Conseil Européen pour la Recherche Nucléaire
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Accelerating Engagement in Fundamental Science Through CERN Videos: What Matters?

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Dedicated to all the COVID-19 survivors and their families

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Declaration

I hereby declare that the thesis titled “Accelerating Engagement in Fundamental Science Through CERN Videos: What Matters?” was produced independently and made use of no resources or sources than those which were clearly stated, with quotations duly marked as such.

August 30th, 2021

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Abstract

Science communication through videos remains a fertile area of research for scientific organisations looking to engage existing and new audiences, particularly on social media. Towards this goal, this study examined two years of video dataset (n=184) on CERN's Facebook page followed by 747,056 people as of August 2021. CERN published 77 videos in 2019 and 107 videos in 2020, witnessing an increase in video posts by 38.96%. Findings reveal a significant reward in viewership on online videos during the coronavirus pandemic, with the increase in interactions on CERN videos up to 191% from 2019 to 2020. Videos, namely, "Voyage into the world of atoms" and "Future Circular Collider," became the most viewed and the most engaging videos of 2019 and 2020. Videos sharing applications of CERN's technology and know-how were the most in-demand after Accelerators and Physics themes, however, Knowledge Sharing videos were the least produced out of all the themes outlined by CERN's editorial strategy. These findings offer practical examples for communicators seeking to produce videos that are effective to grow viewership and look beyond engagement as a one-way, organisation-to-public activity and engage audiences with fundamental science.

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Introduction

CERN, derived from the French acronym *Conseil européen pour la recherche nucléaire*, is a European research organisation that operates the largest particle physics laboratory in the world. Physicists and engineers at CERN use the world's largest and most complex scientific instruments to study the basic constituents of matter. The process gives us clues about how the particles interact and provides insights into the fundamental nature of our universe.

Founded in 1954, the CERN laboratory sits astride the Franco-Swiss border near Geneva. It was one of Europe's first joint ventures and now has 23 member states and contributions from across the world involved in different ways.

The instruments used at CERN are purpose-built particle accelerators and detectors. Accelerators boost beams of particles to high energies before the beams are made to collide with each other or with stationary targets. Detectors observe and record the results of these collisions. Particle physics is esoteric and awe-inspiring, yet it is dependent on massive publicly funded machines "beyond the budget of any single research organisation, or indeed, any single country" (Boisot, 2011). Particle physics provides an especially challenging topic for science communication and public engagement.

Previous research such as Footprints of Fascination: Digital Traces of Public Engagement with Particle Physics on CERN's Social Media Platforms (Kahle, AJ, & Baram-Tsabari, 2016) provides extensive insight into the cross-platform characterization of public engagement with particle physics on CERN's social media. However, scarce research is available to learn the trends on digital media during the COVID-19 pandemic especially with an interest in science and technology content. A survey conducted between July and October 2020 revealed that 61% of users from 6 to 40 years old were watching more videos on social media apps during the COVID-19 pandemic. A further 56% claimed watching more videos on streaming platforms on television, while 52% were more inclined to stream videos on their smartphones (Statista, 2021).

Online videos on social media such as YouTube and Facebook are a popular way to learn as they provide easy access to a wide range of content. Beautemps & André, 2021 conducted an exploratory study to identify criteria that contribute to creating educational videos for informal learning, so these possible criteria can be further investigated in follow-up studies and help video producers. This study provided an initial insight into the elements which influence the perceived quality of educational videos, with a special focus on natural science. The study called participants via various German natural science and technology YouTube and Instagram channels, approximately 5,000 participants between the ages of 9 to 72 years old who completed a web questionnaire. The questionnaire focused on the participants' viewing behaviours and their self-perception of the importance of the content-creator controlled variables. Results found that there are mainly six key elements for a successful educational YouTube video: structure, reliability, quality, community integration, presenter, and topic.

The impact of online videos on social media may differ across various disciplinary areas. For instance, Sugimoto, et al., 2013 compiled a list of TED talks for analysis. The study suggested that TED Talks have a much greater impact on the public than within the scholarly community. Differences were found among broad disciplinary areas, with art and design videos having generally lower levels of impact but science and technology videos generating otherwise average impact for TED. The results showed videos in Science & Technology category received higher scores in YouTube Like proportions. More than 70% of the Science & Technology videos were at or above a 9:1 like to-dislike ratio. For example, David Gallo's "Underwater astonishments" attracted 4,320 Likes and only 16 Dislikes (99.6% Likes). This provides evidence of the positive reception of Science & Technology videos, perhaps reinforcing both public's desire for science and technology news (National Science Board, 2012) and the successful popularization of science through this medium. There was clear evidence that less liked videos are relatively more frequently discussed, which is probably due to controversial videos generating the most debate. This is consistent with previous research on internet debates, which revealed that negativity in comments drives discussion (Chmiel, et al., 2011) or associates with increased discussion, notably on YouTube (Thelwall, Sud, & Vis, 2011). Given that about a third of the videos cover topics related to science and technology, the TED initiative seems to be one of the most well-known science popularization efforts in history. TEDxCERN videos such as "The Basics of the Higgs boson" and "What happened to antimatter" also reached a million views in the previous years.

The dissemination of online videos by science-related accounts and influencers can also play a crucial role and vary across social-media platforms such as Facebook, Twitter, and YouTube. A 2017 Pew Research Center survey found most social media users in the U.S. report seeing science-related posts and a third (33%) consider it an important way they get science news. Some 44% of social media users say they see content unique to that platform at least sometimes, and 26% of users report that they follow a science-related page or account. Other Pew Research Center surveys show that Facebook is used by a far larger share than other social media platforms. While far more adults in the U.S. use Facebook (68%) than Twitter (21%), a handful of science-related pages such as Neil deGrasse Tyson and ScienceAlert are comparatively more active on Twitter. Multiplatform organisations have taken advantage of Facebook's capacity to reach large numbers of followers. For instance, as of August 2021, National Geographic has nearly 48 million Facebook followers, Discovery has 40 million and Animal Planet has 20 million. This illustrates the degree to which social media has transformed the media landscape, making it easier and cheaper for those with few resources to provide unmediated content and garner followings (Hitlin & Olmstead, 2018).

CERN originally ventured on social media with video-based content on YouTube in 2007. Since then, CERN has expanded its digital presence on Twitter, Facebook, LinkedIn, and Instagram. During the 4 July 2012 announcement of the discovery of the Higgs boson, CERN's live tweets reached journalists faster than the press release and helped contribute to worldwide coverage of the discovery. An October 2013 study cited CERN as the most effective international organisation on Twitter (Twiplomacy, 2013). CERN's presence on social media platforms aims to begin a journey with science, foster scientific engagement in the general public and retain positive sentiments towards the Organization to help form an

online community of stakeholders interested in the laboratory and its work. The interactions on social media, through the likes, shares and comments on CERN's digital content, are regularly monitored.

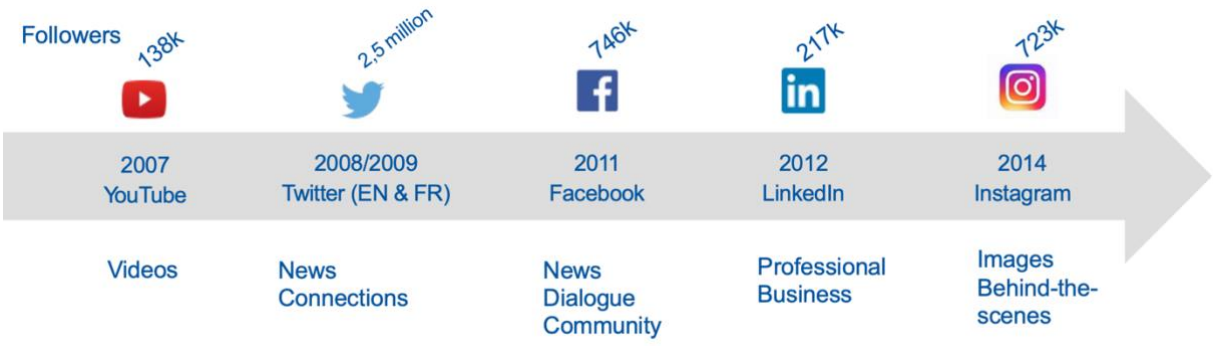


Figure 1. CERN's History on Social Media

In order to provide insights into the elements that influence the visibility of videos that social media users encounter on CERN's page, the author systematically analysed two years' worth of videos from CERN's Facebook page, which is followed by approximately 8 million people as of August 2021. The study sets out to investigate what type of CERN videos were the most viewed and engaged with on Facebook during 2019 and 2020 to draw inferences about factors that can accelerate digital public engagement on social media. Although engagement on social media can be defined in various ways, this study follows a thematic glossary for Facebook Analytics according to Iconosquare, an analytics and management platform for social media (Iconosqaure, 2021).

As one of the main goals of CERN social media is to foster engagement in the general public with fundamental science, the study collects video views as well as user engagements per post, a common indicator of audience engagement based on the total number of shares, comments, and likes and other reactions.

The study will also report the differences in viewership and engagement witnessed on CERN videos during the coronavirus pandemic particularly in 2020.

In addition to being recognised for its gigantic complex of accelerators such as the Large Hadron Collider, CERN is also known to be the birthplace of the World Wide Web. The Organization is the owner of its own top-level domain name, ".cern" similar to ".com" or ".de". This has led to the development of CERN's web and social media strategy with the approach of "theme" + ".cern" in the URL as a visible way of embedding and promoting CERN's editorial strategy: **Theme.CERN.** For example, a video related to computing is branded as Computing • CERN that encourages the audience to use the URL computing.cern to discover all the articles about computing on one of CERN's webpages.

Table 1. CERN Themes for Video Branding

Themes	URLs	Content of Themes
Computing	computing.cern	Includes the birth of the web
Experiments	experiments.cern	Includes detectors and work to improve specific experiments
Accelerators	accelerators.cern	Includes any content related to accelerators
Engineering	engineering.cern	Includes R&D
Knowledge Sharing	knowledge.cern	Includes Knowledge Transfer activities and collaborations
Physics	physics.cern	Includes physics results and developments
At CERN	at.cern	Includes General CERN, History of CERN, CERN people

Table 1 illustrates the video themes outlined by CERN's editorial strategy. The study will additionally investigate the significance of video themes in affecting video viewership and engagement among CERN's online community. The scope of this research covers these seven themes and introduces two additional themes, Educational Activities and Other, discussed later in the study.

Research Framework

Research gaps

Social media engagement may not be the same as public engagement, though a detailed vision into what works to engage public through social media remains a valuable topic of research for scientific organisations and individuals interested to communicate science on digital platforms. Oh, Bellur, & Sundar, 2020 have defined engagement as "the progression from interacting with the interface physically to becoming immersed cognitively in the content offered by it and then onto proactively spreading the outcomes of this involvement." In other words, to be engaged may require social media interactivity, but social media interactivity may not be sufficient to render one engaged.

Firstly, the purpose of conducting this study is to recognise the impact of the underlying factors that may drive quality progression of social media interactivity on video posts, and secondly, to identify best practices to produce physics and other types of CERN videos.

Objectives of the study

1. To assess the influence of factors that drive viewership and engagement with CERN videos.
2. To examine the impact of video themes and time of publishing content to encourage viewership and engagement with CERN videos.

Research Question

What type of CERN videos were the most viewed and engaged with on Facebook during 2019 and 2020 in order to help draw inferences about factors that accelerate digital public engagement on social media?

Hypotheses to be tested

1. There will be a significant relationship between each video element as discussed later and **viewership** among CERN's Facebook audience.
2. There will be a significant relationship between each video element as discussed later and **engagement** among CERN's Facebook audience.

Ethical consideration

All of the metrics visible in Facebook Analytics are based on aggregated, anonymous data and do not reveal individually identifiable information such as email address or phone number.

Methodology

Sample

The researcher collected two years of video data on CERN's Facebook page. CERN published 218 videos (N=218) during 2019 and 2020. In addition to videos natively published by CERN, the sample also entailed videos that CERN shared from other Facebook pages, such as the ATLAS Experiment at CERN. The full dataset also included CERN's various Live streams that later get saved as a recorded video. Facebook prioritizes live broadcasts that encourage people to continue watching videos. Live streams get most of their watch time during the stream or a few hours afterward (Kim, Temiyasathit, & Wang, 2021). In order to avoid inconsistency in viewership and engagement data, only videos natively published by CERN were taken into consideration for the range of this study.

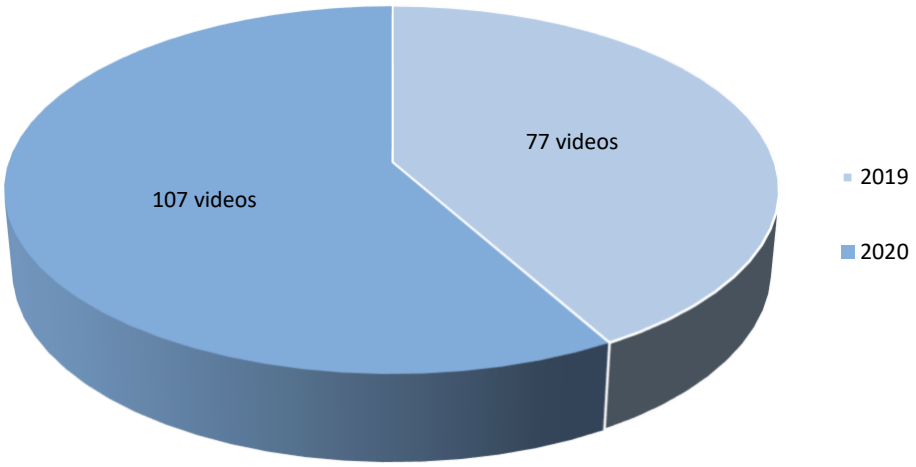


Figure 2. Number of CERN Videos Published in 2019 vs. 2020

The cleaned sample data included 184 videos (n=184). Out of 184 videos, 77 were published in 2019 and 107 were published in 2020. The data was collected after 4 months of publishing the last video of 2020 during which the study expects the videos' reactions to having stabilised.

Research Design

In this Bachelor thesis, the author reports on a quantitative study to note visual content features from Facebook videos such as CERN branding, thumbnail, music, etc., and to statistically model their influence on two dependent variables described as follows:

Viewership

A "video view" is defined as a view of three seconds or more and will appear for all videos, including those that appear as people scroll through News Feed. This study counts video views lasting longer than three seconds.

Engagement

Post engagement is defined as the total number of reactions, comments, and shares on Facebook posts over the selected period.

The author also examines engagement qualitatively by doing comment analysis using a text analysis program called Linguistic Inquiry and Word Count.

Previous research such as Jaakonmäki & Müller, 2017 elucidates three types of factors that drive social media participation:

1. Creator-related features such as the creator's sex, age and number of followers. In the case of this study, the content-creator would be CERN and creator-related features would correspond to CERN's e-reputation.
2. Contextual features such as post's context (e.g., time, location).
3. Content features such as certain features of the content, such as textual content (e.g., words, tags), visual content (e.g., images, videos), and audio content.

We investigate the impact of the following contextual and content features of CERN videos:

1. Time of publishing

CERN enjoys a global following that means taking into account several time zones while publishing content.

Figure 3. Top Countries of CERN's Social Media Audience

Figure 3 depicts the top locations of CERN's Facebook followers for watching videos in 2019 and 2020. The shades of blue reflect the intensity of the engagement rate of countries with CERN, a metric that measures the amount of interaction social content earns relative to the reach of that post. For example, the U.S. engaged the most with CERN's content, by up to 19.32%, whereas South Africa recorded only a 0.45% engagement rate with CERN on Facebook.

2. CERN Branding

CERN's brand identity is an integral part of its digital presence to reflect consistency with the brand values. Its brand identity includes the usage of the Organization's logo and specific design guidelines.

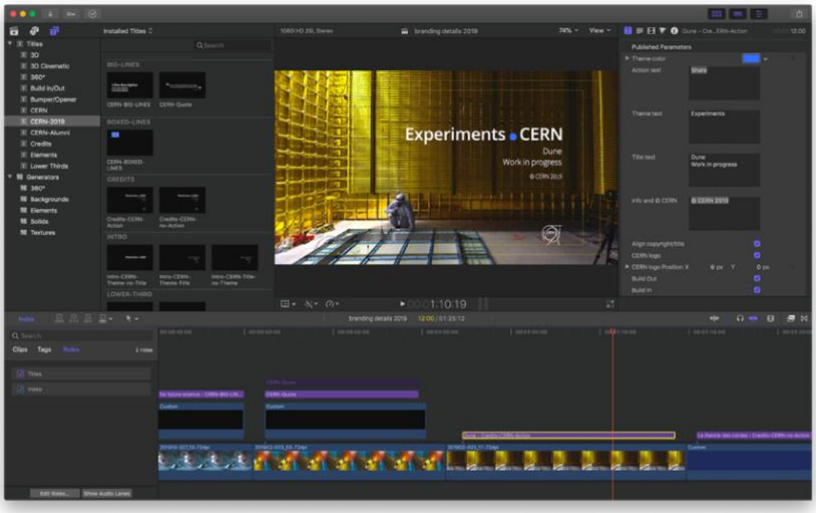


Figure 4. CERN's Most Popular Template for Video Branding

Videos with no strong branding are also featured on CERN social media such as quick shots from a smartphone showing behind the scenes of a physicist's day or the work inside laboratories.

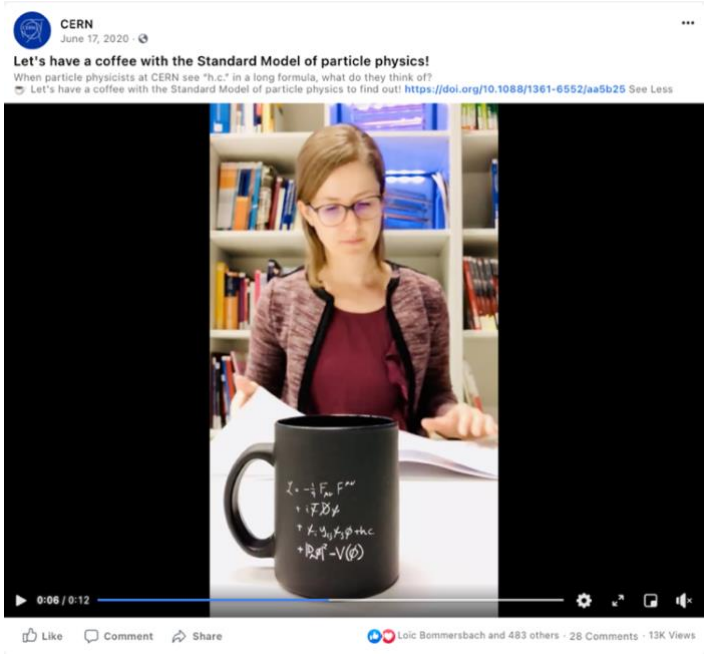


Figure 5. A Video without CERN Branding Showing a Physicist at Work

3. Customised Thumbnail

A thumbnail provides a small graphical representation of a video that helps viewers learn what to expect. If no thumbnail is selected, Facebook chooses a default thumbnail by picking an image from the video. Below is an example of a popular science video with a customised thumbnail.

Figure 6. Thumbnail of "Inside the World's Largest Science Experiment" Video

4. Music

The presence of music in educational or other types of CERN videos can give insight into if and how music can enhance viewership and engagement with videos.

5. Text on Video

Accessibility is an important part of CERN's social media strategy. Internal tests showed that adding captions to videos increased a video's viewing time by 12 percent (Capture Attention with Updated Features for Video Ads, 2016). The author would like to explore how using text on videos can make a difference to engage viewers. In this study, text on video refers to subtitles or text explaining videos particularly the ones with no audio narration. It does not include the name of physicists or other labels such as names of experiments that may be included in several videos without subtitles or textual explanation.

6. Audio Narration

A survey by Beautemps & André, 2021 revealed when asked about the importance of video and audio quality that 14% of the participants stated that the quality of audio was more important to them than video. CERN's audio-visual production team embraces a variety of video styles with or without audio narration. Learning about the role of audio narration by a speaker or speakers in videos could be crucial for video producers.

7. Human Element

Studies show that there is a strong para-social relationship between the viewers and the presenter (Sokolova & Kefi, 2019). YouTube channels are strongly linked to the people who consume content, and YouTubers often have a close relationship with their community.

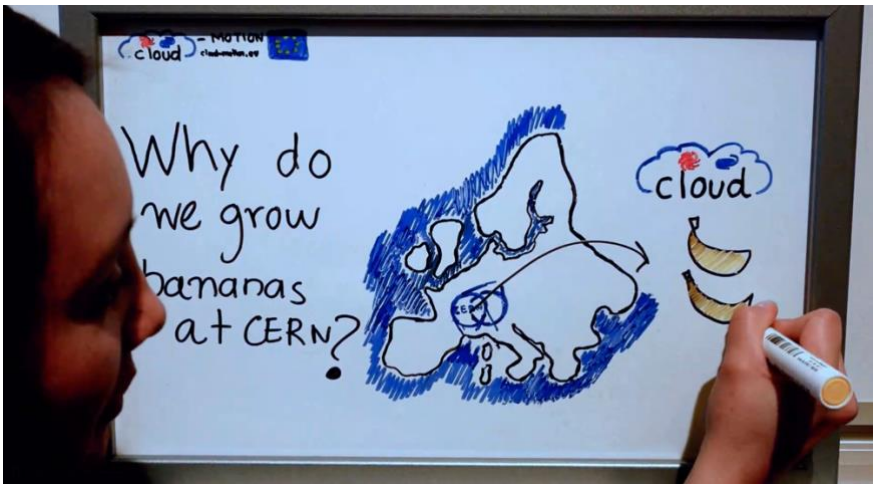


Figure 7. Human Element in "Why Do We Grow Bananas At CERN?" Video

In this study, the human element in videos refers to videos with the presence of a human figure, for example, an experiment spokesperson or an engineer working at CERN. Animated human figures were also counted as human elements. Videos showing the role of a human facilitating science even for a brief second in the video such as a close-up of the hands of the presenter doing a science activity in a classroom is also considered as a human element as shown in Figure 7.

8. Video Orientation

The study records various video orientations used by CERN, categorized into the landscape, square, or vertical formats.

9. Video Theme

For this study, the author uses seven CERN video themes (Computing, Experiments, Accelerators, Engineering, Knowledge Sharing, Physics, At CERN) for data analysis and introduces two new themes to cover other possible ranges, namely, Educational Activities and Others.

Educational Activities refer to school-level experiments or other classroom activities to share particle physics and other scientific concepts. Others include videos that cannot be classified into CERN's seven outlined themes, for instance, the trailer of a video game called the Quantum Prisoner published by CERN.

Data Preparation, Analysis Methods and Results

This study analysed the features of CERN videos and their impact on viewership and engagement on social media, particularly on Facebook. Video themes range from subjects such as computing, accelerators to educational activities. Each factor was investigated separately to understand their role in engaging public with fundamental science in more detail. This section describes general considerations relevant for the data preparation and analysis of this study. In particular, the following section describes standard methods used to analyse item properties and the steps taken to scan and prepare the data for further analysis. Descriptive and inferential statistics were used. The data collected through quantitative and qualitative techniques were analysed using JASP software. Outlier analysis, t-test and non-parametric tests such as Kruskal-Wallis were employed to analyse the data.

Descriptive Statistics of CERN Videos

Many statistical tests assume that all continuous variables follow a normal distribution. Hence, analysing variables for normality, either using statistical or graphical methods is recommended before running inference tests (Tabachnick & Fidell, 2013). Kurtosis describes the shape of a distribution and skewness describes the symmetry of the distribution. If the Shapiro-Wilk statistics deviate significantly from zero, the assumption of a normal distribution may be violated.

Table 2. Descriptive Statistics of CERN Videos

	Video_views		Engagement	
	2019	2020	2019	2020
Valid	77	107	77	107
Missing	0	0	0	0
Skewness	8.546	9.729	4.267	5.397
Std. Error of Skewness	0.274	0.234	0.274	0.234
Kurtosis	74.222	98.002	22.065	39.976
Std. Error of Kurtosis	0.541	0.463	0.541	0.463
Shapiro-Wilk	0.160	0.158	0.519	0.530
P-value of Shapiro-Wilk	< .001	< .001	< .001	< .001

CERN published 77 videos in 2019 and 107 videos in 2020 witnessing an increase in video posts by 38.96%. Table 2 shows the p-value of the Shapiro-Wilk test is lower than 0.001. Therefore, we reject the null hypothesis and infer that the data tested is not normally distributed.

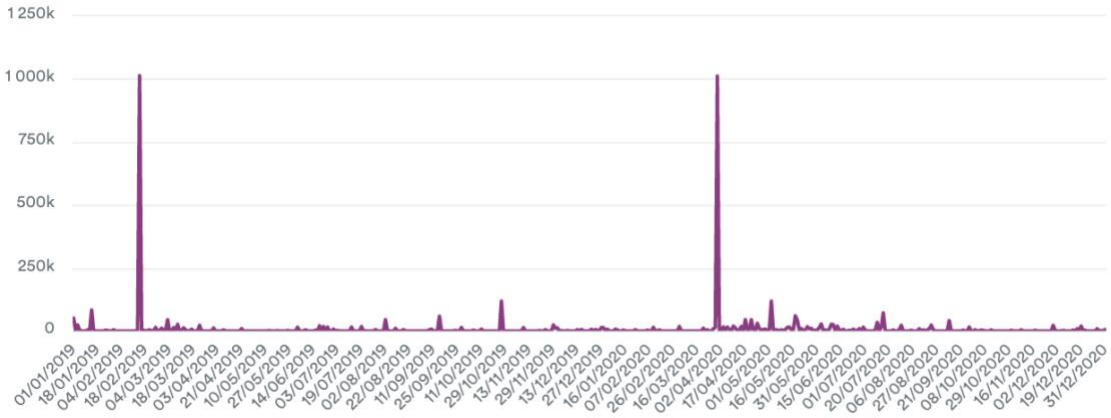


Figure 8. Viewership on CERN Videos from 2019 to 2020

The average value of the most frequent number of views on CERN videos is 4,305 views in 2019 with a standard deviation of 2,469 views. In 2020, the average value of the most frequent number of views on CERN videos is 10,577 views with a standard deviation of 2,606 views. This signifies an increase in viewership on CERN videos from 2019 to 2020 is 145%.

The average value of the most frequent number of engagements – a common indicator of audience engagement with CERN videos based on the total number of shares, comments, and likes or other reactions – is 3,878 engagements in 2019 with a standard deviation of 2,241 engagements. In 2020, the average value of the most frequent number of engagements on CERN videos is 11,310 engagements with a standard deviation of 2,589 engagements. This signifies an increase in engagement on CERN videos from 2019 to 2020 is 191%.

Boxplots and outlier analysis

Outliers are extreme observations that are inconsistent with the rest of the data set. These outliers can have significant and severe effects on several statistical methods, such as linear regressions (Pirker, 2009). The type of outlier that is easiest to find and treat usually is coding errors that were entered into the data set by mistake. Comparing minima and maxima with the expected values for all items identifies this type of outliers.

Another special type of outliers is contaminants, which are extreme cases (in this study: extreme viewership or engagement values) with several outlying variables indicating that they are not commonly witnessed and expected to lie outside the boundary conditions for normally distributed data. Online videos with the threshold of engagements greater than |11,799| and video views greater than |60,197| were identified as outliers. In the following section, the maxima and minima of the outliers will be qualitatively analysed to assess the factors behind the performance of those videos.

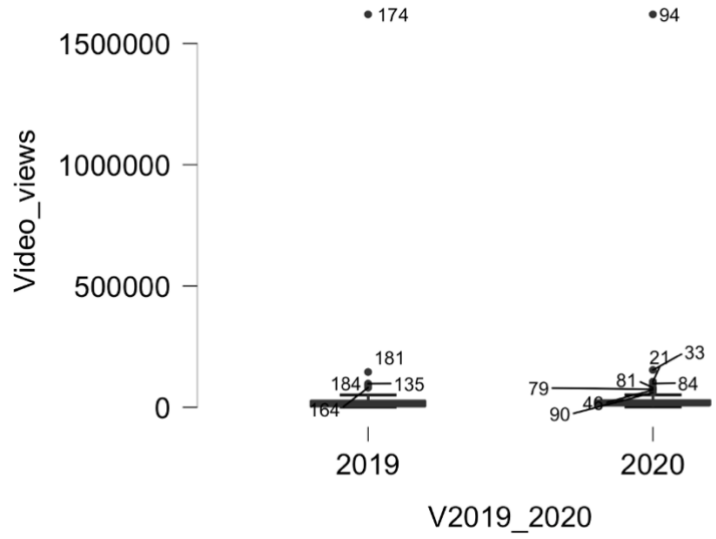


Figure 9. Boxplot of Video Views at CERN

Figure 9 depicts video numbers 174, 94, 181, and 21 gained the maximum viewership during 2019 and 2020. Videos 174 and 94 received more than one million video views in 2019 as well as 2020, depicted as extreme outliers.

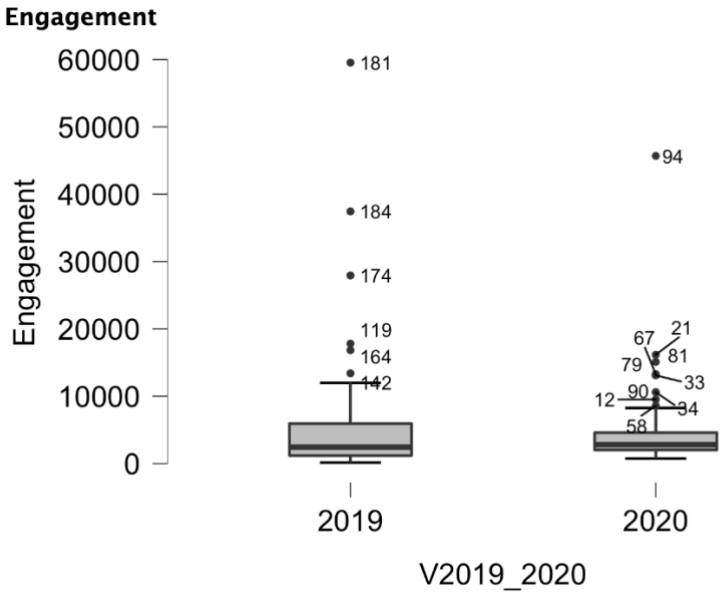


Figure 10. Boxplot of Video Engagement at CERN

Similarly, Figure 10 depicts video numbers 181, 184, 94, 119 and 21 received the maximum engagement from the Facebook audience.

All video numbers are mentioned according to Table 28 mentioned in the Appendix section.

The most viewed CERN video of 2019 and 2020

Figure 11. Voyage into the world of atoms

Video 174 mentioned above was published on Valentine's Day in 2019 taking viewers on a journey to the heart of the matter. The animation shows the structure of matter at smaller and smaller scales by zooming into a human hair, passing through hair cells, fibril structures, keratin molecules, carbon atoms, nuclei, neutrons, protons, and finally quarks. The video was again published on 31st March 2020 shown as video 94 in Figure 11. This video became the most liked video of the year. It is 2 minutes in length, landscape orientation, and falls under the Physics theme. It consists of text on video and does *not* consist of the following:

- CERN branding
- customised thumbnail
- music
- audio narration

This popularity could be explained by the simple concept of the video that resonated with a mass audience to understand particle physics and the basic building blocks of matter that constitute our everyday life. Previous studies like Bishop, 2006 also suggest that using analogies can be a valuable tool in helping people to connect with complex new subjects based on the knowledge or experience that they already possess.

Another interesting metric to look at beyond video views is audience retention of the video – a metric that shows how well a video is holding the attention of the viewers (Facebook for Media, 2018).

Figure 12 depicts the absolute audience retention that measures how many viewers are still watching the video during the entire course of the video.

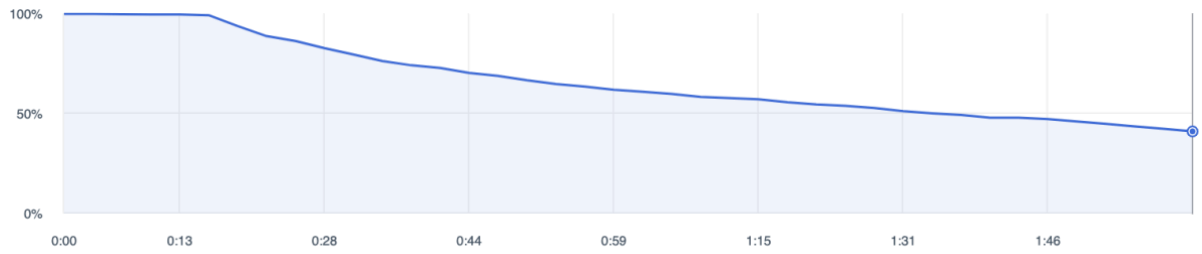


Figure 12. Audience Retention Across the Video

For this graph, only views over 15 seconds were counted to help gain an insight into quality views. It is important to recognise that video views are not linear. Viewers can skip the previous intro, play until 15 seconds, then skip to the 30 second mark and then replay the whole video from the start. Nevertheless, a retention curve helps understand how effective the video was in capturing the attention of the viewers by revealing the retention percentage across the time frame of the entire video. The average percentage viewed of the "Voyage into the world of atoms" video is 67.8% and the video managed to keep 41% retention until the end of this video, which is considerably higher as compared to Facebook videos of similar length.

The most engaging CERN video of 2019

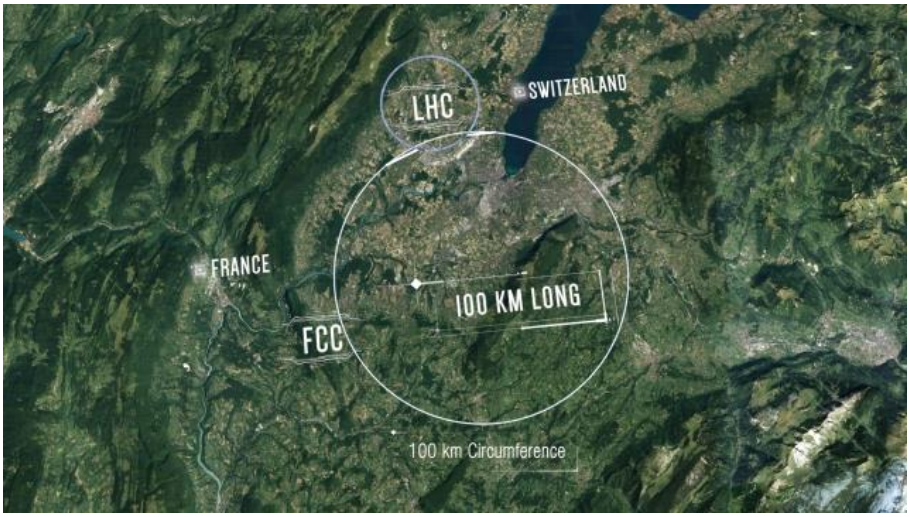


Figure 13. Future Circular Collider

Video 181 mentioned above is 2 minutes in length, landscape orientation, and falls under the Accelerators theme. The video was launched when the Future Circular Collider collaboration submitted its Conceptual Design Report for a post-LHC large-scale research facility in particle physics. The video consists of CERN branding, music, audio narration, human element and does *not* consist of the following:

- customised thumbnail
- text on video

The words that people use can provide important insights into their thoughts and emotions. In order to explore further the audience engagement on this video, the language used by participants in the comments thread was analysed using Linguistic Inquiry and Word Count (LIWC), an automatic text analysis program that counts the percentage of words in a variety of linguistically and psychologically meaningful categories, including categories relating to specific topics (e.g. body and health-related language), emotions (e.g. anxiety), and social relationships (e.g. family-related word use) (Pennebaker, Boyd, Jordan, & Blackburn, 2015). LIWC has demonstrated reliability and validity as a method for assessing psychological constructs, particularly those related to emotion (Tausczik & Pennebaker, 2009).

For the analysis, the percentage of words in each category was computed. Applying this technique allows for a direct comparison of emotional content and cognitive processes towards the FCC at CERN among the online audience. The percentage of words used across a number of categories was used to identify the most common themes in the comments. It is important to note that characterizing comments as ‘‘pro-FCC” or ‘‘anti-FCC” greatly oversimplifies. The focus of the current study, therefore, is the content of the actual statements, claims, and comments that individuals make rather than the classification of two sides. All identified comments (N=280) were aggregated into a single Excel spreadsheet. Commenters’ names as well as the names of other Facebook users to whom statements were directed, were removed from the dataset. In addition, all image files (memes or gifs) and HTML tags were removed. The text on meme images was not retained for analysis because the focus of the current research was on the words, sentences, or phrases originated by commentators when discussing the Future Circular Collider at CERN.

Figure 14. Most Frequent Words Commented in the FCC Video Comments Section

Figure 14 depicts the most popular words in the comments section of the Future Circular Collider (FCC) video were nature, collider, Large Hadron Collider (LHC), physics, CERN, Higgs, Earth, flat and Circular Electron Positron Collider (CEPC).

Interestingly, the word "theory" is more popular among comments critical of the FCC, while "understanding" and "applications" appears in comments more positive towards the FCC. Similarly, 'flat Earth' and 'black hole' are mostly seen in comments critical of the FCC, while 'Higgs boson' references appear mostly in comments positive towards the FCC. The word "nature" appeared the most frequent number times in the comments suggesting a strong link to environmental concerns among the online community.

Top engaging videos of 2019

Figure 15. Opening of the ALICE Experiment

Video 184 mentioned above announced the opening of the doors of the ALICE experiment to allow scientists and technicians to work on the detector upgrade. The video is 53 seconds long, landscape orientation, and falls under the Experiments theme. It consists of raw audio and a human element. It does *not* consist of the following:

- CERN branding
- customised thumbnail
- music
- text on video
- audio narration

The popularity of the video among the audience could be explained by the authenticity of the video with a real-time glimpse of the laboratory in its true glory and sound. The video was Facebook's special 360-degree video that is recorded using a special set of cameras to show all 360 degrees of a scene simultaneously. This means that when the video is playing, viewers could choose from what angle they want to see inside the cavern of the ALICE experiment.

Top engaging videos of 2019

Figure 16. Superconducting Magnet Cables

Video 119 mentioned above was part of CERN's weekly Guess What It Is social media series published every Friday. In this series, CERN publishes a glimpse of an experiment, lab, or machine asking followers to guess what the picture is about. Subsequently, CERN engages in the comments section by posting the answer and acknowledging winners who guessed the answer correctly. This 12-second-long video is in square orientation and falls under the Experiments theme. It consists of raw audio and a human element. It does *not* consist of the following:

- CERN branding
- customised thumbnail
- music
- text on video
- audio narration

"Guess What It Is" is CERN's most popular social media series in terms of engaging the audience. This Friday series' social posts witness a vast range of comments, from viewers with no or limited scientific background, such as students attempting to relate machines shown in the picture to everyday objects and CERN members trying to guess and give more information about the work. This series also encourages viewers to come back on CERN social media to learn about the answer later out ~~by~~ interest or when notified. Publishing more videos as part of this series could be highly rewarding.

Top engaging videos of 2019

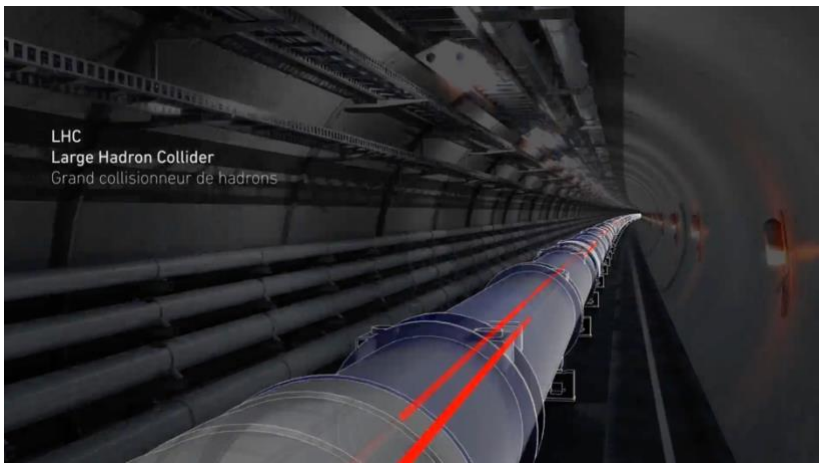


Figure 17. Working of the LHC

Video 21 mentioned above was published to celebrate the anniversary of the day when for the first time, the proton beam was steered through the world's most powerful accelerator, the Large Hadron Collider. The video is 2 minutes and 52 seconds long, in landscape orientation, and falls under the Accelerators theme. It consists of CERN branding and music. It does *not* consist of the following:

- customised thumbnail
- text on video
- audio narration
- human element

CERN operates a complex of eight accelerators and two decelerators. The LHC is supplied with protons by a chain of four accelerators that boost the particles and divide them into bunches. The accelerators are controlled by operators 24 hours a day from the CERN Control Centre. Understanding the working of CERN's accelerator complex is a vast subject to be communicated to CERN's social media audience and videos such as "Working of the LHC" remain one of the most engaging subjects. It presents an opportunity for CERN's social media team and scientists to answer questions in the comments and develop a greater understanding, curiosity and interest in particle physics and fundamental science.

Least Viewed and Engaging Video of 2019

Figure 18. La Nuit Est Belle (The Night is Beautiful)

CERN participates in the annual *"La nuit est belle!"* event, which involves switching off the lights throughout the Greater Geneva area for one night. The initiative is aimed to raise awareness among local residents of the Greater Geneva area about the harmful effects of light pollution and encourage them to save energy and protect the nocturnal biodiversity.

This video was in French catered to the local community encouraging them to participate by turning off the lights and watching the stars. It is 32 seconds long, in square orientation, and falls under the At CERN theme. It consists of music, text on video and human element and does *not* consist of the following:

- CERN branding
- customised thumbnail
- audio narration

Although *La nuit est belle!* is a local event, the mission comes with a cause that shares global concern towards the environment. The event can further be enthused with videos in both English and French to include a broader audience on CERN social media and encourage readers to switch off lights in homes in their regions. CERN's popular hashtags, such as #CERNImpact, could be used to share goals aimed in coherence with the European Strategy for Particle Physics that includes minimising the environmental footprint of future facilities as one of its key priorities.

Least Engaging Video of 2019

Figure 19. Festive Physics at CERN

CERN sends festive greetings to its online community every year. In 2019, a 2-second glimpse of Santa Claus visiting the ATLAS experiment at CERN was published. The video was in landscape orientation and falls under the At CERN theme. It consists of a human element, and does *not* consist of the following:

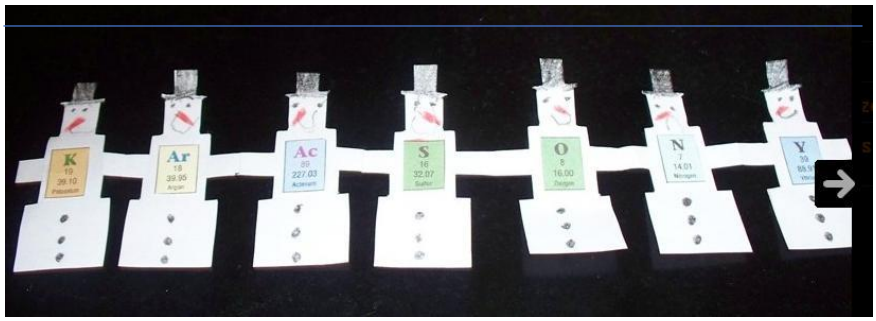
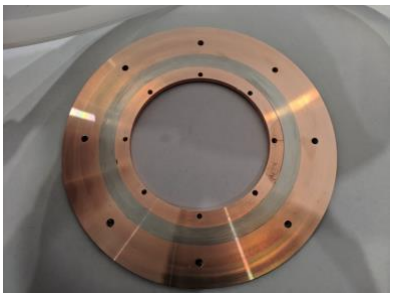
- CERN branding
- customised thumbnail
- music
- text on video
- audio narration

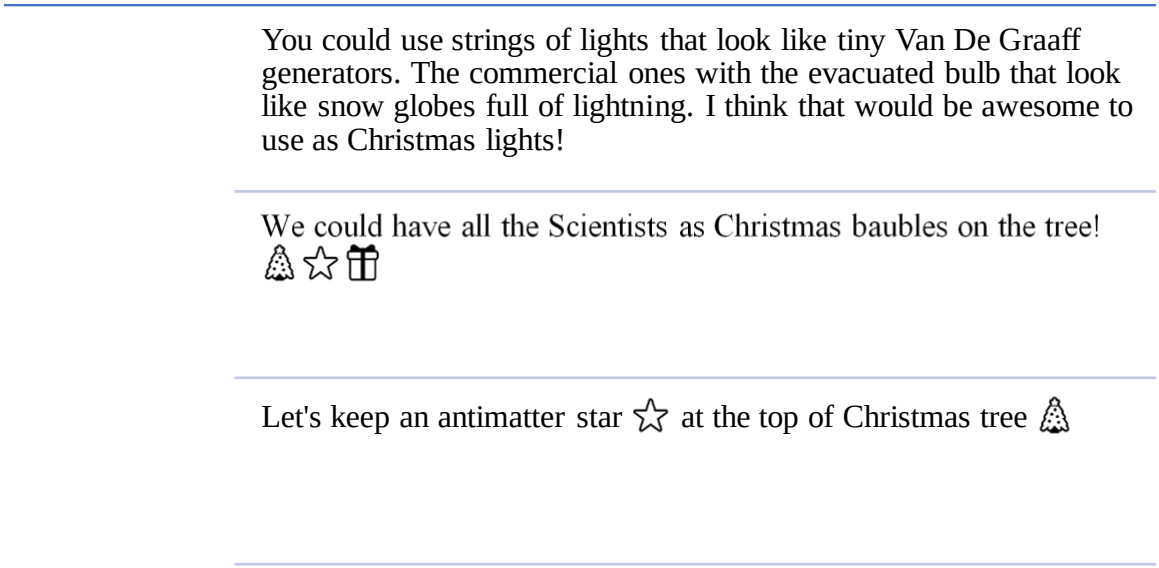
In 2020, a similar post was published with a slightly different caption and witnessed more quality engagement among the audience, even though the number of comments remained almost the same.

Table 3. Caption Difference on CERN's Festive Post in 2019 vs. 2020

Less Engaging	More Engaging
	

Table 4. Audience Comments on CERN's Festive Post in 2019 vs 2020

2019 (1K likes, 54 commetns)	Merry Christmas All we want for Christmas is higher data rate acquisition! Thank you and Happy 2020
2020 (662 likes, 28 comments)	My son made this when he was 5 years old. He cut some elements from the periodic table and glued them to a snowman (which was cut out from paper) The word means Christmas in the Hungarian language.  I suggest decorating your Christmas tree with a garland in the form of a spiral to the top of the tree, along which all the particles of your standard model move. And the spiral at the peak is completed by a star named the Higgs Boson. The entire material world in the universe moves in a spiral to the beat of beautiful music "Love in Mexico " - Carmen María and Edu Espinal. May be for the material world of the universe, this beautiful music sounds like the Higgs Boson on this Christmas night?... Our superconducting pancake coils would look great in there! Made and being tested in the adjacent building 



CERN's social media channels witness a global audience from across different countries and cultures. Though many viewers may or may not relate to Santa Claus or Christmas, the festive post in 2020 witnessed more quality comments when asked to share ideas to decorate a Christmas tree. The comments section was filled with ideas inspired by physics to decorate the Christmas tree.

Analysis of Factors Influencing CERN Videos

As outlined earlier, this study aims to evaluate the effect of the following video elements:

1. Video Theme
2. Time of publishing
3. CERN branding
4. Customised Thumbnail
5. Music
6. Text on Video
7. Audio Narration
8. Human Element
9. Video Orientation

Kruskal-Wallis Test

Kruskal-Wallis test, or one-way ANOVA on ranks is a non-parametric method used for comparing two or more independent samples of equal or different sample sizes. The following test demonstrates the most popular video themes and time of publishing that garnered the most viewership and engagement on CERN videos.

1. Influence of Video Themes

Table 5. Most popular Video Themes Based on Viewership

Video Themes	Mean	SD	N
Accelerators	21,010	9,565	22
Physics	20,639	13,563	16
Educational Activities	20,471	11,761	13
Knowledge Sharing	19,954	18,964	7
At CERN	17,105	11,103	29
Experiments	14,881	11,325	26
Engineering	12,824	8,316	12
Others	9,108	9,675	26
Computing	7,241	5,707	14

Table 5 shows the video themes that gained the most viewership on average during 2019 and 2020. Accelerators are the most watched theme, whereas Computing videos were the least watched. The maximum number of videos were produced in the "At CERN" theme that covers, for instance, life at CERN during COVID-19 or career opportunities at CERN. The least number of videos were produced in Knowledge Sharing, which nonetheless remains among the top four of the most watched video themes.

Table 6. Kruskal-Wallis test for Video Themes and Video Views

Factor	Statistic	df	p
Video_Theme	40.952	8	< .001

Table 6 shows the p-value of video themes on viewership is less than 0.05. Hence, we reject the hypothesis that the mean of all video theme groups is equal. In other words, the role of themes is highly significant for viewership on CERN's Facebook page.

Table 7. Most popular Video Themes Based on Engagement

Video Themes	Mean	SD	N
Physics	4,709	3,039	16
Knowledge Sharing	4,558	4,163	7
Accelerators	4,216	2,062	22
Educational Activities	3,202	1,789	13
Engineering	3,204	1,536	12
Experiments	2,985	1,972	26
At CERN	2,906	1,977	29
Others	2,227	2,223	26
Computing	1,884	1,630	14

Table 7 shows physics-related videos gather the most engagement among the audience on CERN's Facebook page. On average, computing remains the least favourite in terms of viewership as well as engagement. Although there exists only a small fraction of Knowledge Sharing videos produced by CERN, these videos perform significantly high in terms of engagement with CERN's followers.

Table 8. Kruskal-Wallis Test for Video Themes and Engagement

Factor	Statistic	df	p
Video_Theme	35.799	8	< .001

Table 8 shows the p-value of video themes on engagement is less than 0.05. Hence, we reject the hypothesis that the mean of all video theme groups is equal. In other words, the role of themes is highly significant for engagement on CERN's Facebook page.

2. Influence of Time of Publishing

Table 9. Most Popular Time of Publishing Based on Viewership

Time	Mean	SD	N
Morning (6.00 – 12.00)	18,878	11,850	44
Afternoon (12.00 – 18.00)	12,174	10,598	63
Evening (18.00 – 00.00)	16,799	12,038	57

Table 9 shows videos published on Facebook during morning hours as per Central European Time were the most successful in gaining the most viewership on average during 2019 and 2020.

Table 10. Kruskal-Wallis Test for Time of Publishing and Viewership

Factor	Statistic	df	p
Time	12.854	2	0.002

Table 10 shows that the importance of publishing time to receive high viewership with CERN videos is highly significant.

Table 11. Most Popular Time of Publishing Based on Engagement

Time	Mean	SD	N
Morning (6.00 – 12.00)	3,655	2,465	44
Afternoon (12.00 – 18.00)	2,718	2,242	63
Evening (18.00 – 00.00)	3,453	2,268	57

Table 11 shows videos published on Facebook during morning hours as per Central European Time also gained the most engagement on average during 2019 and 2020.

Table 12. Kruskal-Wallis Test for Video Themes and Engagement

Factor	Statistic	df	p
Time	8.886	2	0.012

Table 12 shows that the importance of time of publishing to receive high engagement with CERN videos is quite significant.

Comparing group means with t-tests

Several statistical hypothesis tests can be used to assess the statistical significance of the difference between two sample means. The t-tests are based on a test statistic following the Student's *t*-distribution under the null hypothesis that the population means are equal (Lehmann E. , 1992).

A total sample of 184 videos was dummy coded with 1 (present) and 0 (not present) for each variable. For instance, if a video is coded as 1 for music, music is present in this video whereas if it is coded as 0, it means music is not present in this video. When these variables are measured with or without their presence in online videos, a t-test can be used to compare the group means. While *t*-tests evaluate the statistical significance of group differences (or: how surprising is the effect?), effect sizes quantify the size of the differences (or: how wrong would it be to reject the alternative hypothesis H1?).

Effect size Cohen's d

While statistical tests like the t-test assess the statistical significance between two groups, effect sizes are a way to calculate and compare the size of the differences.

Cohen, 1988 defines the effect size of the group differences in behavioural science according to the combined area covered by two equal-sized equally varying normal distributed populations, which is not overlapping:

- Small effect $d_c = 0.2 - 0.4$, 15% not overlapping
- Medium effect $d_c = 0.5 - 0.7$, 33% not overlapping
- Large effect $d_c \geq 0.8$, 47% not overlapping

Furthermore, the effect size is usually reported along with the respective confidence intervals when using statistical significance testing (Cohen, 1988).

Mentioned below are the outlined factors that may influence viewership and engagement with CERN videos and confirms how small, medium or large is the effect of each factor, if at all.

1. Influence of CERN branding

Table 13. Kruskal-Wallis Test for Video Themes and Engagement

	Group	N	Mean	SD	SE
Engagement	0	71	3061.873	2304.384	273.480
	1	93	3379.312	2351.324	243.821
Video_views	0	71	13813.254	11663.829	1384.242
	1	93	17052.032	11607.281	1203.619

Table 13 shows that during 2019 and 2020, CERN published 71 videos without branding and 93 videos with branding. Sample videos without branding gained an average of 3,061 engagements and 13,813 views. Sample videos with branding gained an average of 3,379 engagements and 17,052 views.

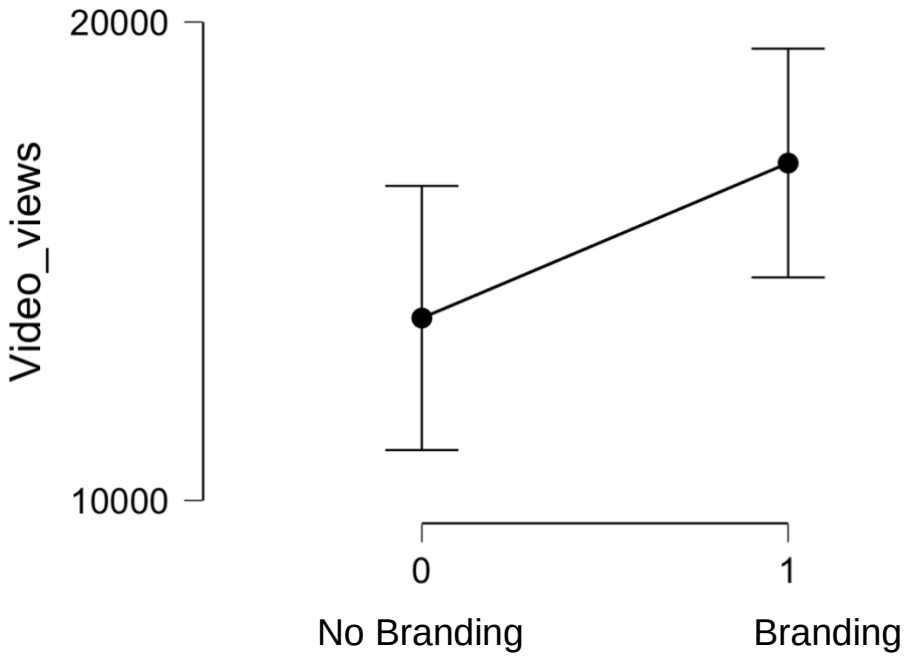


Figure 20. Video views on CERN Videos with No Branding vs Branding

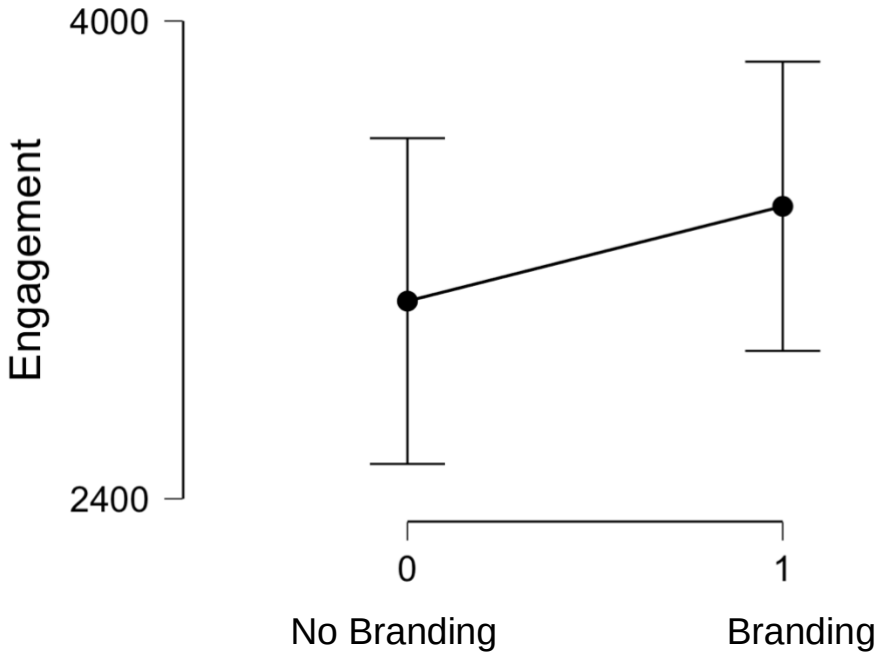


Figure 21. Engagement with CERN Videos with No Branding vs Branding

Figures 20 and 21 depict that viewership and engagement are higher for videos with CERN branding.

Table 14. Independent Samples T-Test for Videos with No Branding vs Branding

					95% CI for Cohen's d	
	t	df	p	Cohen's d	Lower	Upper
Engagement	−0.864	162	0.389	−0.136	−0.445	0.173
Video_views	−1.767	162	0.079	−0.278	−0.588	0.032

Note. Student's t-test.

Table 14 shows though engagement is higher for videos with CERN branding, this difference is not significant. Similarly, videos with CERN branding witnessed high viewership, however, this difference is of a statistical significance of 7%.

2. Influence of Customised Thumbnail

Table 15. Group Descriptives for Influence of Thumbnail on CERN Videos

	Group	N	Mean	SD	SE
Engagement	0	139	3192.964	2297.251	194.850
	1	25	3513.880	2532.740	506.548
Video_views	0	139	15258.899	11705.081	992.812
	1	25	17823.720	11715.246	2343.049

Table 15 shows that during 2019 and 2020, CERN published 139 videos without a customised thumbnail and 25 videos with a customised thumbnail. Sample videos without a customised thumbnail gained an average of 3,192 engagements and 15,258 views. Sample videos with a customised thumbnail gained an average of 3,513 engagements and 17,823 views.

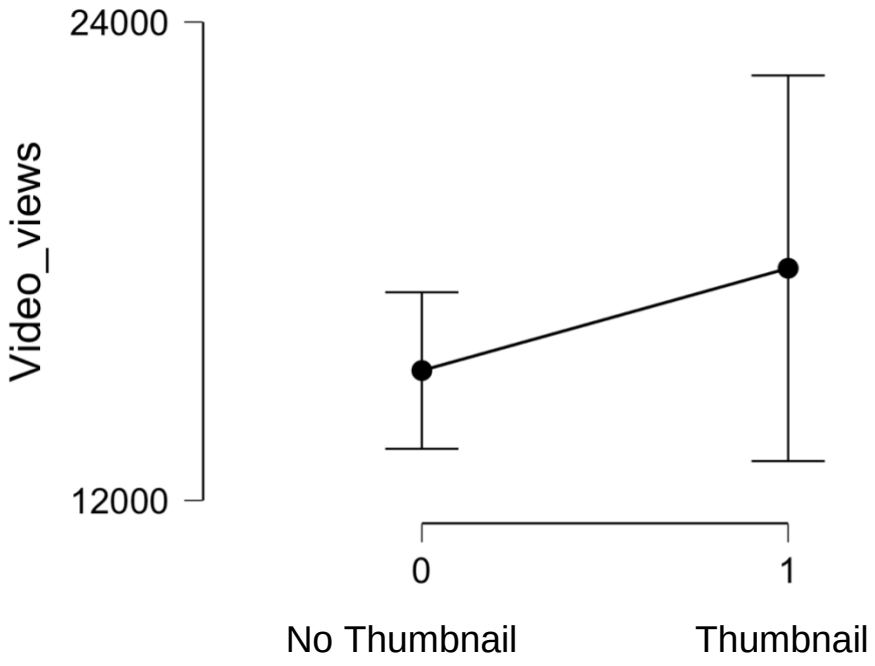


Figure 22. Video views on CERN Videos with No Thumbnail vs Thumbnail

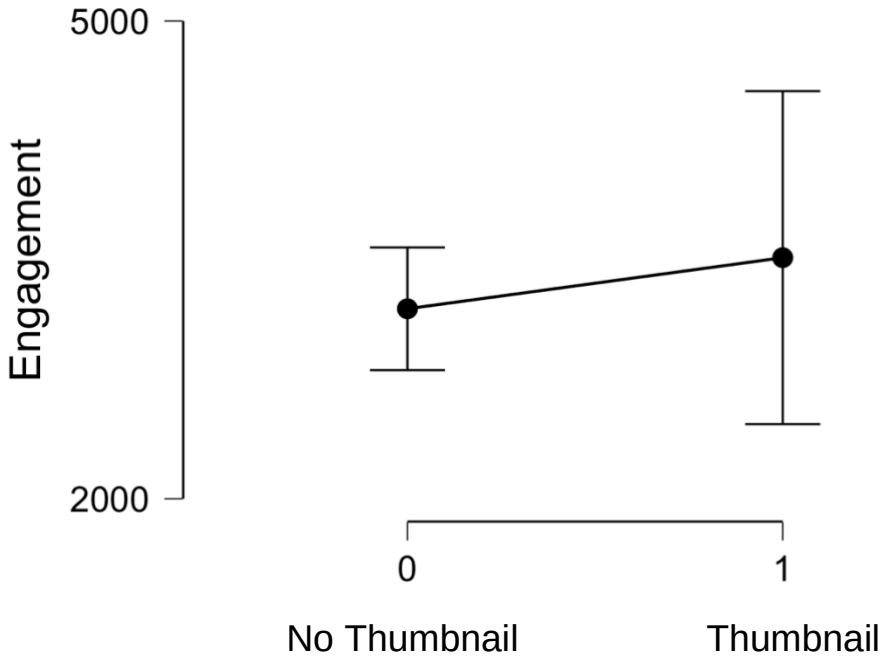


Figure 23. Engagement with CERN Videos with No Thumbnail vs Thumbnail

Figures 22 and 23 depict that viewership and engagement are higher for videos with customised thumbnails.

Table 16. Independent Samples T-Test for Videos with No Thumbnail vs Thumbnail

					95% CI for Cohen's d	
	t	df	p	Cohen's d	Lower	Upper
Engagement	−0.633	162	0.528	−0.138	−0.563	0.289
Video_views	−1.009	162	0.315	−0.219	−0.645	0.208

Note. Student's t-test.

Table 16 shows the impact of customised thumbnails on engagement and viewership on online videos was not statistically significant.

3. Influence of Music

Table 17. Group Descriptives for Influence of Music on CERN Videos

	Group	N	Mean	SD	SE
Engagement	0	66	3000.682	2191.297	269.730
	1	98	3404.327	2415.310	243.983
Video_views	0	66	12169.000	9534.962	1173.673
	1	98	17994.143	12473.800	1260.044

Table 17 shows that during 2019 and 2020, CERN published 66 videos without music and 98 videos with music present in the video. Sample videos without music gained an average of 3,000 engagements and 12,169 views. Sample videos with music gained an average of 3,404 engagements and 17,994 views.

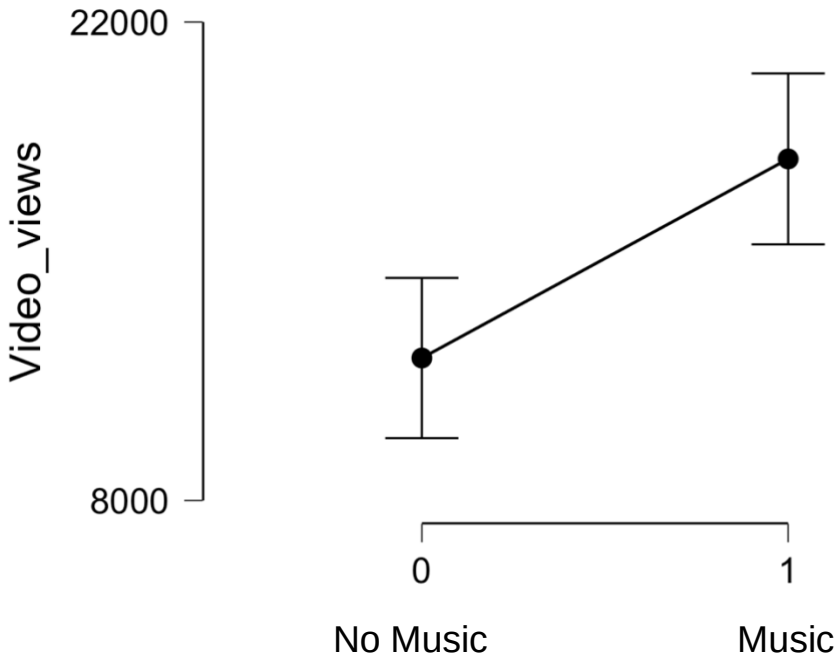


Figure 24. Video views on CERN Videos with No Music vs Music

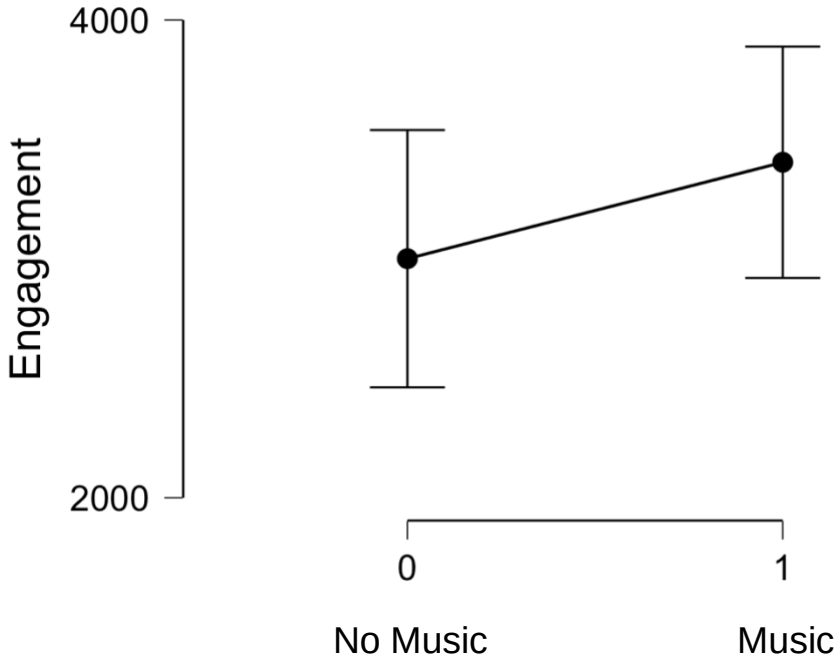


Figure 25. Engagement with CERN Videos with No Music vs Music

Figures 24 and 25 depict that viewership and engagement are higher for videos with music.

Table 18. Independent Samples T-Test for videos with No Music vs Music

					95% CI for Cohen's d	
	t	df	p	Cohen's d	Lower	Upper
Engagement	−1.089	162	0.278	−0.173	−0.486	0.140
Video_views	−3.213	162	0.002[a]	−0.512	−0.828	−0.194

Note. Student's t-test.

Table 18 shows presence of music is highly significant in boosting viewership with a high statistical significance of 0.2%. For video views, the absolute value of Cohen's d is equal to 0.5, which means there is a medium effect of music on video views. The impact of music on creating engagement with online videos was not statistically significant.

4. Influence of Text on Video

Table 19. Group Descriptives for Influence of Text on CERN Videos

	Group	N	Mean	SD	SE
Engagement	0	102	3300.735	2232.039	221.005
	1	61	3154.656	2516.441	322.197
Video_views	0	102	16140.824	11882.429	1176.536
	1	61	14856.377	11557.358	1479.768

Table 19 shows that during 2019 and 2020, CERN published 102 videos without the presence of text on videos and 61 videos with text on videos such as subtitles or textual explanation. Sample videos without text on it gained an average of 3,300 engagements and 16,140 views. Sample videos with text on it gained an average of 3,154 engagements and 14,856 views.

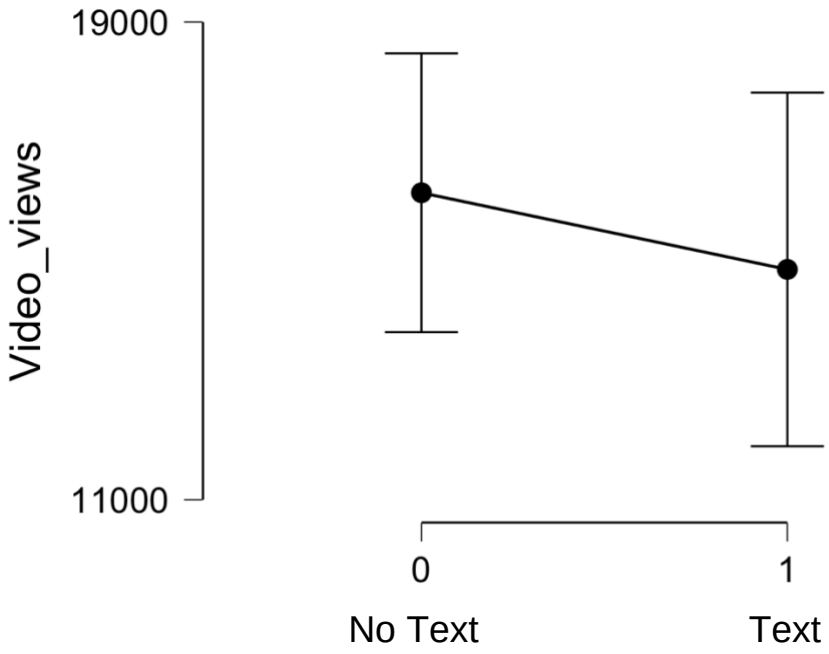


Figure 26. Viewership with CERN Videos with No Text vs Text

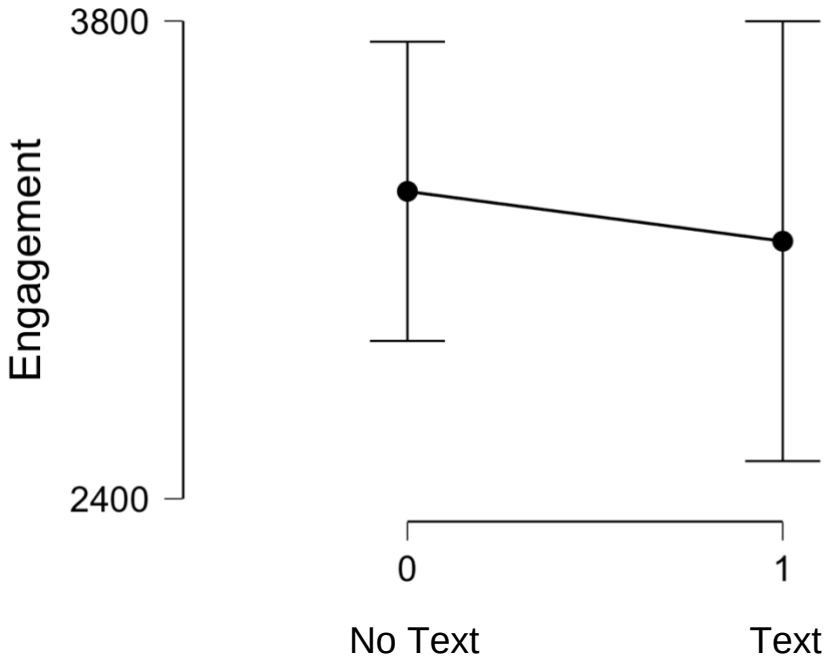


Figure 27. Engagement with CERN Videos with No Text vs Text

Figures 26 and 27 depict that viewership and engagement are lower for videos with text.

Table 20. Independent Samples T-Test for Videos with No Text vs Text

					95% CI for Cohen's d	
	t	df	p	Cohen's d	Lower	Upper
Engagement	0.385	161	0.700	0.062	−0.255	0.380
Video_views	0.675	161	0.501	0.109	−0.208	0.426

Note. Student's t-test.

Table 20 shows the impact of having text in online videos as subtitles or textual explanation was not statistically significant in contributing to engagement or video views. It should be noted that the sample data of videos with text (i.e., 61 videos) is quite less as more videos without text (i.e., 102 videos) were published during 2019 and 2020. Larger sample sizes may reveal the role of having text in online videos in contributing to making videos more accessible.

5. Influence of Audio Narration

Table 21. Group Descriptives for Influence of Audio Narration on CERN Videos

	Group	N	Mean	SD	SE
Engagement	0	90	3123.622	2393.293	252.275
	1	74	3385.716	2256.936	262.363
Video_views	0	90	14867.778	12118.487	1277.401
	1	74	16601.081	11194.546	1301.340

Table 21 shows that during 2019 and 2020, CERN published 90 videos without audio narration and 74 videos with audio narration. Sample videos without audio narration gained an average of 3,123 engagements and 14,867 views. Sample videos with audio narration gained an average of 3,385 engagements and 16,601 views.

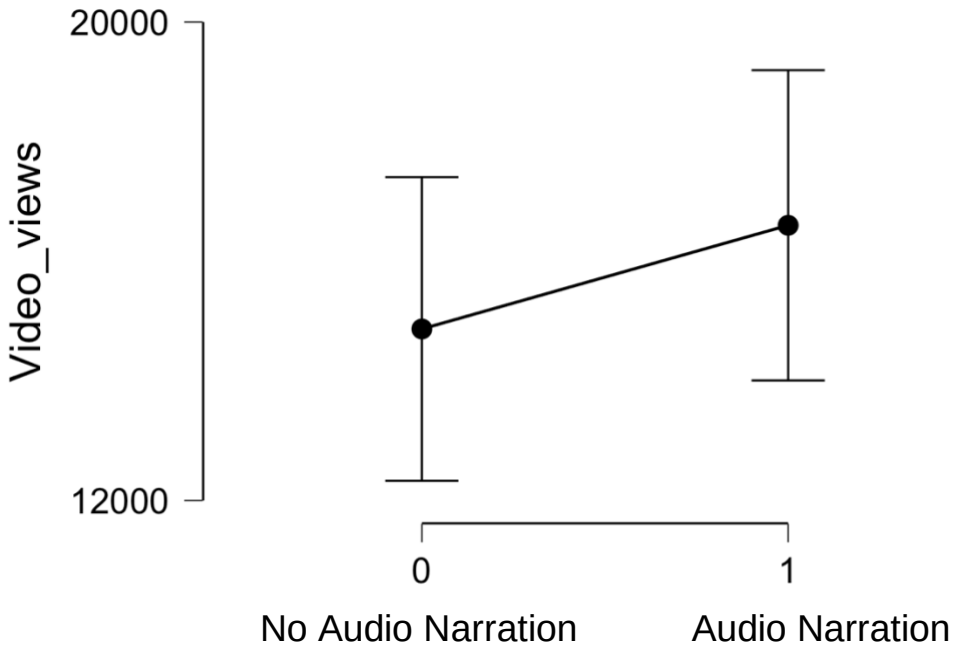


Figure 28. Viewership with CERN Videos with No Audio Narration vs Narration

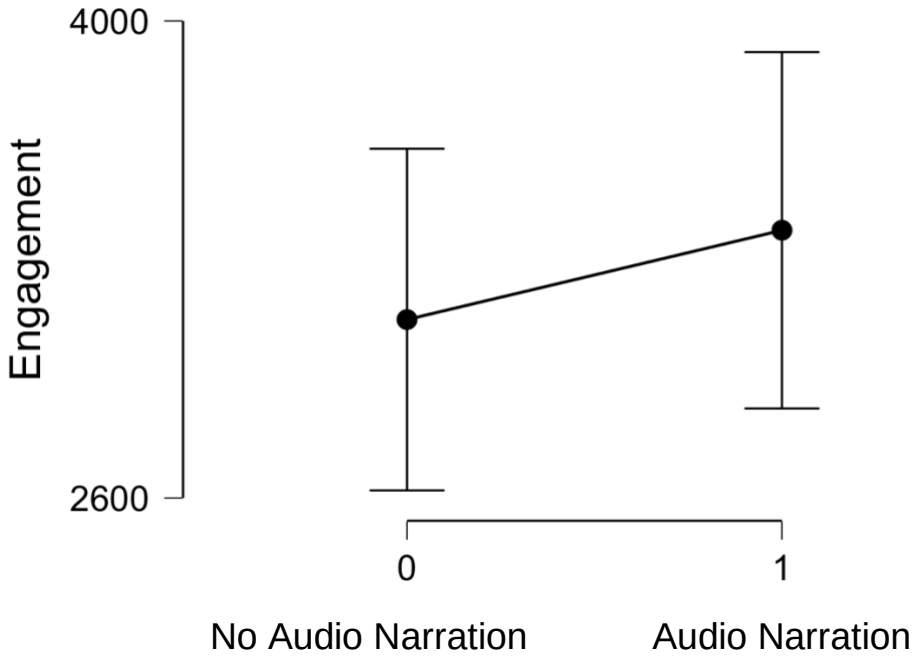


Figure 29. Engagement with CERN Videos with No Audio Narration vs Narration

Figures 28 and 29 depict that viewership and engagement are higher for videos with audio narration.

Table 22. Independent Samples T-Test for videos with No Audio Narration vs Narration

					95% CI for Cohen's d	
	t	df	p	Cohen's d	Lower	Upper
Engagement	−0.716	162	0.475	−0.112	−0.420	0.196
Video_views	−0.943	162	0.347	−0.148	−0.456	0.160

Note. Student's t-test.

Table 22 shows the impact of audio narration in online videos was not statistically significant in contributing to engagement or video views.

6. Influence of Human Element

Table 23. Group Descriptives for Influence of Human Element on CERN Videos

	Group	N	Mean	SD	SE
Engagement	0	36	3436.333	2596.876	432.813
	1	128	3187.195	2256.464	199.445
Video_views	0	36	13584.111	12906.329	2151.055
	1	128	16230.875	11333.751	1001.772

Table 23 shows that during 2019 and 2020, CERN published 36 videos without a human element and 128 videos with a human element. Sample videos without a human element gained an average of 3,436 engagements and 13,584 views. Sample videos with a human element gained an average of 3,187 engagements and 16,230 views.

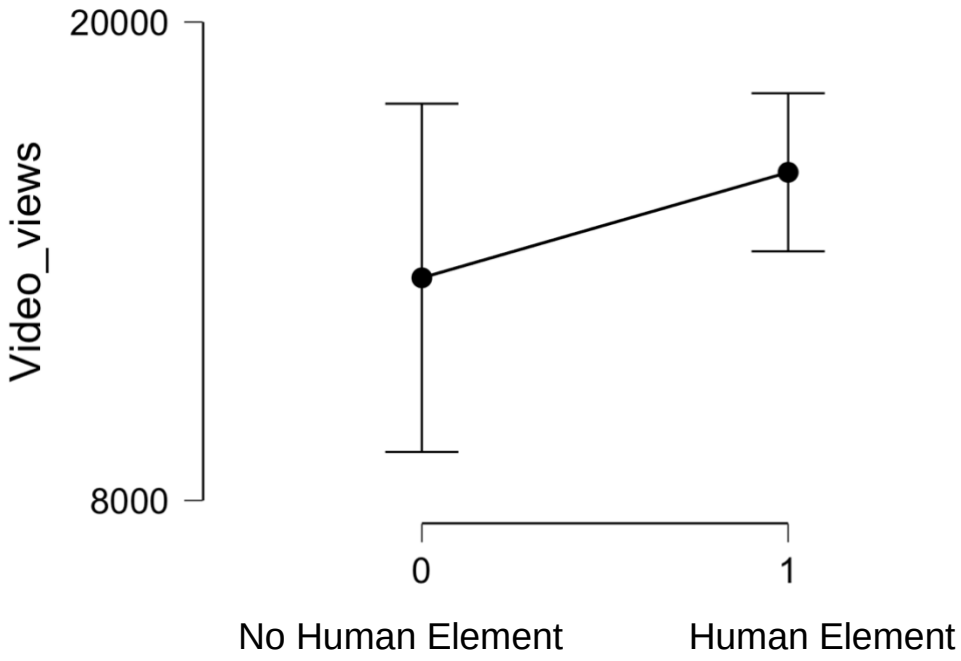


Figure 30. Viewership with CERN Videos with No Human Element vs Human Element

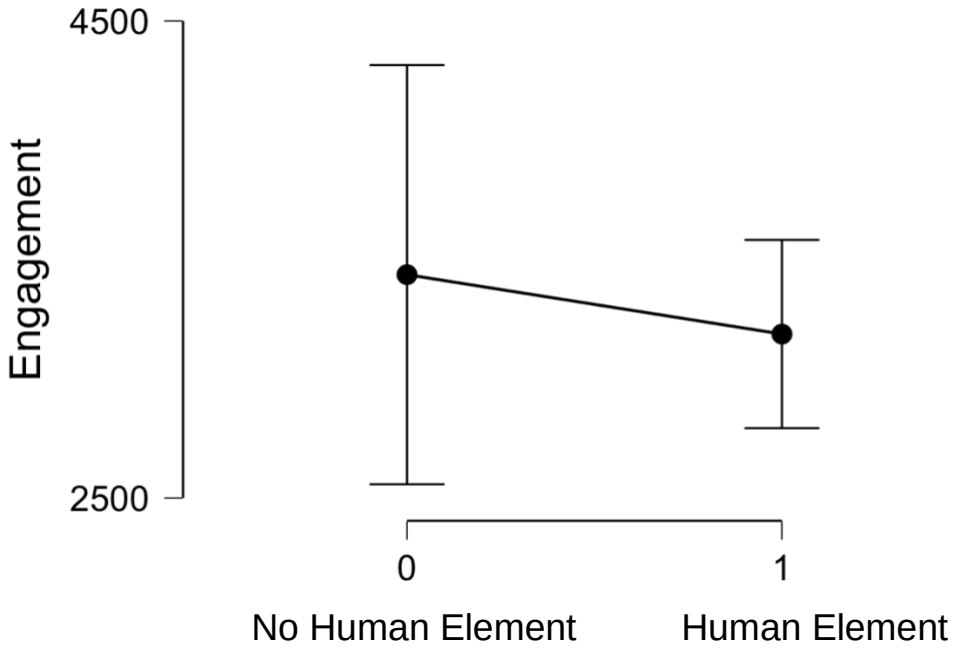


Figure 31. Engagement with CERN Videos with No Human Element vs Human Element

Figures 30 and 31 depict that viewership is higher for videos with a human element but did not witness more engagement.

Table 24. Independent Samples T-Test for Videos with and without Human Element

					95% CI for Cohen's d	
	t	df	p	Cohen's d	Lower	Upper
Engagement	0.566	162	0.572	0.107	−0.263	0.477
Video_views	−1.200	162	0.232	−0.226	−0.597	0.145

Note. Student's t-test.

Table 24 shows that the impact of a human element in online videos was not statistically significant in contributing to engagement or video views.

7. Influence of Video Orientation

Table 25. Group Descriptives for Influence of Video Orientation on CERN Videos

	Group	N	Mean	SD	SE
Engagement	0	127	3434.535	2378.462	211.054
	1	37	2580.622	2046.190	336.391
Video_views	0	127	16819.425	11551.673	1025.045
	1	37	11635.486	11495.140	1889.789

Table 25 shows that during 2019 and 2020, CERN published 127 landscape videos and 37 videos in vertical or square format. Sample videos with landscape orientation gained an average of 3,434 engagements and 16,819 views. Sample videos with square or vertical orientation gained an average of 2,580 engagements and 11,635 views.

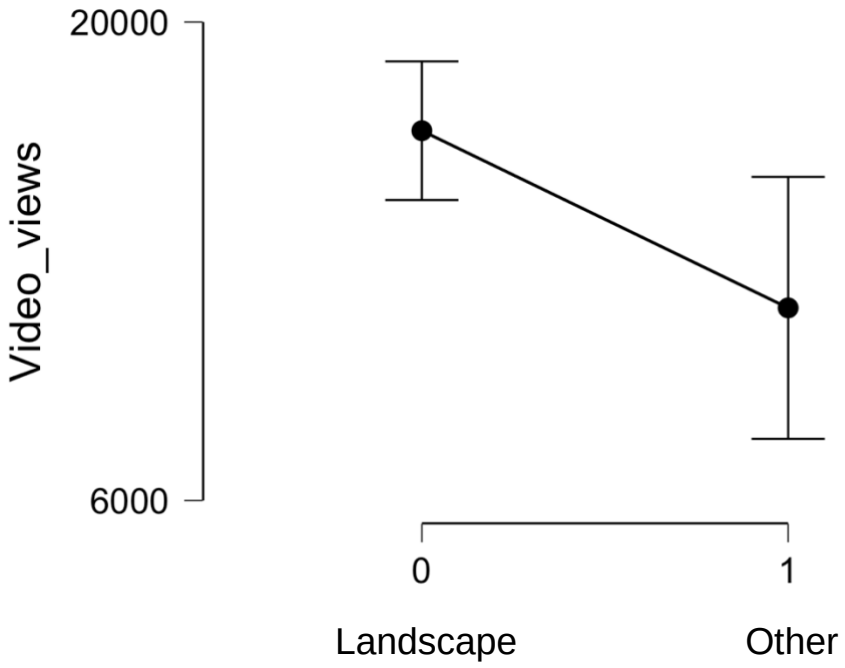


Figure 32. Viewership with CERN Videos with Landscape vs Vertical or Square

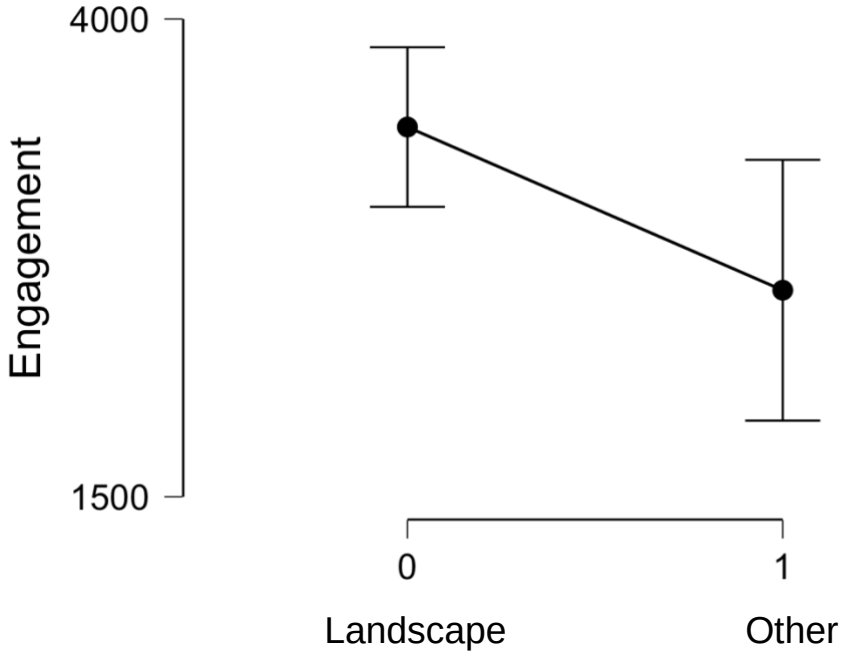


Figure 33. Engagement with CERN Videos with Landscape vs Vertical or Square

Figures 32 and 33 depict that viewership and engagement are higher for videos with a landscape orientation.

Table 26. Independent Samples T-Test for videos with Landscape or Other Ratio

					95% CI for Cohen's d	
	t	df	p	Cohen's d	Lower	Upper
Engagement	1.980	162	0.049	0.370	9.327e −4	0.738
Video_views	2.405	162	0.017	0.449	0.079	0.818

Note. Student's t-test.

Table 26 shows landscape orientation in online videos contributed to more engagement with a statistical significance of 4%. The absolute value of Cohen's d for engagement is equal to 0.3, which means there is a small effect of video orientation on engagement. Similarly, landscape orientation in videos was influential in receiving higher video views with a statistical significance of 1%. The absolute value of Cohen's d is equal to 0.4, which means that video orientation has a small effect on video views.

It should be noted that sample data of videos with square or vertical formats (i.e., 37 videos) is very less as more landscape videos (i.e.., 127 videos) were published during 2019 and 2020. Larger sample sizes may reveal the role of different video orientations contributing to making videos compatible for different devices.

Discussion

The central goal of this project is to provide a macro-level analysis of the impact of CERN videos using a range of viewership and engagement metrics and focusing on the value of different video themes, time of publishing content across the day, and the influence of video elements to enhance visibility. Given CERN's large audience, these videos present a potential for the widespread popularization of science and engage the audience in scientific subjects.

Viewership and Engagement – A Holistic Perspective

The level of impact for CERN videos varies substantially. "Opening of the ALICE Experiment" became one of the most viewed and engaging videos of 2019. Similarly, "Working of the LHC" became one of the most viewed and engaging videos of 2020. "Voyage into the world of atoms" became the most viewed video in 2019 as well as in 2020. This suggests a strong interest among the audience for viewing and engaging in content delving into CERN's accelerator complex, its upgrades and working. Videos demonstrating high degrees of views provide insights into the popularity of CERN videos though other aspects of viewership such as retention curve and watch time should also be considered.

This provides a useful opportunity to understand which parts of the videos captured viewers' curiosity and interest to generate more effective videos.

"Future Circular Collider" became one of the most viewed videos and the most engaging video of 2019. Although the number of comments generated serves as an indicator of involvement, the quantitative metrics alone are not helpful to reveal if the comments are mostly positive or negative. Additional comment-based analyses are recommended that indicate overall favourability or dissatisfaction with the message. Sometimes videos may not generate high viewership or engagement like "La Nuit Est Belle" or "Festive Physics at CERN" due to the regional or cultural relevance of the topic. This is an opportunity to unite the focus towards scientific topics and ideas such as a call for solutions to address light pollution to engage CERN's online audience globally. When the social media audience was asked for science-inspired ideas to decorate the Christmas tree, the engagement in numbers didn't severely increase, however, more insightful comments were witnessed in the comments section.

Topic Interest

As displayed in Table 5 and Table 7, Accelerators and Physics video themes are more favourably received (i.e., scores higher in viewership and engagement) than Computing.

CERN's Computing videos mostly reflect the origin and history of the World Wide Web (WWW), and newly produced multimedia sharing the timeline of this great invention along with its current and forthcoming prospects could help recapture audiences' interest. More online videos on other computing topics such as CERN's Openlab initiatives or career opportunities for students in fields of IT, computer science, quantum technology, etc., could also help incentive interest in computing videos.

Educational Activities appeared to be the third most viewed video theme after Accelerators and Physics, and also one of the top video themes in terms of engagement. This suggests a strong interest in watching physics and educational content among CERN's followers. CERN's educational videos such as "How Melting Ice Cubes Affect Your Sugary Summer Drink" or "Higgs Boson Discovery Explained" performed very well during the coronavirus lockdown as well as in 2019, and could gain more visibility with a strong CERN branding and other video elements such as customized thumbnails.

Similarly, Knowledge Sharing videos piqued high interest among the audience in terms of both viewership and engagement. In fact, Knowledge Sharing is the second most engaging video theme out of CERN's 9 video themes. However, Knowledge Sharing videos were the least produced of all, indicating the demand for more online videos sharing the applications of CERN's technology in society.

Successful Video Elements

Table 27. Most Influential Elements in CERN Videos During 2019 and 2020

Video Elements	Viewership	Engagement
CERN Branding	✓	✓
Customised Thumbnail	✓	✓
Music	✓	✓
Text on Video	✗	✗
Audio Narration	✓	✓
Human Element	✓	✗
Landscape Orientation	✓	✓

Table 27 provides a summary of video elements such as branding, audio, etc., in creating a strong digital presence on social media. Videos with CERN branding and customised thumbnails witnessed high viewership during 2019 and 2020. The presence of music in videos contributed to viewership positively with a high statistical significance and a medium effect as shown in Table 18. This result also creates a foundation for future research on studying the impact of types of music in stirring viewership and engagement among the audience. Online videos with text such as videos containing no audio and only textual explanation do not show strong evidence of high viewership or engaging the audience. Videos with the presence of a human element in the video, such as an experiment spokesperson or a science communicator had high viewership, but it was not as successful in engaging the audience. The role of human element in videos remains a potential area to explore in understanding some aspects such as diversity of presenters or jargon usage by scientists that may play a vital role in engaging CERN's global audience. Lastly, online videos with a classic landscape orientation were seen to be more successful in terms of viewership on Facebook as compared to other formats such as square or vertical.

YouTube and Facebook – A Tale of Two Platforms

The main focus of the study lies in probing online videos related to physics, accelerators, science education, etc., that are universally applicable. But as the media landscape continues to evolve, it is interesting to mention the key differences and recommendations for the two social platforms, YouTube and Facebook, for dissemination of such online videos.

CERN’s Facebook page is followed by approximately 747,056 people while the YouTube channel enjoys 142,000 subscribers as of August 2021. CERN’s Facebook community is much larger than YouTube, though videos are not the only focus on Facebook. Users go to YouTube with the sole intent of watching videos and searching for them on their own. On the other hand, Facebook curates videos for its users. This makes it a lot more essential for video producers to comply with video recommendations for Facebook Feed. Facebook recommends using recognizable branding, using close-in shots, easily legible text, bright colours, and faces for viewing on a small screen and scrolling quickly. For making videos easy to find, eye-catching thumbnails and video tags are crucial (Facebook Blueprint).

It is also resourceful to create a video message to help educate fans on how to find and follow videos on Facebook Watch. Below mentioned is a sample script, but Facebook encourages to create something with a personal touch:

Hi [Page Name] fans, I'm so excited for you to see my new video [Video Title] available on Facebook Watch. Need help finding it? In the Facebook app, tap the Watch icon or find it in the menu, search for [Page Name] and then follow my Page. Once you start following my Page, my latest videos will appear on your Watchlist!

Limitations

Although CERN’s audience spans across many geographical locations and age groups, in terms of the gender of the viewers, the ratio is skewed towards males with up to 71% men and 29% women as shown in Figure 34.

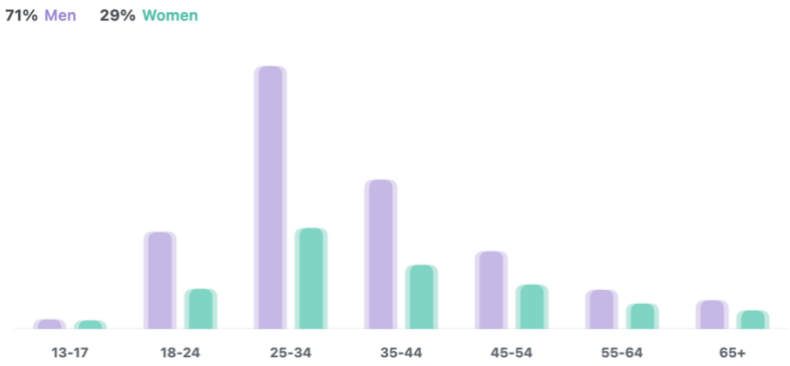


Figure 34. Demographics of CERN's Facebook Audience During 2019-2020

The dataset contains a majority of viewers coming from CERN’s followers and only a section of viewers, particularly 16.2% from Facebook recommendations to someone who has not liked or followed the Page and 14.6% from Shares as shown in Figure 35. To strengthen the generalizability of the results, similar methods to the one provided here may simply be employed with data from other social media platforms.

Figure 35. Who are CERN's Video Viewers on Facebook?

In terms of disciplinary differences, the study was only able to assess 9 video themes as classified by CERN's editorial strategy. Videos sometimes had overlapping themes. For example, the video "CERN wishes you a Happy New Year" is classified as Accelerators but it can also be classified as Experiments or At CERN theme. Similarly, some videos by S'Cool LAB, CERN's physics education research facility, such as "What do dancing raisins and particle detectors have in common?" is classified as Educational Activities but can also fall under the Physics video theme. In fact, video theme names such as "Experiments" can have different annotations to its meaning to different audiences, as an example, an experiment could mean a chemistry or physics lab activity for school students whereas, for CERN personnel, it refers to several facilities that make use of the LHC or other experimental facilities.

Conclusion

Findings from this study suggest CERN videos that were the most viewed and engaged with had a strong production value. The presence of the following elements contributed to the high production quality of a video: 1) CERN Branding, 2) Customised Thumbnail, 3) Music, 4) Audio Narration, 5) Human Element, and 6) Landscape Orientation.

Furthermore, findings question the impact of each of the 9 outlined video elements for a strong digital presence on social media. Consistent with research by Beautemps & André, 2021 this study shows that a human element plays a crucial role in influencing people to watch videos, however, videos are strongly linked to the presenter in the video that can make or break the audience's interest in engaging with the video. Videos sharing applications of CERN's technology and know-how were the most in-demand after Accelerators and Physics themes.

This study also offers comprehensive implications for organisations who seek to consider social media engagement as an antecedent to the development of a mutually beneficial organisation–public relationship. The findings offer practical examples for communicators seeking to look beyond engagement as a one-way, organisation-to-public activity, and

‘‘acknowledge the interconnectedness of organisations and social environments’’ and the need for dialogue with stakeholders (Johnston, 2014). As a result, practitioners who want to engage their audiences through social media should incorporate personal, social, and participatory characteristics into their pages and websites. Previous studies like Smith & Gallicano, 2015 indicate researchers should take a user-constructed approach towards social media participation, considering parameters that include rewards for attention. This is similar to the findings of this study, where online videos witnessed a plethora of insightful comments once encouraged to write ideas and be liked from CERN’s page.

Social media provides a multimedia spectacle for scientific organisations to share science in a fun, engaging and authentic way. Although there are several science channels present on social media, few appear to have effectively harnessed the social web’s potential for engaging and interacting with a large audience. Future research may benefit from exploring the role of asking questions in a video or the post descriptions. Our findings demonstrated that engagement is enhanced when social posts contain an opportunity for the viewers to participate in constructive ways. A text-based analysis is a potentially valuable method for assessing audience perceptions of CERN, and it may provide unique information about specific concerns or arguments presented on social media, which could be used to guide future interventions.

CERN social media represents a new and, with over a million views on its online videos across various platforms, a highly successful form of popularizing science. Given the broader impact of publicly funded research and demonstrated popularity of CERN videos, it is worth taking advantage of the proliferation of social media and its relevant metrics online to investigate further the potential of science communication through videos. This should hence help scientific organisations understand how to best disseminate research to existing and new audiences.

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Appendix

See Table 28