credibility (Brossard and Scheufele, 2013; STATISTA, 2023). Second, the authors of this research are interested in the non-formal aspect of education and what scientists, teachers and other experts share through social networks to stimulate discussion about science beyond the classroom.

"The use of background music does not seem to impact the engagement with the audience of science communicators..."

Computer technology and the development of social networks are bringing about massive changes in education and the way students learn and interact with society. During the COVID-19 pandemic, the importance of combating fake news in the electronic media led to the emergence of more alert science communication adapted to current forms. Science educators are increasingly incorporating online teaching and learning as well as social networking into their classrooms and teaching methods. Science classrooms are increasingly moving away from the traditional classroom style, gradually moving toward "content in the form of videos, experimentation, and discovery" (Habibi and Salim, 2021).

Despite the growing importance of social networks in science education and communication, there is relatively little research on how TikTok is transforming educational environments and online learning (Escamilla-Fajardo et al., 2021). The COVID-19 pandemic positively influenced the study of the relationship between TikTok and science dissemination, as it became a popular tool for science broadcasters to connect with their audience and transmit scientific information in an accessible and attractive way. Therefore, this research seeks to identify the video features that favor the engagement of science broadcasters through TikTok.

The TikTok platform is characterized by the ability to record, edit and share short videos with the possibility of adding visual effects, sounds and background music. In 2021, the video length limit was extended to three minutes, and ByteDance is currently experimenting with videos up to ten minutes (Hutchinson, 2022). Educational videos on digital platforms are an engaging and customizable form of learning, especially for the younger generation, and are particularly well suited for science content because of the simplified explanations and visual demonstrations they can provide (Beautemps and Bresges, 2021; Zeng et al., 2020).

During the COVID-19 pandemic, TikTok became one of the most popular social networking platforms, especially to meet the entertainment needs of the millions of people who were isolated in their homes (Habibi and Salim, 2021).

Currently, TikTok has over one billion monthly active users (TikTok, 2022) and is exceptionally popular among the younger generation, with 25% of users under the age of 19 (Statista Research Department, 2022). Children and adolescents watch an average of 91 minutes of TikTok per day, compared to 56 minutes of YouTube, globally (Perez, 2023). The TikTok platform has evolved beyond entertainment and integrated science communication efforts during the COVID-19 pandemic. TikTok made available $250 million US dollars to support frontline medical workers, educators, and local communities deeply affected by the global crisis (TikTok, 2021).

With the growing popularity of TikTok among users of all ages, there is an excellent opportunity for scientists to strategically examine how to use social networks to expand their reach and create a more scientifically literate audience. According to Zawacki et al. (2022), TikTok can be a platform to foster scientific engagement and outreach; it has become a valuable tool for scientific communication, and its popularity among young people and the availability of a large audience make it an important resource for scientific outreach.

To understand the nature of engagement in TikTok, first of all, it should be noted that the concept of engagement refers to a mental state that makes the individual enjoy the representation of an action or object (Laurel, 1993), or the fact of being involved with something (Cambridge University Press, n.d.). This concept can acquire different meanings depending on the context in which it is used. For the purposes of this paper, we are interested in addressing digital engagement. Digital engagement has been described, in the context of social networks, as the set of reactions that a follower has to a message received (Valerio et al., 2014).

Regarding the possible reactions on the TikTok platform, the degree of engagement with the posted videos is considered to be the most important metric and measure of success. It has been described that this measurement

can be made in terms of interactions with others, which can take different forms, such as liking, sharing or commenting (Hwong et al., 2017; Muñoz et al., 2022)..

User engagement on TikTok can be measured quantitatively through the analysis of the relative number of likes, comments, shares, shares, and views of each post (Cervi and Marín-Lladó, 2021; Chen et al., 2021; Habibi and Salim, 2021; Li et al., 2021; López-Navarrete et al., 2021).

2. Objectives

The objective of this research was to identify the characteristics of content associated with engagement in Spanish-speaking science broadcasters through TikTok. To achieve this objective, 10 broadcasters who use a TikTok account to disseminate their contents were analyzed. The study samples were 94 videos shared by these broadcasters between August and December 2022.

3. Methodology

The methodological approach was done through a mixed stance, since a quantitative and qualitative analysis was performed, in addition, this approach helps to know in a deeper and more critical way the studied phenomenon (Tashakkori et al., 2020), in this case, the engagement of science communicators in TikTok. A quantitative methodology was used to know more visible aspects, such as the number of followers, number of videos, number of likes, number of interactions, etc.; while a qualitative approach was used to analyze the content of the videos themselves, such as the fulfillment of the mission, the message sent to the audience, whether it is a documentary, etc.

Broadcasters were selected from different areas of science: physics, astronomy, chemistry, biology, biomedicine, biophysics and mathematics (see Table 1 below). In the sample of broadcasters analyzed, the most frequent discipline is physics. Out of the ten broadcasters who focus on communicating science-related topics on TikTok, eight of them report having undergraduate or graduate studies in physics. The rationale for the choice of broadcasters was due to a broad search for diverse content creators.

Table 1. *Profile of the 10 selected science broadcasters*.

	Name of the broadcaster in TikTok	Full name	Country	Area	Followers	Bio (self-description in TikTok profile)
1	Jasantaolalla	Javier Santaolalla	Spain	Physics	3.6M	PhD in particle physics.
2	Quifimate	José Pácheco Gonzales	Bolivia	Chemistry, Physics	130k	Chemistry and physics teacher. Offers private lessons.
3	El_profeluis	ND	Mexico	Physics	2.1M	Mexican professor of mathematics and physics. Offers guides for university admission.
4	Terepaneque	Teresa Paneque	Chile (lives in Germany)	Physics, Astronomy	699K	Astronomer. PhD(c). Chilean in Germany. Her doctoral topic is planet formation.
5	Morracientifica	Sara (Unknown last name)	Mexico	Physics	13k	Mexican. She holds a Master's degree in Physics from Denmark.
6	Joseilicgarcia	Jose García	Chile	Physics	43k	Theoretical Physicist.
7	Ladyscience	Teresa Arnandis	Spain	Biomedicine, Biophysics	652k	PhD in Biomedicine. University professor. Author of *¡Eres un milagro andante!*
8	thequantumfracture	José Luis Crespo	Spain	Physics	229k	Bachelor's degree in physics.

9	profesor_clandestino	Yudai (Unknown last name)	Peru	Physics, Mathematics	394k	Young Peruvian who shares in his videos ideas of physics, mathematics. He offers reinforcement classes in basic mathematics, physics, derivatives, integrals, etc.
10	Profcinreyes	Cinthia Reyes	Mexico	Varied	67k	PhD. Chemical engineer from Guadalajara.

Source: Elaborated by the authors.

The choice of these profiles is due to the fact that, as demonstrated by Zawacki et al. (2022), physics, biology and chemistry are the most successful branches of science communication because their content easily allows for experiments. According to the data presented by these authors, hashtags related to physics, biology, and chemistry are the most video plays on TikTok in October 2021, with 3.3 billion, 3.2 billion, and 3 billion views, respectively. Also, preference was given to physics as a discipline that helps to understand everyday phenomena and can be explained in a very graphic way with examples that the audience can identify with.

An exhaustive analysis of social network accounts of individuals who identify themselves as scientists was carried out to select the broadcasters. Broadcasters were classified as scientists if in their biography they mentioned the disciplines of interest (physics, biology or chemistry). The ten broadcasters who showed interest in physics were selected from a total of selected broadcasters who met the criteria. The selected broadcasters were six men and four women from five Spanish-speaking countries: Spain, Mexico, Chile, Bolivia and Peru. The rationale for the choice of broadcasters was made with a gender perspective, trying to ensure that both men and women were equally represented.

The justification for the choice of the broadcasters was made through non-probabilistic sampling, in a purposive manner (Hernández-Sampieri and Mendoza, 2018), since they were chosen in a direct way, promoting gender equity. Unfortunately, TikTok does not offer a ranking that can be objectively based on this type of choice of participants.

Two videos were selected from the chosen broadcasters: the most viewed (with the highest number of views) and the least viewed (with the lowest number of views) for each month, in the period August-December 2022. In total, we expected to have a total of 100 videos, but there were cases where the broadcasters only published one video per month, leaving a total of 94 science dissemination videos in the analysis.

For the analysis of video content in TikTok, the framework used was the proposal of Li et al. (2021) that focuses on three features: video format, video type and thematic content. The study by Li et al. (2021) examined how these video features related to quantitative indicators of user engagement: the number of views, likes, comments, and shares. Li et al. (2022) developed a code catalog based on the content analysis studies in TikTok elaborated by Zhu et al. (2019) and Medina-Serrano et al. (2020).

First, information was collected on the video format (Table2), including length, subtitles, use of text, presence of spoken language, presence of captions, music, and number of hashtags used. With the exception of length (video length) and number of hashtags, each variable was coded as present (1) or absent (0).

Table 2. *Variables related to the format of the videos in TikTok.*

Variable	Operationalization	Examples	n (%)
1. Length	Video duration.	Not applicable	-
2. Number of hashtags	Number of hashtags used by the broadcaster.	Not applicable	-

3. Use of subtitles	The video includes a text fragment that translates or transcribes the dialogue or narration.	https://www.TikTok.com/@el_profeluis/video/7129593133523848453deo/7129593133523848453	12 (12.8%)
4. Use of text	A text snippet is added to the video that repeats, enhances, replaces or highlights the audio messages.	https://www.TikTok.com/@thequantumfracture/video/7167010973453274373	46 (48.9%)
5. Use of spoken language	The video features spoken language.	https://www.TikTok.com/@quifimate/video/7127122001772416261	71 (75.5%)
6. Use of captions	There is a text snippet displayed at the bottom of the video that summarizes the video content or provides context for the video.	https://www.TikTok.com/@terepaneque/video/7147654340247915782	13 (13.8%)
7. Use of music	The video features background music.	https://www.TikTok.com/@jasantaolalla/video/7181833573488512262	41 (43.6%)

Source: Elaborated by the authors.

The variables length and number of hashtags were measured categorically. The length variable was divided into four categories:

(1) videos up to 15 seconds,

(2) videos between 16 and 30 seconds,

(3) videos from 31 to 60 seconds, and

(4) videos longer than 61 seconds.

The variable number of hashtags was also divided into two categories:

(1) videos using 0 to 5 hashtags and

(2) videos using 6 to 10 hashtags.

Secondly, video types were identified according to the following categories: performance, animated infographics, documentary, news, oral speech, pictorial slideshow and TikTok dance, as shown in Table 3. Typology variables were also coded as present (1) or absent (0).

Table 3. *Variables related to the format of the videos in TikTok*.

Variable	Operationalization	Examples	n (%)
1. Performance	A video in which information is presented through individual or group performances and role plays.	https://www.TikTok.com/@morracientifica/video/7137718614135819526?	1 (1%)
2. Animated infographics	A video that uses a combination of images, illustrations, charts, graphs, text, cartoons and other elements that are animated to display information.	https://www.TikTok.com/@thequantumfracture/video/7137702615479012613	12 (12.8%)

3. Documentary	A video that provides a factual record or report of events or people (testimonials from relevant sources, experts).	https://www.TikTok.com/@terepaneque/video/7135891335827049733	13 (13.8%)
4. News	A video that presents information about recent or important events or recently published events.	https://www.TikTok.com/@thequantumfracture/video/7147831400580893957	8 (8.5%)
5. Oral speech	A video in which speakers present information to the audience orally and often in form (they stand in front of the camera).	https://www.TikTok.com/@quifimate/video/7129317735154158853	24 (25.5%)
6. Pictorial slideshow	A video that presents a series of still images in a pre-established sequence.	https://www.TikTok.com/@terepaneque/video/7173442671694941445	6 (6.4%)
7. TikTok dance	A video featuring the viral dance challenges circulating on TikTok.	https://www.TikTok.com/@terepaneque/video/7165219715676261637	3 (3.2%)

Source: Elaborated by the authors.

Finally, the thematic content of the videos was analyzed. The variables selected for the present study were: mission fulfillment, the presence of advertising, the existence of a duo or the use of the reply function of TikTok, as shown in Table 4. Each content variable was coded as present (1) or absent (0).

Table 4. *Variables related to the thematic content of the videos in TikTok.*

Variable	Operationalization	Example	n (%)
1. Mission fulfillment	The video fulfills the mission of the broadcaster.	In this video, *profe_clandestino* solves a physical problem by referring to a Dragon Ball fight. https://www.TikTok.com/@profesor_clandestino/video/7140370239069441285	69 (73.4%)
2. Advertising	The video is a paid partnership or brand collaboration.	In this video *Terepaneque* refers to a telescope lens enhancement solution, relating it to a brand of lenses that she promotes. https://www.TikTok.com/@terepaneque/video/7182377669567466757	6 (6.4%)
3. Duo	The video is published in Duo format. This format allows to publish the video together with a video of another creator on TikTok.	*LadyScience* takes up a video about Covid vaccines and gives her scientific point of view. https://www.TikTok.com/@ladyscience/video/7154377879781002502	6 (6.4%)
4. Reply	The video is a response of the broadcaster to one of the comments that remain in his/her videos.	*Morracientífica* makes a response to a comment about the importance of managing the English language. https://www.TikTok.com/@morracientifica/video/7169396759158934790	5 (5.3%)

Source: Elaborated by the authors.

The variable of interest in this study is engagement. The following formula was used for its measurement, recommended by Li et al. (2021), López-Navarrete et al. (2021), Chen et al. (2021) and Cervi and Marín-Lladó (2021):

[(n. of likes + n. of comments + n. of times shared) / n. of reproductions] x 100.

This formula includes all the usual indicators for measuring engagement: number of likes, number of comments, number of times shared and number of views.

4. Results and Discussion

This section presents the results obtained by following the proposed methodology to identify the characteristics of the content associated with engagement in Spanish-speaking science broadcasters through TikTok.

As just mentioned in the method section, we used as a frame of reference the proposal by Li et al. (2021), which analyzes the engagement of TikTok videos organized into three categories:

a) video format,

b) video type, and

c) video content.

In order to facilitate their understanding, the characteristics of the content associated with the engagement of Spanish-speaking science broadcasters through TikTok are presented below, organized into these categories.

4.1. Video format

It was found that, in the category of video format, the characteristics most associated with engagement were:

a) the length of the video,

b) the number of hashtags,

c) the absence of subtitles,

d) the use of text and

e) the absence of captions.

The first variable analyzed, related to the format of the videos, was length. Habibi and Salim (2021) suggest that the audience on TikTok has a shorter attention span than on other social media platforms and, therefore, prefers shorter videos. However, contrary to the findings of Habibi and Salim (2021), in the present analysis, longer videos (above one minute) were found to generate more audience engagement. As can be seen in Table 5, the longer the video, the higher the engagement rate. Among the most viewed videos, those longer than one minute reach an average engagement rate of 13.32, while the least viewed videos, whose length is longer than 61 seconds, reach an engagement rate of 9.46. One explanation could be that longer videos have more time to address a scientific topic in greater depth and detail. The length above one minute seems to allow a better explanation of complex concepts and a more complete exploration of scientific arguments and evidence.

The second variable related to the format was the variable number of hashtags. Studies related to the use of hashtags in social networks, such as Chang (2010) and Small (2011), have shown that the use of hashtags helps users to search, follow, and share information. Within the present study, as in the analysis by Li et al. (2022), a higher number of hashtags is related to a higher engagement rate for a video on TikTok. As explained by Li et

al. (2021), hashtags on TikTok appear to share similar functions to those on other social media platforms and should be used strategically to attract viewers and promote user engagement. Table 5 shows that, for the least viewed videos, the engagement rate of videos that use between 0 and 5 hashtags is 5.93, while those that use between 6 and 10 hashtags is 8.39. For the most viewed videos, those using between 0 and 5 hashtags the engagement rate is 9.61, while those using between 6 and 10 hashtags is 11.7.

Table 5. *Engagement rates according to length and number of hashtags*.

	Length				Number of hashtags	
	Up to 15 sec. (19.6%)	Between 16 and 30 sec. (8%)	Between 31 and 60 sec. (38.4%)	Longer than 61 sec. (17.9%)	Between 0 and 5 hashtags (61.7%)	Between 6 and 10 hashtags (38.3%)
Least viewed	4.76	5.25	7.13	9.46	5.93	8.39
Most viewed	7.92	5.09	11.24	13.32	9.61	11.7
Global	6.81	5.17	9.18	11.39	7.77	10.01

Source: Elaborated by the authors.

Regarding the format feature related to subtitles in the present study, it was found that the absence of subtitles results in higher engagement rates, this being valid for the most viewed videos as well as for the least viewed ones. This finding does not coincide with the results of Li et al. (2021), who found that videos with subtitles received more engagement than those without subtitles.

Another format variable analyzed was the use of text. Adding a text snippet to the video that repeats, enhances, replaces or highlights the auditory messages also did not show positive results in the engagement rates of the analyzed videos. This finding is also contrary to the proposals of Li et al. (2021) and Perego et al. (2010), which state that text and subtitles allow the audience to better understand the video content, which can promote interaction with the posted content.

In relation to spoken language, this study revealed that videos that include spoken language generate higher audience engagement. This finding applies to both the most viewed videos in each month analyzed and the least viewed videos. These results contrast with the findings of Li et al. (2021), who, when examining the dissemination of scientific information on COVID-19, found that TikTok videos with spoken language generated less engagement (comments, shares) than those without spoken language. However, it is important to note that the results of this analysis are consistent with the findings of Zhu et al. (2019), who highlighted the audience's preference for easy-to-understand spoken language free of scientific jargon. This informal and informative spoken language style is characteristic of all the broadcasters analyzed in this study.

On the other hand, the use of captions seems to have a negative influence on the engagement of the analyzed popular science videos. Although the use of captions (brief explanations that accompany a publication or image) can, according to Hayes et al. (2020) be useful for providing experimental instructions and scientific explanations in popularization videos, in the case of the content analyzed in this study they do not seem to increase audience engagement rates.

Regarding music as a format variable, it was observed that about half of the broadcasters videos used this feature (41 of the 94 videos, i.e., 43.6%). Only for the most viewed videos a positive effect of the use of music on engagement is observed, however, this effect seems to be minimal (an engagement rate of 10.82 for the most viewed videos that do use music and an engagement rate of 10.39 for the most viewed videos that do not use music). For the least viewed videos the use of music is associated with lower engagement: 5.42% for the least viewed videos that do use music verses 7.61% for the least viewed videos that do not use music. It is worth noting that this result is surprising since, as indicated by Medina-Serrano et al. (2020), a distinctive feature of TikTok is the use of background music in the videos. According to these authors, it is common

to use music as part of a dance routine, a lip-sync competition, or as a backdrop for an oral speech. In this analysis, the use of background music does not seem to impact the engagement with the audience of science communicators. Although sound plays a role in the construction of the broadcasters' stories, it does not seem to be an essential format feature to convey a specific message.

Table 6. *Engagement rates for different format characteristics*.

	Subtitles		Text		Spoken language		*Caption*		Music	
	(87.20%)		(51.10%)		(24.50%)		(86.20%)		(56.40%)	
Category	No	Sí	No	Sí	No	Sí	No	Sí	No	Sí
Least viewed	6.74	6.46	6.81	6.61	4.73	7.57	6.95	4.76	7.61	5.42
Most viewed	10.92	8.64	10.77	10.38	9.73	10.78	10.97	8.66	10.39	10.82
Global	9.54	7.5	8.82	9.76	9.23	9.29	9.62	7.18	8.97	9.67

Source: Elaborated by the authors.

4.2. Video type

It was found that, in the category of video type, the most important characteristics for engagement were:

a) the use of animated infographics,

b) the presentation of news and

c) the absence of slideshow.

The first attribute examined to classify the videos in terms of type was the presence or absence of performance by the broadcaster. This attribute refers to videos in which the information is presented through individual performances or role plays. It is important to note that the use of acting is not a resource widely used by the science communicators analyzed, since only one video out of 94 used acting. However, it is interesting that the engagement rate in this video was much higher (15.24) than the average engagement rate of all the videos (8.68).

In relation to the use of animated infographics, it was observed that these generated higher engagement rates in all the videos analyzed, both the most popular and the least popular. Among the least viewed videos, those that used animated infographics showed an engagement rate of 17.94%, compared to 6.20% for videos that did not use them. Similarly, for the most viewed videos, the difference in engagement was 9.46% for those that did not use infographics, compared to 14.85% for those that did. These results match with the findings of Zhu et al. (2019), who observed in general communication on science and public health topics on TikTok, that animated infographics and materials from documentaries generated more engagement than videos without animations or documentaries.

Regarding the use of documentary materials, in this study, videos that provide a record of facts show higher engagement than videos that do not include reports of events or people (testimonials from relevant sources or experts). For the least viewed videos, the engagement rate of videos that do not use documentary material is 6.44% compared to 8.18% for videos that do. This difference, although in a smaller proportion, is also found for the most viewed videos: the engagement rate of videos that use documentary material is higher (10.83%) compared to the engagement rate of videos that do not use this type of material (10.51%).

In relation to the news, oral discourse and slideshows variables that refer to the type of video, Li et al. (2021) found that engagement did not differ significantly. Similarly, a minor impact of these three variables is observed in this study (see Table 7). However, the use of news, oral speech and slideshows generated slightly higher engagement rates for all the videos analyzed, both the most viewed and the least viewed.

The last category analyzed in terms of the type of popular science videos was the presence or absence of dance. As mentioned above, in the TikTok platform it is common for music to be combined with a dance routine. Medina-Serrano et al. (2020) explain that in TikTok videos the protagonists dance to sometimes point to fragments of text and information. In this way, dance is used to transmit information and, at the same time, to enhance interaction with the audience, which is considered a crucial element for scientific communication through social networks (Heldman et al., 2013).

Regarding the effectiveness of the so-called "TikTok dance", Li et al. (2021) show that videos that include rhythmic movement led to more engagement than any other type of videos. The explanation by Li et al. (2021) is that videos that include dancing are often presented with rhythmic music and easy-to-mimic lip sync and body movement, all of which can foster audience-centered interactions and increase engagement. However, as can be seen in Table 7, in the videos analyzed in this study, dancing did not lead to higher engagement. The reason could be that dancing is not a common feature for any of the selected broadcasters. This could be why videos that include dancing do not necessarily encourage interaction with the audience and do not lead to increased engagement.

Table 7. *Engagement rates for different video type characteristics*.

	Performance (2.2%)		Animated infographics (12.8%)		Documentary (19.1%)		News (15.9%)		Speech (55.3%)		Pictorial slideshow (9.5%)		Dance (4.3%)	
	No	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Least viewed	6.71	--	6.20	17.94	6.44	8.18	6.59	7.54	5.54	7.88	6.69	6.85	7.06	1.63
Most viewed	10.38	15.24	9.46	14.85	10.51	10.83	10.09	12.73	10.11	10.90	10.58	10.69	10.52	13.73
Global	9.15	15.25	8.39	15.36	9.16	9.80	9.05	10.47	9.00	9.5	9.43	7.83	8.83	7.34

Source: Elaborated by the authors.

4.3. Video content

It was found that, in the category of video content, the most important characteristics for engagement were:

a) being in line with its mission,

b) the absence of advertising and

c) the absence of duets.

Of the total number of videos analyzed, 69 (73.4%) were found to be in line with the broadcaster's mission. Regarding the variable mission fulfillment, it stands out as fundamental that science communicators in TikTok remain faithful to their promise to their audience. For the least viewed videos, the engagement rate rises from 5.58 for videos that do not adhere to the mission to 7.37 for videos that do stay true to the goal of the discloser. The difference is even greater for the most viewed videos. Here, engagement rises from 6.74 for videos that do not necessarily adhere to the broadcaster's mission to 11.35 for videos that do comply with the mission and goal. The mission fulfillment variable highlights the importance of maintaining high levels of credibility and trust with the audience. Users are looking for the broadcasters' videos to be aimed at fulfilling the goal of their channel (Pattier, 2022), so consistently fulfilling the promise to the audience seems to raise consistency and integrity in science outreach considerablye.

Six of the videos analyzed (6.4%) resorted to paid partnerships or collaborations with brands. When studying the engagement of these videos, it is concluded that the use of advertising is not beneficial for the generation

of interaction with the audience. This result was to be expected, since it is commonly known that the use of commercials in the context of science outreach could lead to loss of credibility with the audience. In addition, it is important to note that broadcasters do not use paid partnerships as a tool to increase their ratings but as an additional source of income. Some studies related to advertising in digital media have pointed out that these practices are sometimes unethical, in that consumers are deceived, enticing them to consume the content, without stating that the main purpose is to display advertising (Nelson et al., 2009; Taylor, 2017). This negative image that the consumer has with respect to advertising could explain the low engagement found in the videos with this characteristic.

On the other hand, a total of six (6.4%) were found to be a duo with another person. In TikTok, the use of the duo format allows the video to be published together with a video of another creator. It is concluded, for the sample analyzed, that the public does not value duets. In the context of science popularization, it is possible that the target audience is not so interested in this type of interaction of the broadcaster of their choice with another broadcaster. It is possible that they prefer to consume scientific content directly from the broadcaster of their choice, without necessarily seeking additional interaction.

Finally, in terms of content analysis (see Table 8), a total of five videos (5.3%) were found to use the reply feature. The reply feature in TikTok indicates whether the video is a response from the broadcaster to one of the comments left on his or her videos. Finally, in general, it is observed that there is no significant impact on engagement when using the reply mode.

Table 8. *Engagement rates for different thematic video content characteristics*.

	Mission (73.4%)		Advertising (6.38%)		Duo (6.38%)		Reply (5.32%)	
	No	Yes	No	Yes	No	Yes	No	Yes
Least viewed	5.58	7.37	7.09	4.19	6.78	3.48	6.72	6.62
Most viewed	6.74	11.35	10.58	--	11.08	6.28	10.52	12.08
Global	5.95	10.49	9.63	4.19	9.52	5.81	9.31	8.82

Source: Elaborated by the authors.

5. Conclusions

The ten broadcasters analyzed in this study target diverse audiences and have different goals and missions. Still, by analyzing the metrics of the 94 videos included in the study, it is possible to get a sense of what, in general, seems to work best in science outreach to engage the public. The following is a series of guidelines that the science outreach community could adapt to their strategies to achieve greater engagement with their audience.

As for the format to be used, several aspects could be taken into account. First, it was observed that videos longer than one minute seem to provide more complete information and satisfy the audience's curiosity. In addition, the number of hashtags used can be beneficial, as providing information about the topic of the video seems to be rewarded by the audience. In terms of visual and auditory content, the use of subtitles, text or captions do not seem to be the factors that most influence audience engagement. The videos with the highest engagement tend to include spoken language, which may be related to the preference for a teaching model in which the broadcaster plays a central role in imparting knowledge in a manner similar to that of a classroom. Finally, unlike other communities in TikTok, for science communicators the use of music does not seem to play a central role in the success of their videos.

On the other hand, the type of video seems to be a more important factor than the format in terms of engagement for science communicators on TikTok. This may be because the type of video allows the broadcasters to customize and adapt the subject matter to their own unique style of outreach. First, performance could be effective; although only one of the videos in the months analyzed included performance, it showed a relatively high engagement rate compared to the most viewed videos that did not have performance.

"It was observed that videos longer than one minute seem to provide more complete information and satisfy the audience's curiosity..."

Performance could prove to be an interesting resource to increase dynamism and audience interaction in science outreach on TikTok. Animated infographics are very effective in terms of engagement rates when included in videos. Documentary material also engages audiences effectively. Videos that involve the editing and compilation of several clips were more successful than publications in which the broadcaster speaks only in static form. In addition, in terms of video typology, it is recommended to use elements such as news, oral speeches and slides. Finally, in the videos analyzed in this study, dancing can be contradictory, as it could be associated with both low and high engagement. The results show that the videos in which dance was used have a very low engagement in the least viewed, but also higher in the most viewed. This may be due to the fact that none of the selected broadcasters have dance as a common feature in their content. Dancing, as well as acting, could represent interesting resources to explore in science outreach on TikTok.

In terms of video content in science outreach on TikTok, there are several aspects to consider. The most important factor would be that the broadcasters stay in tune with their personal outreach mission and attached to the expectations of their audiences. This is the factor that seems to promote engagement, curiosity and enthusiasm the most. With respect to advertising, it is concluded that it is not recommended for science communicators on TikTok, as it can generate conflicts of interest, compromise objectivity and undermine the public's trust in the impartiality of scientific information. It is also concluded that duos and reply between broadcasters are not necessarily the most appropriate to increase engagement in science outreach.

In conclusion, this analysis of 94 videos, conducted with ten science communicators on TikTok, shows the importance of following general guidelines to achieve greater engagement in science communication. To positively impact followers, it seems to be crucial to maintain authenticity in communication efforts and to be aligned with the personal outreach mission, in order to encourage audience engagement and enthusiasm. In addition, the study highlights how important it is for communicators to share meaningful content to their respective audiences, enriching their audience's scientific knowledge by making it engaging and accessible.

Although TikTok remains primarily an entertainment platform, this study demonstrates that it can provide valuable content and generate meaningful interactions with an audience interested in science-related topics.

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AUTHORS' CONTRIBUTIONS, FUNDING AND ACKNOWLEDGEMENTS

Authors' contributions:

Conceptualization: Velarde-Camaqui, Davis; Viehmann, Cristina; Díaz Méndez, Rosa Elvia; Valerio-Ureña, Gabriel. **Formal analysis:** Velarde-Camaqui, Davis; Viehmann, Cristina; Díaz Méndez, Rosa Elvia; Valerio-Ureña, Gabriel. **Drafting-Preparation of the original draft:** Velarde-Camaqui, Davis; Viehmann, Cristina; Díaz Méndez, Rosa Elvia; Valerio-Ureña, Gabriel. **Drafting-Revision and Editing:** Velarde-Camaqui, Davis; Viehmann, Cristina; Díaz Méndez, Rosa Elvia; Valerio-Ureña, Gabriel. **Visualization:** Velarde-Camaqui, Davis; Viehmann, Cristina; Díaz Méndez, Rosa Elvia; Valerio-Ureña, Gabriel. **Supervision:** Velarde-Camaqui, Davis; Viehmann, Cristina; Díaz Méndez, Rosa Elvia; Valerio-Ureña, Gabriel. **Project management:** Apellido Apellido, Nombre. **All authors have read and accepted the published version of the manuscript:** Velarde-Camaqui, Davis; Viehmann, Cristina; Díaz Méndez, Rosa Elvia; Valerio-Ureña, Gabriel.

Acknowledgments: The authors gratefully acknowledge the financial support of Writing Lab, TecLabs, Tecnológico de Monterrey, Mexico, in the publication of this work.

AUTHORS:

Davis Velarde-Camaqui
Tecnológico de Monterrey (Monterrey Institute of Technology). Mexico

PhD student in Educational Innovation at Tecnológico de Monterrey. His research focus is directed to educational innovation through the application of Augmented Reality, as well as the support and dissemination of Science. He has taught at different universities in Peru. Expert in psychometrics, as well as undergraduate thesis advisor.
a00832505@tec.mx

H-index: 1
Orcid ID: https://orcid.org/0000-0001-9064-7104
Google Scholar: https://scholar.google.com/citations?user=oZmFEYYAAAAJ&hl=es&oi=ao
ResearchGate: https://www.researchgate.net/profile/Davis-Velarde-Camaqui
Academia.edu: https://cinco-itesm.academia.edu/DavisVelardeCamaqui

Cristina Viehmann
Tecnológico de Monterrey (Monterrey Institute of Technology). Mexico

PhD student in Educational Innovation at Tecnológico de Monterrey. Her research focus is socio-scientific controversies and the use of futures thinking in science education. She has taught at the Monterrey Center for Higher Studies in Design (CEDIM) and the University of Monterrey (UDEM). She is an expert in foresight and strategic innovation.
a00807496@tec.mx

Orcid ID: https://orcid.org/0009-0004-2716-6729
ResearchGate: https://www.researchgate.net/profile/Cristina-Viehmann-2
Academia.edu: https://independent.academia.edu/CristinaViehmann

Rosa Elvia Díaz Méndez
Tecnológico de Monterrey (Monterrey Institute of Technology). Mexico

Master in Clinical Nutrition. Doctoral candidate in Educational Innovation at the Tecnológico de Monterrey. Research interests: teaching-learning processes in health sciences and scientific dissemination.
a00832504@tec.mx

H-index: 1
Orcid ID: https://orcid.org/0000-0002-9964-7415
Google Scholar: https://scholar.google.es/citations?user=XMDI44IAAAAJ&hl=es&oi=ao

Gabriel Valerio-Ureña
Tecnológico de Monterrey (Monterrey Institute of Technology). Mexico

He holds a PhD in Educational Innovation, he is a computer systems engineer and has a Master's degree in Information Technology Management. He has 22 years of experience as a research professor at Tecnológico de Monterrey, where he was also a consultant in knowledge management for 10 years and is a member of the National System of Researchers. He is the director of the Doctorate in Educational Innovation at Tecnológico de Monterrey. His line of research revolves around the impact of digital tools in education and business.
gvalerio@tec.mx

H-index: 15
Orcid ID: https://orcid.org/0000-0002-9964-7415
Scopus ID: https://www.scopus.com/authid/detail.uri?authorId=57211556602
Google Scholar: https://scholar.google.es/citations?user=XMDI44IAAAAJ&hl=es&oi=ao
ResearchGate: https://www.researchgate.net/profile/Gabriel-Valerio
Academia.edu: https://itesm.academia.edu/GabrielValerio

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