Science on Youtube (That We Know Of)

An Exploration of the New Media Environment of Youtube and its Effects on Popular Science Communication Videos

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1. Introduction

The last number of decades have seen dramatic changes in the accessibility and distribution of new forms of technology and with it shifts in methods of communication and information sharing. The internet has become the main source of information for a large percentage of the world's population. The fleetingly dominant television has become less relevant as both a medium for entertainment and information and has been replaced with online platforms. Public discourse looks very different, with social media platforms facilitating a participatory culture which encourages the expression of opinion, disregarding whether or not that opinion is informed. The element of engagement is a new development, especially the extent of its importance in this new media. Print media, radio and television did incorporate varying degrees of audience engagement but there remained a level of separation that no longer exists. The internet has become noticeably more pervasive in our society far quicker than the emerging technologies of the past. It is continuously changing how the population accesses information and what kind of information is available. As a result, online science communication is also experiencing significant changes. It is now subject to a variety of new challenges such as information overload, less control over sources of scientific information, and the influence of platforms on what information gets communicated and how.

We are experiencing a "platformization of culture" according to Cho (2021) wherein cultural production as well as various forms of dissemination and consumption have become entirely

dependant on digital platforms to the extent that art and entertainment are “shaped, mediated , and sustained by platform’s infrastructural, economic and administrative operations” (Cho, 2021). I propose that this extends to science communication in the sense that it has become reliant on digital platforms and therefore is also being heavily molded by the affordances of the platforms themselves. One such, highly important platform in the area of science communication is Youtube, which has revolutionised science communication through the affordances of the platform. Through its broad, searchable and tagged archive, accessibility, communicative elements between user and creator such as comments and likes, recommendation system, and monetisation features among various other factors, Youtube has constructed a means of science communication clearly distinct from previous iterations such as journalism and literature, referred to here as popular science videos. These are defined as “a video that focuses on the communication of scientific concepts for a broad audience on the Internet” (Morcillo et al., 2015, p. 1). Popular science videos are the subject of this paper as they represent the most common and more importantly most consumed form of science communication on the platform.

Previous studies have laid out the relevance of studying science videos on Youtube (Boy et al., 2020, Welbourne & Grant, 2016, Allegaier, 2019). Social Blade, a website designed to track Youtube engagement statistics, lists both Science and Technology and Education as two of the top categories of Youtube videos (socialblade.com). Youtube is widely regarded as a useful tool for both formal and informal education (Colás-Bravo & Quintero-Rodriguez, 2023), however the ever changing media landscape, fueled largely by a drive for profit means that the medium is constantly evolving in ways that don’t always align with the values of education. Although

various aspects of Youtube as a medium for education and science communication specifically have been studied, the ever evolving and updating nature of the medium requires constant scrutiny and study. The addition of new elements is bound to disrupt the ecology of the platform and therefore, in accordance with the platformization theory, disrupt the current forms of dissemination and consumption therefore affecting Youtube science communication.

The newest and most relevant update is Youtube shorts which was added in 2021 to the platform in an effort to compete with the new, popular short form video app TikTok as well as every other app that adopted a similar feature was one of the biggest changes to Youtube in recent times. The adaptation of the TikTok formula across platforms, despite the fact that it has been proven to be addictive (Qin et al., 2022), is a direct result of monetisation strategies of Youtube. Shorts have the potential to disrupt the established formula for science communicators on Youtube by disrupting the ecosystem. While it's not yet known the precise ways in which they have had an influence, a provisional analysis here lays out the possibilities. The amount of content uploaded to Youtube continually increases exponentially, thanks to the nature of Shorts and with more content for people to watch, more people are inclined to use the platform regularly. Information overload is already an issue that affects educational content by causing difficulty in differentiating legitimate science communicators and those who may have different intentions. The monetisation of the platform and the impact that Shorts is having on the monetisation aspect of Youtube is also a factor in determining the standing of science communication on Youtube. More users means more marketing opportunities for brands to take advantage of which has effects on both the general interface and on the creation of content to optimise monetisation which both disrupt the established science video formats.

This paper seeks to answer the research question:

What are the effects of the media environment of Youtube as a platform on the form of popular science communication videos and what are some potential effects of changes in the Youtube ecology on the future of popular science videos on Youtube?

A media ecology analysis will allow for a broad view of the interplay of the various affordances of the Youtube platform and how they have shaped the current state of popular science videos on the platform. It allows for a discussion on the potential of factors like Youtube Shorts and rising advertising rates on the established science video format. This approach considers various factors on Youtube as a means for effective, informal yet accessible science communication and allows exploration of the potential effects of the recent developments of the platform on existing forms of popular science communication. In order to answer the research question, a media ecological analysis of the current Youtube environment and its effect on popular science videos is laid out. This paper focuses on an analysis of three science Youtube channels, with three different methods of communicating science and how the medium has influenced both their popularity and their content.

To answer the second part of the research question, a discussion of the potential effects of two imposing aspects of the platform which were identified during the analysis of the videos, monetisation and short-form content, on the future of science communication on Youtube will be carried out. This discussion will be focused on the most recent literature surrounding both

monetisation and short-form content as well as on effective informal learning online to reach a preliminary conclusion upon which to base further research.

Considering Youtube is used so frequently as an educational tool and a place to discover new information, it is vital to continue to assess the affordances of the medium and how it is changing. Youtube is integrated into the lives and homes of billions of people worldwide, many of whom come across scientific content regularly thanks to its popularity. The societal relevance of studying one of the most popular mediums for information sharing cannot be overstated. With a growing amount of content online and an ongoing misinformation crisis, studying the effects of media on science communication is vital (Bucher, 2019).

In the academic realm, this research contributes to the understanding of popular science videos on Youtube and how the features of the platform have shaped them. It also provides some insights into the updated version of Youtube which is yet to be studied with regards to science communication. Although there is extensive and continuous research into Youtube content and the uses of Youtube as a learning resource, a recent analysis of the media ecology of Youtube since the introduction of Shorts does not yet exist. This paper seeks to draw attention to the changing environment of Youtube and its potential effects on the dissemination of science information on the platform.

2. Theoretical Framework

2.1 Science Communication

It is first necessary to define one of the core concepts concerning this research, science communication. The process of science communication is that by which information acquired by scientists is disseminated to the public or those outside the scientific community. It encompasses the complex relationships between science literacy, scientific culture, public awareness and public understanding of science whose collective aim is to elicit responses from the public. These specific responses are identified as, awareness of science, enjoyment or other positive reactions to science, interest in science, to form opinions on science related matters, and understanding of scientific concepts and methods (Burns et al., 2003). These responses are referred to with the AEIOU vowel analogy: Awareness, Enjoyment, Interest, Opinion Forming and Understanding. Science communicators make use of appropriate skills, media, dialogue and activities in order to encourage these responses from the non-expert audience. Science Youtubers fulfil this criteria using the affordances of the medium. Youtube videos are wide reaching, with a diverse and broad audience, allowing for the spread of awareness. Since Youtube is primarily an entertainment platform, the emphasis on enjoyment is a prerequisite to creating popular science content, as is interest. Interest is also fuelled by the affordances of the Youtube algorithm and recommendation system which delivers science videos to those it deems most likely to watch them. The participatory nature of the platform allows for opinion forming through comments and other engagement features and understanding can be developed through both supplementary

materials that often accompany science videos and through direct communication with the science communicator.

There are two distinct modes of science communication, formal and informal. Formal communication settings include educational institutions such as schools and universities and generally consist of more regulated and highly formulated programs to impart scientific knowledge. Informal communication consists of a less structured approach to learning and can be susceptible to decontextualized and fragmented information, particularly when it comes to areas like scientific news reports or social media discourse. Common sources of informal science communication are popular media such as books, television shows and social media such as Youtube, Tiktok or Facebook. The focus of this study is the informal science communication of Youtube videos.

Science communication is a relatively new area of study, particularly in regard to its use on the previously mentioned social media platforms. Studies have been conducted about the use of audiovisual mediums as a tool for science communication and education (Boy et al., 2020, Pattier, 2021, Brame, 2016), however these studies are generally focussed on the use of videos to supplement formal learning and largely fail to address the increasingly available opportunities for informal acquisition of scientific knowledge and as a consequence largely ignore the impact of the media ecology of platforms that are hosting informal science content, such as Youtube. Nonetheless, the use of media studies in understanding science communication through the exploration of the medialisation of science communication and the interactivity between science, the public and media, has been established as a useful approach (Bucher, 2019).

2.2 Media Ecology

The theoretical approach from media and communication studies used to inform this research was media ecology which is described as "the study of media as environments" (1967) by Neil Postman in the first known definition of the field. The basis of Postman's definition is the idea that an environment can be understood as a complex system of messages and therefore media of communication can be studied as environments. An environment structures our lives, introducing implicit rules and specifications for how best to exist within it. By failing to acknowledge media environments as such, and misinterpreting them as simple machines or tools, we run the risk of misunderstanding their effects on us. Media ecology attempts to make the specifications of the limits of our activity within our media environments explicit rather than obscured by their mischaracterisation (Strate, 2017, p.5). Media ecology is a broad, interdisciplinary and evolving field. In the book *Media Ecology: An Approach to Understanding the Human Condition*, Lance Strate outlines the basics of media ecology as it is understood today, which begins with Postman's initial definition and expands from there. In it, he identifies four main terms central to the understanding of media ecology as a field of inquiry: medium, bias, environment and effects. The term media or singular medium refers to a vast spectrum of agents that facilitate communication. According to media ecology these can take many forms from tools and technology to language and signals.

Media ecology is still an underrepresented approach, potentially due to the controversial nature of the works of both McLuhan and Postman; however, it has been adopted as a fruitful methodology across fields that deal with digital media. Media ecology is a prominent approach

in the study of social movements, protest and the role of social media in their formation. A study on the effects of technology and communication arrangements on the organisation and strategy of social movements found that the media for dissemination of information and organisation had an impact on the form of the social movement itself (Trere & Mattoni, 2016). An analysis of the uses of media ecological approaches in studying social movements and the mobilization of protests concluded that due to its ability to aggregate approaches from different fields and to analyse the interrelativity of different elements of social movement organisation and communication, media ecology is a useful tool for studying media and technology in the context of social movements (Treré & Mattoni, 2016). This conclusion is reinforced in an exploration of the 2010 Toronto G20 protests from a social media ecology lens, which analysed various communication efforts across numerous social media platforms and their effects on how information about the protests was disseminated and shaped by the platforms on which it was hosted (Poell, 2014). It can be inferred that media ecology is a useful theoretical model when studying digital environments like Youtube.

One important aspect, not explicitly used by the mentioned studies is the concept of remediation which refers to the interplay of various forms of media within themselves. The idea is based on McLuhan's idea that the content of a medium is another medium (McLuhan, 1964, Ch.1). This is central to the practice of studying media as environments, as environments consist of a host of elements that rely on and interact with each other, continuously contributing to the whole. It is a relevant concept to this research as Youtube is in the process of adopting a new medium, Shorts, into its platform which is understood here as remediation and has the potential to disrupt the current media environment. Ecology studies the variety of interactions of these separate entities

that come together to shape their surroundings. In media ecology, this approach is taken towards media environments, which consist of a variety of interacting elements that each affect the others as well as contributing to the whole. When studying ‘new media’, remediation and transmediation are essential due to the overlap and interactivity between platforms and different media that define the digital era (Cunningham et al., 2016). All of these terms will be further explored as they relate to Youtube and science communication.

2.3 New Media

This paper deals with media as it is understood by McLuhan, Postman and other media ecologists. In their terms, media refers to any way in which information is transferred or indeed translated. This can mean anything from a social networking platform like Facebook to the computer on which one might access Facebook or the air through which sound reaches our ears. Media can be understood to be everywhere and influence almost everything, particularly how we perceive the world around us. However, particular attention will be given to a subset of all media, the dubiously named ‘new media’. The term ‘new media’ can refer both to emerging media that differs in some way from what may come to be considered ‘old media’ or, in a more specific context, it can mean the digital media of today which is largely characterized by computer-mediated high-speed communication and user-generated content (UGC). The new media of today includes technologies such as laptops, tablets and smartphones as well as the Internet, search engines and social media (Brossard & Scheufele, 2013). Social media such as Youtube is particularly relevant as it encompasses the features of new media, being highly accessible, interactive and multimodal. Accessibility refers to both the ease of use of social media and the fact that they are accessible at almost any time in any place. Interactivity refers to

the many ways in which users can navigate their favourite social media sites including elements such as likes, comments, tags and contributing their own content. The multimodal nature of social media sites is important to note, particularly in the context of knowledge acquisition since different modalities have different cognitive impacts. Modalities here refers to modes of communication for example, text, audio, video or picture. Images are useful tools in increasing comprehension of difficult concepts and that they are more effective in transmitting recallable information (Léon & Bourk, 2018). However, pictures are highly ambiguous, the same image might be interpreted in different ways depending on the context in which it is presented therefore they are often accompanied by other modes to aid interpretation (Bucher, 2019).

With the development of new media, the relationship between science communication and media studies changed. The so-called "medialization of science" refers to the increase in media attention towards scientific issues and the repercussions of said media on science (Bucher, 2019). Through the processes of medialisation, science communication has been drastically transformed. Visualization or the use of visual representation was revolutionary in this process. Documentary visuals such as experiments and science talks, where people could physically see science unfolding before them, technical visuals referring to devices such as microscopes or x-ray, and data visualisations such as charts and infographics have all contributed to the overall comprehension of science as well as influenced how science is done. This is only enhanced by digital media which has the ability to integrate various forms of visual and textual modes. The idea of medialisation, that media both shapes the communication of science and reflexively impacts the process of science itself informs the argument that the Youtube platform has shaped science videos.

2.4 Participatory Culture and Convergence Culture

Web 2.0 was an evolution of the original web with new and improved features. This new iteration boasted more interactive interfaces, allowing users to both access and contribute to content on websites. Web 2.0 encouraged and developed collaboration between web users and made possible the kind of social networks that we're familiar with today (Duffy, 2008). Youtube evolved as one of the pioneering sites of the new collaborative and interactive environment has led to a participatory culture which has had major implications in the epistemological uses of the internet. It broke down barriers between scientists and the public, tore apart limitations of time and space that had previously limited science communication and allowed for a multimodality that increased the effectiveness of knowledge dissemination (Ilundáin & Anguiano,). Participatory culture is a term developed by Henry Jenkins (2006) to describe a new cultural paradigm wherein the individual is encouraged to actively take part in the production, distribution and interpretation of cultural goods. In a pioneering piece of literature concerning Youtube as an object of study Burgess and Green described participatory culture as "Youtube's core business" (2009, p.6) in the sense that Youtube is in the business of "the provision of a convenient and usable platform for online video sharing: users (some of them premium content partners) supply the content, which in turn brings new participants and new audiences" (Burgess & Green, 2009, p. 4). The emphasis on the contribution of the user is tied to Henry Jenkins' conception of a new convergence culture which can be understood as "both a top-down corporate-driven process and a bottom-up consumer-driven process" (Jenkins & Deuze, 2008, p.6). A similar theory is that of the platformization of society (Van Diijk & Poell, 2018) where many cultural, political, economic, etc. sectors have become dependent on platforms which are shaping how people within these sectors interact. The implications of this new culture,

exemplified by the Youtube platform, on the process of science communication were unprecedented. Science is now in the hands of the everyman, heavily influenced by the tension between the creative, user-driven aspect of the medium and the corporate nature of the platform. Jenkins argues that UGC exists within and apart from commercial contexts and can either support or subvert corporate control. This tension is captured in the informal science communication videos that have grown in the Youtube eco system. The growing demand for monetisation in one form or another means that creators are limited to an extent by the parameters of the algorithm and often forced to seek outside funding to support them which can disrupt the effectiveness of the content either through ideological tension between advertisers and creators or through the literal disruption by way of advertisements. In this way, the convergence culture that we now inhabit is likely impacting the epistemological value of media environments.

2.5 Education on Youtube

The relevant media environment to this paper is the popular video sharing platform Youtube which is the current top social platform by number of active users as of 2025 (Datareportal.com, 2025) and is one of the most prominent distributors of scientific information online (Brossard, 2013). As of January 2025 Youtube has at least 2.53 billion users around the world (Datareportal.com, 2025), making it one of the largest social media sites active right now. Education is one of the main genres of popular Youtube videos with creators such as CrashCourse utilising the accessible, free platform to encourage learning both inside and outside the classroom. A 2018 study found that Youtube is the preferred learning method of 59% of gen Z participants as compared to the still significant 55% of millennial participants (Pearson, 2018). The same study found that 55% of gen Z believed that Youtube had contributed to their

education and that 47% of gen Z spent more than 3 hours on Youtube per day (Pearson, 2018). It's clear that Youtube is a significant learning resource, particularly for young people today. An increasing amount of scholarly literature is being generated around the use of Youtube for learning and education purposes (eg. Lee et. al 2017, Tan, 2013, Chintalapati & Daruri, 2017). The majority of this literature, however, does not address the actual medium itself and how it might inform both the form of the educational content and the experience of the user who is either producing or viewing.

2.6 Science Videos on Youtube

Science videos on Youtube have been previously studied with regard to their potential and limitations when it comes to effective education and science communication (Kohler & Dietrich, 2021). Studies into Youtube science communicators are becoming increasingly numerous in recent years due to the importance of the platform in mass communication and the rise of science communicators whether institutional or individual. Social media science communicators are playing a significant role in the intake of scientific information by the general public (Brennan, 2021) and the effectiveness of visual-audio communication in the uptake of knowledge is already proven in existing research (Kohler & Dietrich, 2021). Recent research into audiovisual platforms and science communicators does focus on the effectiveness of the format in transferring knowledge and well as audience reception of information depending on how and who presents it (Welbourne & Grant, 2016.

The perception of authority on Youtube is different from that of traditional media, thanks to the accessibility and participatory nature of the platform. According to Boy et al. (2020) 'Youtubers' or online video creators not associated with a scientific institution are the dominant science

communicators on Youtube. This means that those with the most influence in the area of science communication are not those who are traditionally considered trustworthy sources with the support of scientific institutions. Credibility is now built upon different criteria including the presentation of the information, how entertaining or charismatic the presenter is and how familiar the user is with the presenter (Boy et al, 2020). Experts still play a role in science communication and do produce a percentage of educational videos. The role of experts is undeniably changing however. Rather than being the ones to directly communicate their own knowledge, it appears they may need to rely on mediators, particularly the skill set of Youtubers or online video creators. Burgess and Green (2009) pointed out that Youtube is better thought of as a "continuum of cultural participation" in contrast to thinking in terms of distinctions between experts and laypeople or other such dichotomies. They acknowledged that when discussing Youtube it is useful to understand everyone who uses Youtube, whether as a viewer, creator or otherwise, as participants in the culture of Youtube which is fundamentally different from previous forms of broadcasting and mass communication. This changes the established dynamic of science communication wherein the divide between provider of information and receiver was very clear. Features such as the verification badge, a small checkmark next to a username, denote authenticity, proving that a creator is who they say they are i.e. not an impersonator, and that they have over 100,000 subscribers, another engagement metric which verifies quality.

Many science videos on Youtube fall into the infotainment genre, given the popularity of entertainment on the platform and the desire to attract a more general audience. Infotainment, also commonly known as edutainment, refers to the use of entertainment value to convey information or educational content. In science communication, this manifests as integrating

scientific information into the narration of a story (Bucher, 2019). As a result of the process known as popularisation wherein scientific discourse is recontextualised, science communication is highly reliant on infotainment as a means of transferring scientific knowledge (Bucher 2019). While it has been proven that diegetic techniques, integrating scientific information into narratives as opposed to supplementing narratives with informational elements, are effective in transferring knowledge, there are also concerns surrounding over simplification and loss of credibility. Infotainment runs the risk of interfering with a "maximally effective exchange of information" (Grice, 1945). Entertainment elements such as humour can obscure the complex nature of the scientific method and give the false impression that some concepts are easy to understand leading to an overestimation of one's epistemic ability. On the other hand, infotainment is proven to be more effective at transferring scientific information to viewers without a university degree and are proposed to be more generally advantageous over traditional expository narratives when it comes to promoting recall of information therefore it is a valuable part of online science communication (Léon et al., 2020). The same study found that in the making of short form content, key information should be provided up front and that the traditional format of a 'grand-finale' is not effective due to a decrease in knowledge recall as a video goes on.

3. Methodology

A qualitative methodology was chosen for this research due to its interpretive ability and its capability of handling broader effects. By relying on observations of the Youtube ecology, this paper strives to incorporate as many elements of the user experience as possible and therefore analyse the medium in its most authentic form. By then relying on previous research to highlight

the effects of the various elements that are observed, I hope to reveal how they interact and relate to one another in the context of forming an environment conducive to the communication of science and the acquisition of scientific knowledge.

Media ecology was the approach selected for this research as it endeavors to explore the ways in which the form and affordances of the medium influence our experience and perception. By examining Youtube as a media environment and taking into account various affordances of the medium, a broader understanding of the use of Youtube as an epistemological environment and a platform for science communication can be formed.

In order to approach this topic in a way that honours the ideals of media ecology, an analysis of the Youtube media environment was constructed followed by an analysis of six videos from three science communication channels, Vsauce, Kurzgesagt, and Lindsay Nikole. As a result of the nature of Youtube, channels that have been around longer have amassed more views and subscribers therefore in the interest of maintaining an up to date overview of science on Youtube, one smaller channel was included in this analysis.

First a media ecological analysis of Youtube as a medium is laid out, using four guiding questions as laid out by Lance Strate: What are the characteristics of the specific medium or media? What biases are associated with those characteristics? What are the effects resulting from those biases? How is the environment shaped or altered by those effects? With these questions in mind, the effects of the characteristics and biases of the Youtube medium on the development of the science video is explored. A visual analysis of the interface of both the website and the app

was conducted bearing in mind the consequences of each affordance for the development of science videos. The analysis suggests Youtube's position as a participatory culture, a business model, an algorithm driven and highly personalised interface and as an educational environment. While independent effects have been studied, an examination of the interactions of elements of Youtube has yet to be conducted. This allows for a more comprehensive overview of the environment created by the platform and how it shapes the content of science videos.

Following that, the analysis of the videos themselves is laid out. Vsauce and Kurzgesagt are two well established science channels that have been posting on Youtube for over a decade. Since they take two different approaches to visualising the information, they serve as decent examples of ways in which the affordances of the medium can be utilised. They also have both taken to creating Shorts, an element of intrigue thanks to their relatively new introduction to the Youtube environment. Lindsay Nikole was chosen as an example of a smaller channel who recently made the transition from short-form content on other platforms to long form. She stands in contrast to the other two, providing possible insight into the relationship between short and long form content, and showing that the medium has influenced how creators depict science information in an informal manner.

Two videos from each channel were analysed, the most popular video from each and the most recent video, as well as the home page of each channel.

Channel	Title	Upload Date	Length	Views	Likes	Comments
Vsauce	The Banach-Tarski Paradox	01/08/2015	24:14	46 million	1 million	109,124
Vsauce	Did People Used To Look Older?	11/07/2022	22:54	19 million	880, 000	53, 006
Kurzgesagt	The Coronavirus Explained and What You Should Do	19/03/2020	8:34	89 million	1.1 million	72, 396
Kurzgesagt	Why Does Fentanyl Feel So Good?	20/05/2025	14:47	5.4 million	266, 000	17, 318
Lindsay Nikole	Is CRAB the final form?	18/02/2023	10:54	3.2 million	186, 000	8, 876
Lindsay Nikole	The Sabertooth Cats (That We Know Of)	25/05/2025	24:05	205, 000	17, 000	909

3.1 Metric scores of videos, collected 26/05/2025

In addition, the most popular Short on each channel was noted to be referenced in the discussion about Shorts.

Channel	Title	Upload Date	Views	Likes	Comments
Vsauce	Thermite Balls	12/05/2023	288 million	11 million	86, 000

Kurzgesagt	How to Cut a Sandwich Perfectly- With Science	25/05/2023	18 million	802, 000	6, 774
Lindsay Nikole	USE YOUR LEGS	01/09/2022	23 million	1.4 million	7, 766

3.2 Metrics scores of Shorts, collected 26/05/2025

The analysis was guided by the following points:

- Style of video
- Style of narration
- Background music yes/no
- Use of visual aids and which ones
- Use of language, formal/informal
- Presentation style
- Camera work
- Editing style
- Intro/Outro
- Description
- Number of ads/paid promotions internal and external

A similar analysis of the most popular Youtube short on each of the selected channels was also conducted based on similar guidelines and is used to discuss the differences in communicating science in short form versus long form content as well as to aid in answering the second half of the research question: how changes in the Youtube ecology may affect science videos.

4. How Has the Media Environment of Youtube Shaped Popular Science Videos

4.1 Media environment of Youtube

Youtube is typically accessed via either a website domain or the app, meaning that it is hosted by at least two kinds of media, smartphones and other mobile devices and laptops or desktop computers. Although they boast similar interfaces, there are significant differences between the app infrastructure and that of the website. The website displays a row of three suggested videos with their respective thumbnails, titles, channel name, profile picture, view count and upload date. The sheer amount of video uploaded to Youtube every minute means that competition for engagement is huge. To encourage initial engagement, creators use attention grabbing techniques in titles and thumbnails. A common rhetorical technique used by science channels is using questions as their titles to pique the curiosity of a potential viewer. This is combined with a thumbnail image, generally portraying either pictures of the presenter emoting or some form of edited image directly from or relating to the video. Thumbnails can have additional text, often an exclamation or attention grabbing quote or keyword. In order to be chosen over other videos, titles and thumbnails must appeal to the viewer, which is often achieved in science videos through reference to popular memes or everyday queries that are familiar or relatable to a general audience. Often Youtubers will create multiple thumbnail images and combine them with different titles and switch them out depending on the engagement metrics following a video release. This practice exemplifies the importance of thumbnails and titles within the Youtube

ecosystem and the biases they create. The necessity for grabbing attention does lead to a bias toward sensationalised content, geared more towards entertainment than education. This is reflected in the popularity of science channels that do live experiments to create a spectacle.

A unique feature to the website is a ‘verification badge’, a small check mark beside a channel name used to denote the authenticity of a creator according to Youtube’s validation system. This is an important feature for science communicators to prevent the spread of misinformation. However this verification is mainly based on the identity of the creator and subscriber count, which points to the differences in value appointed to those in an elevated position. A separate music note badge appears on “official artist channels” as Youtube is a popular music streaming service. These badges are not visible on the mobile app. Both interfaces include a banner above the main display containing tabs that filter the content based on user activity. For example, selecting the ‘music’ tab will filter homescreen video recommendations to only include videos tagged as music. These tabs are personalised to each user. They are useful for creating networks of users who watch the same content and perhaps hold similar values but that can also isolate those who may be more susceptible to misinformation, leading to the creation of echo-chambers which are a significant point of contention in media studies and cultural studies today (Brown et al., 2022). Both the website and the app also contain a search feature, however the search bar on the site is far more prominent than the small magnifying glass in the corner of the screen on the app. Although it’s likely simply due to lack of space and a more visually pleasing design choice, the small search button and the lack of verification badges on the mobile app do combine to suggest that users of the app are encouraged to be less critical and to think for themselves, it appears that the structure of the app may encourage a stronger reliance on algorithmic choices. A

unique feature on the app is the ‘cast’ button, which allows for videos to be displayed on a television screen via either a smart TV or an external casting device plugged into the TV. This indicates that users often choose to view videos on a bigger screen if they are using a mobile device.

The differences between the app and the website extend to the experience of shorts and videos. Video viewing is largely unchanged since the conception of Youtube with a few quality based improvements and new features. On the app, users can see the title of the video, a more precise view count, the number of likes but not that of dislikes, the number of comments as well as one of the top comments, the channel name and profile picture along with the number of subscribers and options to share, ‘remix’ into a short, download, clip, save or report the video. Most of these are engagement mechanics which influence the reach of a video. A big factor in engagement on Youtube is subscribers, which encourages creators to upload consistently in terms of style, frequency, and subject matter in order to maintain a consistent audience and therefore consistent engagement. When searching for a video on Youtube, engagement is one of three big factors accounted for in their ranking system alongside relevance and quality (How Youtube Search Works). These three factors influence each other as videos with more engagement are more likely to be deemed good quality and/or trustworthy and therefore considered more relevant. Engagement also translates to monetisation so for Youtubers, whose profession it is to make videos, working within the parameters of both the algorithm is necessary and monetisation guidelines. In recent years, this has proven very difficult which is why creators have had to adapt other methods of monetisation such as Patreon, selling merchandise or sponsorships and promoting these via their channels. Description boxes often contain information about the video,

as well as external links to either other channels that were referenced, relevant extra information, or to the sites of businesses that sponsored the video, often via affiliate links. This is discussed in further detail later on.

Youtube now also offers transcripts of videos as well as captions which are both auto generated if not manually done by the creator. This extends Youtube's accessibility, which is a key affordance of the platform that lends itself to science communication. The comments section was updated recently and is now divided into three tabs: top comments which have been interacted with the most, timed comments which correspond to moments of the video, and newest comments which are sorted by recency. The different formats highlight comments as a key feature on Youtube. Top comments show the most popular opinions and takeaways from the video, timed comments, which are new, allow for specific references to the video itself and recent comments support continued conversation after the initial influx of views and comments.

Under the comments box, a new recommended or related video is shown, as well as an ad, followed once again by a row of shorts. These are displayed differently than the home screen, rather than a grid of four to six, they are accessible in a scrollable row of fifteen shorts. Punctuated again by either a post or another video, two rows of fifteen shorts are displayed. The prevalence of ads and Shorts, especially on the app version of the site is obvious. Their relevance to the Youtube environment is clear when scrolling through the app. When the selected video is flipped to a horizontal display, as is the most common format to watch on a mobile device, most interactive features remain available apart from subscription to the channel. This allows for interaction while watching. Swiping up from the bottom of the horizontal screen will display

recommended videos with the notable absence of shorts and posts. This encourages the viewer to jump immediately to another long form video. The biggest differences in viewing experience on the website is a lack of interactive features when the video is playing in full screen. Unlike the app, the user only has the ability to play/pause, skip to another video, adjust the volume, share, add to ‘watch later’ or access video settings. Before a video plays on a default Youtube account i.e. without paid subscription to Youtube premium or the influence of any external ad blockers, two ads of around ten to fifteen seconds are shown. If they are longer than fifteen seconds, a skip button appears, allowing the user to jump to the video itself. Ads will usually continue to appear intermittently throughout the video. This will be expanded upon in further detail in a later section.

The most notable difference between the two interfaces is the positioning of Youtube shorts. On the website, a row of five shorts in vertical format, differentiating them from videos made for Youtube, is displayed underneath the initial row of videos. As the user scrolls down they see another two rows of three regular videos each, followed by another row of five shorts, after which shorts are no longer shown and continuous videos appear in a grid format. The app opens directly onto a screen featuring four to six shorts, depending on settings, in a grid pattern. Continuing to scroll down will reveal a single regular Youtube video followed by a ‘post’, generally consisting of some text and images by a relevant-to-the-user channel. Posts have similar interactive features to videos i.e. likes, dislikes, comments and shares and are unique to the app. Continuing past the post, the user will be presented with four videos followed by another four to six shorts. This pattern, with minor deviations continues, with the user being presented with a set of shorts four times as they peruse the home page until they scroll far enough that the

feed becomes mainly videos with the occasional post. Shorts are noticeably more prevalent on the app interface since they are more suited to be viewed on a smartphone. On both interfaces, shorts are displayed in a distinctive vertical format on the home page. Their thumbnails feature basic stills from the video and are unformatted, unlike most regular thumbnails which are often specifically chosen and curated by the creator in the process of uploading. The thumbnails are overlaid with text, usually a caption with a quote from the short or a brief commentary and hashtags in the style of other short form video content rather than a more formal title as would be typical of a Youtube video. Channel names, profile pictures and upload dates are not included on either interface and view count is only displayed on the website. This takes away from the personalisation of Youtube, where users often watch videos by creators they're familiar with. The lack of initial identification appears at odds with the general Youtube environment. The implications of Shorts on science videos is discussed in a later section. Finally, on a default web browser, with no ad blocking extensions, an ad appears in place of the first video thumbnail on the left side of the home screen and at least two more are displayed in place of videos as the user scrolls through their page. Similarly, on the app, ads will often appear in place of the first video as well as periodically as the user scrolls.

4.2 Background of Chosen Channels

Vsauce

Vsauce is one of the oldest and most well known science Youtubers. Michael Stevens began posting science videos in 2010 when Youtube was still in its infancy. The channel currently has 24.1 million subscribers and has uploaded a total of 601 videos which have in total amassed

almost 6 billion views to date. Older videos on the channel are typical of Youtube at the time, with a loose focus on gaming but mainly random, short videos with garish thumbnails and titles in all caps lock. He began posting short science videos answering questions like “What Is Video ??” (2011), appealing to the curiosity of the young user base. Earlier videos are consistently less than ten minutes and very frequently uploaded. Vsauce quickly became one of the most well known and well liked creators of educational science content on Youtube, providing a blueprint for what science communication on Youtube could look like. Over time, his content became less chaotic and streamlined into slightly longer, higher quality videos, still answering intriguing questions. These videos were hugely popular, garnering over 10 million views each. The quality of videos on the channel continued to rise and the length of videos grew to around twenty minutes but uploads happened far less frequently. Despite this drop in quantity, view counts remained impressive with his most successful video “The Banach-Tarski Paradox” reaching 46 million views. It was at this point where Michael began to expand past Youtube videos, starting a company called Curiosity Box, a subscription box which provides customers with science toys, puzzles and books. He also began other projects such as a tour, “Brain Candy Live” and a series for Youtube Originals, videos professionally produced exclusively for Youtube Premium users, called Mind Field. This show is currently available to watch for free with ads on the Vsauce Youtube channel. While it remains in the spirit of his regular content, communicating scientific, in this case psychological, concepts in an engaging manner, the Youtube Premium series is more reminiscent of television entertainment shows than the Youtube tradition. Eventually, Vsauce video frequency reduced to less than one video a year, with the last long form upload posted on November 17, 2022. Over the last few years, Vsauce has embraced Youtube Shorts, largely as a means to promote Curiosity box. Shorts has now become the main output of the Vsauce Youtube

channel and they appear to be successful in maintaining an audience, regularly earning up to 20 million views each. The newfound importance of shorts to the Vsauce channel is indicated by their placement on the channel home page. They appear as the first row, before any long form video. The shift to Shorts was not necessary for Vsauce however, due to the ease with which they can be produced reminiscent of the early days of Vsauce and their potential for advertising and maintaining some form of audience engagement and relevance with relatively minimal effort, it's not difficult to understand why.

Kurzgesagt- In a Nutshell

Kurzgesagt is a German based channel that has been making animated educational science content since 2013. It is a team based operation, as explained in their channel description which names "illustrators, animators, number crunchers and one dog" (Kurzgesagt-In a nutshell, Youtube) as the make-up of their team. They also frequently collaborate with NGO's, other organisations and even media companies, mainly to provide further funding. They currently have channels in nine different languages: English, German, Spanish, French, Portuguese, Arabic, Hindi, Japanese and Korean. Their English channel is the most subscribed to with 24.4 million subscribers and over 3 billion views over all of its videos. Their aims are described in both the channel description and their channel trailer; "to spark curiosity about science and the world we live in" and "to explain the universe and our existence, one video at a time". Similar to the Vsauce channel, they often use questions as video titles. The channel has a unique method of science communication, using beautiful, colourful animation to illustrate the scientific concepts it explores with smooth, clear dictation by the voiceover artist. Their videos have remained

consistent in length, style, and quality since the beginning of the channel, likely due to the team effort that goes into each video, unlike many initial Youtubers who did everything themselves, such is the case of Vsauce. They have uploaded between 17 and 20 videos a year since 2013, prizing quality over quantity as stated in their channel header. Like Vsauce, they also began the foray into short-form content, posting their first Youtube Short in 2023. These Shorts are not prioritized on their home page, only appearing underneath their numerous playlist options.

Lindsay Nikole

Lindsay Nikole is a relatively new creator in comparison to the other channels analysed here and is the only one of the three to have made the shift from short-form to long-form content rather than the other way around. After gaining traction on TikTok and Instagram Reels, she began posting long-form videos on Youtube in 2022. This is not an uncommon phenomenon, many creators who gain popularity on one site often move to different platforms to both expand their reach and to make use of different properties of the mediums. Another instance of a science creator who made the same transition is MiniMinuteMan, an archeologist. For science communicators, this transmediation is important since information is interpreted and comprehended differently depending on the medium, lon form content is generally considered more conducive to effective science communication due to the ability to explain concepts in more depth and avoid over-simplification. Lindsay currently has 1.8 million subscribers and around 500 million views, making her the smallest channel of the three chosen for this research. Unlike the other channels, Lindsay outlines her credentials in her channel description, mentioning her bachelor's degree in zoology, which is the subject of her videos. The home page

of her channel again differs from the other two, displaying her most recent video followed by playlists which sort most of the videos into series. Shorts do not feature on her homepage.

To assess these channels as science communicators, the AEIOU model of effective science communication (Burns et al., 2013) is useful. Awareness is of course created by their reach as Youtube channels and across social media. Enjoyment is a key element of successful science videos on Youtube, viewers have to enjoy the content to be encouraged to subscribe or like and come back to the channel. Interest is encouraged through visuals, dynamic explanations and the presenters own passion for science and learning. Particularly when it comes to Lindsay and Vsauce, their genuine interest in the subjects of their videos encourages the interest of the audience. Kurzgesagt achieves interest through beautiful animation, bright colours and relevant topics. Opinion forming is encouraged by each of the creators who encourage their audiences to leave comments about the videos or through in video prompts to allow the audience to think about the material such as rhetorical questions. Understanding is promoted through the consistent references to additional materials, encouraging viewers to continue learning after the video is over. Overall, according to this model, these creators can be considered effective science communicators.

4.3 Comparison and Analysis of Selected Videos

The thumbnails across the three channels had various differences and similarities. Both Kurzgesagt and Lindsay Nikole made use of overlaying text on images that emphasised the subject of the video, where Vsauce rarely if ever includes text in the thumbnail image. Kurzgesagt and Lindsay Nikole also both have mostly consistent thumbnail styles while Vsauce

does not. Consistent thumbnails encourage recognisability and familiarity which are both vital factors in the engagement of viewers but Vsauce thumbnails encourage engagement in a different way, through emphasised facial expressions or alternatively highly simplistic images related to the content that fill the thumbnail image. These stand out among other, more complex images. Kurzgesagt only ever uses animation in the same style as their videos as thumbnails, which works due to the brightly coloured, eyecatching nature of their animation style, while both Vsauce and Lindsay Nikole use images of the presenters edited onto a background.

Both Vsauce and Kurzgesagt regularly link sources, references, and more information in their description boxes, which is not seen in Lindsay Nikole's videos. The inclusion of a bibliography gives them integrity and credibility as science videos. Lindsay's descriptions are noticeably more informal and personal, potentially due to a smaller audience and her position as someone new to the platform. Vsauce videos did not have descriptions beyond sponsorship links and links to additional information or other social media and Kurzgesagt uses formal, factual language to describe the topic covered in the video, which reflects their professional structure. All the channels had links in the description to either the website of a sponsor, to Patreon, which is a separate monetisation platform which allows creators to run a subscription service and sell digital products, or to merch stores and creator run businesses, to supplement their earning from the Youtube Partner Program.

Similarities between analysed videos:

Inclusive language was featured across all six videos, pronouns such as 'we' and 'us' were dominant. All the videos also made use of direct address, referring to the viewer as 'you' or

talking directly into the camera. This is typical of many Youtube videos and informative media, drawing the audience in and creating a sense of community. It also hints at Youtube's participatory nature and its tendency to blur the traditional boundaries between a teacher and a student. Many Youtubers start out as viewers before they begin to create videos and often continue to watch or collaborate with other channels, building a network and community on the site where the distinction between creator and viewer is less prevalent than traditional media.

The content of all the videos was generally tied to some kind of *popular online discourse*, formulating relevance within the broader media environment. As a result of the current environment of transmedial interplay, discourse is no longer regulated to a single medium and more often takes place across a network of platforms. Remediation continually takes place with posts originating on one site and almost immediately being copied or posted somewhere else. This leads to the broad spread of discourse throughout what we refer to as the internet, which can be known as going viral. Since such a wide audience gains familiarity with subjects of general discourse online, using them to inspire science videos encourages a wider audience engagement and promotes interest without the need to convince them.

Music was also used in every video, usually in the background and in the case of both Vsauce videos and Kurzgesagt, it reflected narrative arcs and enhanced the emotional engagement of the viewer. This is a traditional media strategy that has been carried over to Youtube videos likely because it is very effective in keeping a viewer engaged and encouraging reactions and emotions at certain narrative points. Vsauce in particular used this affordance to maintain attention by combining it with editing techniques and different video clips.

All six videos were well *scripted*, using logical, easy to follow narratives. This allowed for broad appeal to a general audience, especially since every video intentionally began with broader context and gradually focused into the topic being presented. The narrative was always presented in a well dictated, comprehensible manner. Scripted content is not unique to Youtube but does ensure that the audience stays engaged throughout the video by constructing a narrative which is vital for engagement metrics.

The use of *images*, drawings, graphs and animations to illustrate concepts was immediately apparent. Every video used visual aids to help the viewer to understand the ideas. This is a well established tool in science communication (Bucher, 2019). In videos with a presenter on screen, the use of props as visual aids was also common. On screen text was employed to either complement the visual or to include additional information not stated in the narration.

All three creators referenced *scientific studies* directly and explicitly, often displaying a screenshot of the paper within the video. This offers credibility to their information and is made possible by the ability to edit videos before they are posted.

Every video ended with an *outro* and an endscreen with clickable links to other videos or to merchandise stores. This encourages more engagement and support for the channel while also potentially promoting a continuation of learning. It is also an element of Youtube's interactivity.

Another common element was the in video advertisement, usually promoting an unrelated business who had sponsored the video or in the case of Vsauce, a separate business venture. This is a direct result of the discrepancies between professional and amateur on Youtube, because this boundary is so blurred, those who make content creation a full time job are not fully considered professionals and cannot always rely on the platform to pay them and therefore must take other measures.

Differences between analysed videos:

Both Michael and Lindsay, who each appear in their videos, introduce themselves to the audience where the voice of Kurzgesagt does not. The audience-creator relationship promoted by the Youtube environment is nurtured through the familiarity and interaction between the two parties. Vsauce, like many Youtubers of his time, uses the same introduction in every video "Hey Vsauce, Michael here!" as though he's talking to a friend. By using familiar language, Youtubers build trust and expectation from their audience. For a science Youtuber, that trust is especially important as it implies the expectation that the information will be effectively communicated and be correct (Sundar & Limperos, 2013).

Although Michael and Lindsay have similar presentation styles where they stand in front of a background and talk to a camera on a tripod, there are some differences in the video format itself. Vsauce videos changed settings occasionally and also used video recorded separately such as footage of Michael drawing on paper to illustrate a concept while the narration became a voiceover. Lindsay's videos both consisted of one setting at one time. Rather than relying on different shots to maintain visual interest, Lindsay's videos relied on creative editing. The editor

of Lindsay Nikole videos almost appears as another actor in the videos, sometimes even addressing the audience through text on the screen. While plenty of Youtubers, especially from the younger days of the platform, do their own editing like Michael of Vsauce, hiring someone else to do it is increasingly popular since it significantly reduces the workload of creating a video and allows for faster production and more frequent uploads. Editing is also vital in maintaining audience attention and enjoyment. It can be functional, as in the case of Vsauce or humorous, as seen in Lindsay's videos.

Lindsay Nikole's videos were by far the most categorisable as 'infortainment', incorporating highly informal language including profanity, and promoting personalisation through anecdotes and direct communication with the viewer, asking specific questions to answer in the comments such as what kind of content they would like to see, and answering questions posed by viewers in the comments of previous videos, encouraging long term interaction and providing a sense of continuity, familiarity and community, all of which is supported by the Youtube participatory model.

Kurzgesagt stood out as the only channel of the three that did not utilise the personalisation or direct communication aspects of the platform. Although the voice of Kurzgesagt is consistent, as is the style of videos which does afford familiarity and build expectation and trust, it is not in the typical Youtube fashion. It relies more on expository narratives which are generally considered more trustworthy and the distance created by the disembodied voice may reinforce traditional teacher-student dynamics and add to the credibility of the channel. It can also be proposed that the fact that Kurzgesagt is a team of people creating videos and that they consistently mention

this and refer to themselves in the collective creates a sense of transparency which may also elevate audience trust. In this case, authenticity would be created through transparency rather than explicit personal connection.

Many elements of the science videos identified above corroborate the findings of Morcillo et al. and their established typology of the science video on Youtube. They found that popular science videos are predominantly in English, that there are a variety of subgenres within science videos, they often have a moderate level of production even leaning towards professional in some cases, a high complexity of montage or variety of camera shots and also use of external devices for better sound quality, an exceptional storytelling ability, intro and outro sequences which keep new viewers informed and maintain existing viewership, and finally the ability to build an emotional network (Morcillo et al., 2015). The noted high production value which was also present in each of the videos analysed here highlights the blurring of the boundary between professional and amateur that is enhanced by convergence culture. The wide variety in styles of science videos is representative of the broad reach of Youtube and the diversity of its users. In contrast to a medium like television or lectures, users are capable of selecting from a range of science videos, curating their own learning experience based on their personal interests, connections with creators and favourite style of content. If the more structured, formal, animation style of Kurzgesagt does not suit a viewers interest, they can watch videos that are just as well researched on Lindsay Nikole's channel which is more informal, has a higher level of interactivity and a different presentation style.

Conclusions

The core elements of a science video which make it effective are a robust level of research and transparency of where the research was found, provided either by links in the description or references in video, the composition of a compelling narrative, in other words, good storytelling ability, and a level of consistency, familiarity and community fostered by the interactions between the creator and the viewer as well as among the viewers themselves. The length of the video is also important to ensure that the information is communicated in a sufficient level of detail without losing the viewer's attention. This aspect is aided by elements such as creative editing as noted in Lindsay Nikole's videos, background music and dynamic camera shots as noted in Vsauce videos or visually pleasing animation as in Kurzgesagt videos. All of these elements are afforded by the Youtube medium and shaped by years of fostering participatory culture and fine tuning Youtube videos to be both enjoyable and profitable through engagement.

However the balance between Youtube as a creative, user-generated environment which has greatly contributed to the cultural dissemination of scientific information and Youtube as a business built on participatory culture, is transforming. While analysing videos for this paper, it was noted that advertisements were extremely prominent both in and outside of Youtube videos. Both Kurzgesagt videos, each between ten and fifteen minutes, contained three ads by Youtube and one contained two in video promotions, one for a sponsorship and one for the channel's Patreon. Vsauce's most popular video contained six ads in twenty-two minutes while his newer video contained thirteen Youtube ads as well as two in video promotional segments for his business and a Youtube premium show. Lindsay Nikole's most popular video contained five Youtube ads in eleven minutes and her more recent video contained ten ads in twenty-two

minutes as well as an in video sponsored segment for a mattress company. As a viewer, the constant distractions provided by ads, disrupts concentration and interrupts the narrative of the video, impacting immersion, engagement, attention, and potential recall of information. The following section expands on the growing prominence of ads on Youtube and their potential effects on the effectiveness of the platform for science communication.

5. Potential Effects of Monetisation and Youtube Shorts on Science Videos

5.1 Monetisation of Youtube

Youtube is a video sharing platform owned by Google since 2005 and has been evolving according to profitability ever since. Since Youtube does rely heavily on its user base for both the production and consumption of the videos that ultimately attract the consumer base that is so enticing to advertisers, many changes to the Youtube platform are made to improve the quality of the user experience and can have positive effects however the drive for profit can also obscure the affordances that lend themselves to the various uses for the platform including education and science communication. Youtubers are now relatively common and it's not unusual to come across those who refer to themselves as 'content creators', 'influencers', or even 'online science communicators' however Youtube was not initially considered as a platform on which individuals could earn money. The introduction of the Youtube Partner Program introduced a distinction between regular uploaders of popular content and the users who didn't. This program offers pay to channels that reach and maintain a certain number of subscribers and views and who remain within the community guidelines and monetisation policies (support.google.com).

This both restricts content to an extent but also provides more freedom to creators whose videos take time and effort, such as science channels whose videos often require extensive research, scripting, formatting and editing. However, restrictions increased when growing standards for monetisation meant that creators had to search for new, more reliable and consistent forms of income, hence the sponsorships and merchandise stores. All of this influences the user experience and has potential effects on science communication on the platform despite ads rarely being mentioned in studies surrounding Youtube science videos.

Ads now appear incredibly frequently on a default Youtube interface, not only on the home screen but before and during videos, underneath videos and between shorts. They have been an integral element of Youtube's media ecology since the introduction of monetisation. Over the years, the amount of ads have noticeably increased leading to users searching for solutions. There are ways of circumnavigating the ads both from the platform itself and from outside of it. One way, on the desktop version of Youtube, is to install an external ad blocker which stops Youtube from displaying any ads but has the unfortunate effect of negatively impacting creators who make money from their content. Another method of removing ads is through a subscription to Youtube Premium, a version of the app that removes ads, allows videos to continue playing when the app is closed, offers access to Youtube music and exclusive series as well as other perks. This study is focused on Youtube as a free and widely accessible site and therefore will not be covering the differing biases of Youtube Premium, however the fact that it exists and is available does impact the media ecology of Youtube in regards to science communication. It creates further tension between the foundations of the platform as free, accessible and participatory which promoted the ideological democratization of content where the users were all

considered to play a role on the platform, and the inherent divide between premium users and regular users. Rather than providing everyone with access to the same information in the same context, which was an initial educational appeal of the platform, users who can afford to pay a premium now are privy to content without ads as well as videos produced specifically for the premium experience, for example the Vsauce series Mind Fields which explores various psychological effects and theories through practical experiments.

Science communication is not only about spreading knowledge and information about new scientific discoveries, it is about promoting science as a vital element in the structure of our society, promoting trust in science as a discipline, and inspiring the general public to think about how science is done and why. Youtube has proven to be a useful resource in accomplishing this goal in many ways but the recent noticeable increase in the number of ads on the platform providing visual and mental distraction might be problematic to the effectiveness of science videos.

5.2 Implications of Shorts and Disruptions to Science Communication on Youtube

The drive for profit has also incentivised the addition of Youtube Shorts to the platform, a new element of the Youtube environment that has been continually referenced throughout the paper. Research found that advertising effectiveness is not impacted by video length, supporting the push for short-form content. (Maenhout, 2023). Although research surrounding Youtube Shorts and science communication is essentially non existent in these early days of their introduction to the platform, it is here suggested that the current state of popular science communication on the platform is likely to change based on research into short form content on other platforms and the

disruption they have already caused to the Youtube ecology (Rajendran et al., 2024). Hereafter, a brief media ecological analysis of Shorts as an element of the Youtube environment is conducted.

Shorts are often made for other smartphone apps such as TikTok or Instagram and then reuploaded onto Youtube. The videos are all vertical and generally made by phone cameras to fit phone screens. This means that shorts fit into the app infrastructure far more naturally than the website, which is important to note considering the majority of users watch from mobile devices. Viewing on the app essentially mimics the experience of using TikTok, a platform which facilitates short form videos, usually between a few seconds and a few minutes long, which are presented in a scrollable column, allowing the user to swipe through an infinite number of algorithmically curated videos. On a laptop or TV screen, shorts are viewable but clearly unsuited to the infrastructure leading to a large amount of empty space on either side of the vertical video, which doesn't encourage continuous scrolling to the same extent as the app. Viewing on the app, generally on a smartphone, pulls up a fit-to-screen video with icons on the right hand side that encourage engagement such as like, dislike, comments, share and remix. These are common features across social media sites and are not out of place in the Youtube environment. The screen also shows an expanded version of the caption which often contains hashtags which help to filter videos. A feature that is unique to Youtube shorts is the link above the caption to a long form video uploaded by the same creator, although this doesn't appear on all videos. This suggests a use for Shorts in the promotion of channels who also create longform content, which is considered to be a better resource for science communication (Violot et al., 2024). Another unique feature is a bubble above the channel name which suggests a search term for example, "pop music", which then brings the user to a search results page featuring both

shorts and long form videos, which is particularly of note when it comes to science communication videos. This feature could intrigue users using a short format and then encourage them to find out more in a long form video that they now have an invested interest in. In a similar fashion to other short form video platforms, ads will appear every few videos identifiable by a small text reading ‘sponsored’ under the channel name and usually a button that links the website of the service or product it is selling. This is part of Youtube attempting to incentivise creators to use Shorts by monetising them.

Each of the channels chosen for this paper create Shorts alongside long form content. Vsauce creates shorts in lieu of long form videos on his main channel. His Shorts are lower quality than his long form content and focus on more visually exciting experiments than abstract concepts. His Shorts are high energy and fast paced, which is different to his regular content. Comparing his most popular Short to his most popular long form video: the Short has significantly more views and likes, which is typical. He uses dynamic and varied camera shots in both and uses a similar editing technique if a little sped up for the Short. Michael himself is much more composed in his long form video. He includes links to more information in the description of both. If we look at how Michael has adapted to the introduction of shorts, his frequency is much higher with his short form content, likely because his long form videos are high quality and time consuming. Shorts allows him to maintain a connection with his longstanding audience without the effort of making a new long form video. He also consistently uses them to promote his other ventures on Youtube and beyond.

It can be said that Shorts are a great way to gain people's awareness which seems to have been the strategy of Lindsay Nikole. She is an interesting case study since she began her content creation on short form content. Her short videos range from evolution skits like her most popular Short, USE YOUR LEGS, which depicts a humorous conversation between two lizards discussing the differences in the evolution of snakes and legless lizards, to short versions of what became her long form content, discussing various animals or her most popular long form series: the History of Life on Earth. By attracting an audience on short videos and gaining interest in her topics, she created a base for her long form following. Lindsay depicts one of the uses of Shorts for science communication, building a familiarity for topics and an interest in learning more, which can then be facilitated by long form content. In this way Shorts might be of some benefit to science Youtubers.

Kurzgesagt shorts are almost identical to their long form content but in bite sized pieces. They upload Shorts at the same frequency as their regular videos, maintaining consistency and quality. As a result there doesn't appear to be much discrepancy between their long and short form engagement, as suggested by the study mentioned earlier.

These are only three instances of science Youtubers and their experience with Shorts. It remains to be seen how Shorts impact the popularity and effectiveness of science videos in the long run considering their relatively recent introduction.

The effects of Shorts on long form content are only beginning to be studied but a recent paper found that since the introduction of short form content, there has been a significant decrease in

views and engagement on popular long form channels (Rajendran, et al., 2024). This decrease only applies to channels with a majority long form content, as opposed to those with a majority short form which were predictably, unimpacted. It follows that long form content creators are generally making the switch to more short form content, encouraged by higher views and engagement. As of 2024, the same study found that Shorts have not had as significant an impact on informative or educational content, instead affecting lifestyle and entertainment. While this is good news for science videos, it could still be impacted as the popularity of Shorts grows. Short form content is proven to be addictive (Qin, 2022), and with the company clearly pushing it forward by making shorts a non removable feature on home pages and recommendation screens, users are being lured away from long form content when browsing the app.

With distractions on the interface rising, the future of Youtube as a platform for science dissemination is dubious. If the push for more advertising and more Shorts continues, the media ecology of the internet's most well loved long form video platform is at risk. The tension created by the addition of Shorts creates competition between the two forms of video, both literally for creators whose revenue is directly affected and ideologically, must have ramifications which will soon make themselves known. The fragmented, decontextualised nature of Shorts is damaging to the possibility of effective science communication in that format, and in a broader sense, reflects a possible decontextualised society where science may lose its value. It is therefore imperative to continue critical study of our media environments and their effects on both the content it inspires and how it shapes the way we think.

Conclusion

By analysing the media environment of Youtube and three science channels, this paper has explored the effects of the platform on the form of science Youtube videos. It has explored how the affordances of the medium lead to effective science communication in popular science videos. Through the interaction, familiarity, engagement strategies, and socially relevant subjects connected to scientific research, all encouraged by the platform of Youtube, science videos inspire curiosity and interest in science in a broad audience. Despite their many advantages, science videos are also subject to the growing restrictions of Youtube monetisation and the rise of short form content on the platform which both contribute to the changing Youtube environment and both the creation and effectiveness of science videos in the future. Long form content is much more conducive to effective information sharing, and the burst of new competition in the form of infinite, addictive short videos has the potential to hinder the use of Youtube as a platform for science communication. That said, science channels are already attempting ways of adapting to the new media environment of Youtube and will likely continue to do so. Shorts are already impacting the revenue of long form videos but through separate monetary ventures, science channels can continue their work, keeping education free and accessible.

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Videos Used in Analysis

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The Banach-Tarski Paradox - https://youtu.be/s86-Z-CbaHA?feature=shared

Kurzgesagt - The Coronavirus Explained and What You Should Do - https://youtu.be/BtN-goy9VOY?feature=shared

Why Does Fentanyl Feel So Good? - https://youtu.be/m6KnVTYtSc0?feature=shared

Lindsay Nikole - Is CRAB the final form? - https://youtu.be/pv--L0FyIu4?feature=shared

The Sabre Tooth Cats (That We Know Of) History of Cats Episode 2 - https://youtu.be/3QPsz4TWMpE?feature=shared