1 2 9 0

UNIVERSIDADE D
COIMBRA

Miguel Filipe Leite Ferreira

COMMUNICATING SCIENCE THROUGH VIDEO

THE USE OF VIDEO ABSTRACTS IN THE DISSEMINATION AND LEARNING OF SCIENCE(S)

Tese no âmbito do Programa de Doutoramento História das Ciências e Educação Científica, orientada pelo Professor Doutor João Loureiro, coorientada pela Professora Doutora Betina Lopes e pelo Professor Doutor António Granado, apresentada ao Instituto de Investigação Interdisciplinar da Universidade de Coimbra.

outubro de 2023

Instituto de Investigação Interdisciplinar da Universidade de Coimbra

COMMUNICATING SCIENCE THROUGH VIDEO

THE USE OF VIDEO ABSTRACTS IN THE DISSEMINATION AND LEARNING OF SCIENCE(S)

Miguel Filipe Leite Ferreira

Tese no âmbito do Programa de Doutoramento História das Ciências e Educação Científica, orientada pelo Professor Doutor João Loureiro, coorientada pela Professora Doutora Betina Lopes e pelo Professor Doutor António Granado, apresentada ao Instituto de Investigação Interdisciplinar da Universidade de Coimbra.

Outubro de 2023

universidade de aveiro
theoria poiesis praxis

1 2 9 0 UNIVERSIDADE D COIMBRA

This work was carried out at Centre for Functional Ecology - Science for People & the Planet of the Department of Life Sciences of the University of Coimbra and supported by Fundação para a Ciência e Tecnologia (FCT; Portugal) within the project (UIDB/04004/2020) financed by FCT/MCTES through national funds (PIDDAC), and an individual grant to Miguel Ferreira (SFRH/BD/131072/2017).

Acknowledgements

First, I am profoundly grateful to my supervisor, João Loureiro. Beyond all the support, knowledge and friendship, he always had a quick, practical and motivated response. “As long as you feel well and happy, everything can be done”, he said, and everything was done. However, we would not have arrived here today without his security, trust and patience. As a researcher, teacher and science communicator, he is an eternal source of inspiration and a beacon of hope for the values of companionship, humbleness and professionalism.

I want to express my deepest gratitude to my co-supervisor, Betina Lopes, for all her support, friendship, availability and motivation. Her enthusiasm for facing challenges, reformulating them and designing new solutions is contagious. Her ideas and how she embraced this project were fundamental drivers for this accomplishment.

I would like to thank my co-supervisor, António Granado, for all his support, trust and practical way of analysing the problems. Due to his suggestion to explore video abstracts and his ideas, the topic was shaped, grew, and today exists as a thesis.

Special thanks to Ivan Viegas and Mariana Palma for their enthusiasm, friendship and readiness to embrace this video production challenge. My project and my daily work as a communicator do not exist without researchers and their science, and it is a privilege to work with attentive and available professionals like them.

Special thanks to Sílvia Castro, Hugo Gaspar, Catarina Siopa and Helena Castro for accepting both challenges: producing a video and transforming this experience into a paper. Nothing in this chapter would have been possible without their commitment, availability, support, enthusiasm and love for the science they practice. Go FLOWerLab!

Thanks to Karine Paniza and Marta Costa for all the sympathy and support in collecting the images and sound in both videos produced.

To Jacopo Wassermann, thank you for your kindness, sharing and support in the bibliography regarding scientific cinema.

Thanks should also go to Sara Lopes and Mariana Castro for all their support in the statistical analysis.

I would like to thank everyone who took part in this study and made it a reality: to all the members of the expert panel for accepting the titanic challenge of watching and evaluating 21 video abstracts; to the Teachers for their availability and willingness to participate in the interviews; to

Professor João Fonseca, for all his support and availability in implementing the questionnaires and to all the students at Escola Secundária de Tondela, for their participation.

I would like to thank the Centre for Functional Ecology, especially its Coordinator, Professor Helena Freitas, for all the trust in me and my work and for all the support given to this project.

I would like to thank the PhD Program in the History of Sciences and Scientific Education, especially Professor Décio Martins and Professor João Rui Pita, for all the knowledge and support given during training, travel and scientific presentations.

Big thanks to Raquel and Rita for their enormous friendship and support. Your constant encouragement, attentive listening and suggestions were crucial. Long live the confessional chat!

Finally, and because no body exists without a heart, I want to thank my family:

To my sister-in-law Sasha, for all her friendship, availability and tireless support in the English language reviewing

To my brother André for the incredible animations and his tireless support in the review process.

To my mother Ana, for her unconditional love, support and dedication. The joy with which she approaches every day is an unstoppable source of inspiration and strength. All this kindness, sweetness and positivity were present every step of the way.

To my wife Liliana, for all her love, understanding, support and dedication. Those were busy years, with many changes and many sacrifices, but also times of achievements. This is one of them, which was only possible because I had the most extraordinary, kind, professional and devoted person by my side.

To my daughter Rita, for lighting up this brand new world and rewriting the meaning of love with every smile.

To my father Pedro, who, through memories and longing, makes me every day a better man. As Bruce Springsteen sings dad: “Everything is everything, But you’re missing”.

Declaro que esta tese foi elaborada por mim e confirmo não ter sido previamente submetida, total ou parcialmente, para obtenção de outro grau académico. Confirmo que o trabalho descrito foi realizado por mim e pelos co-autores, no caso de publicações conjuntas, como indicado nos capítulos 2, 3, 4, 5 e 6. Nestes casos, a minha contribuição está explicitamente indicada abaixo.

O estudo apresentado no capítulo 2 foi desenhado por mim e por João Loureiro. Realizei a inventariação, análise de conteúdo e categorização dos vídeos. João Loureiro realizou a análise estatística. A primeira versão do artigo foi escrita por mim, sendo as sugestões dos outros autores discutidas e inseridas na versão final.

O estudo apresentado no capítulo 3 foi desenhado por mim e por João Loureiro. Apliquei os questionários, realizei a análise de conteúdo e posterior categorização. A primeira versão do artigo foi escrita por mim, sendo as sugestões dos outros autores discutidas e inseridas na versão final.

O estudo apresentado no capítulo 4 foi desenhado por mim e por João Loureiro. Fui responsável pela concepção, filmagem, edição e promoção do *video abstract*. Sílvia Castro e Helena Castro deram as entrevistas e, juntamente com Catarina Siopa e Hugo Gaspar, recriaram a metodologia no campo e no laboratório. A primeira versão do artigo foi escrita por mim, sendo as sugestões dos outros autores discutidas e inseridas na versão final. Todos os autores contribuíram na escrita do guião, preparação das entrevistas e das filmagens.

O estudo apresentado no capítulo 5 foi desenhado por mim e por Betina Lopes. O questionário foi construído por mim e por Betina Lopes. Realizei a análise de conteúdo e posterior categorização. A primeira versão do artigo foi escrita por mim, sendo as sugestões dos outros autores discutidas e inseridas na versão final.

O estudo apresentado no capítulo 6 foi desenhado por mim e por Betina Lopes. A entrevista foi construída por mim e por Betina Lopes. Conduzi as entrevistas, realizei a análise de conteúdo e posterior categorização. A primeira versão do artigo foi escrita por mim, sendo as sugestões dos outros autores discutidas e inseridas na versão final.

Table of Contents

List of Figures

List of Tables

Resumo

Os *video abstracts*, sumários audiovisuais de um artigo científico, estão a florescer no universo dos vídeos de ciência online. Estes vídeos permitem aos investigadores contar as suas histórias, recorrendo a diferentes formatos e recursos, explorando simultaneamente novas parcerias e novas audiências. Para além disso oferecem um conteúdo rigoroso a nível científico, contribuindo assim no combate à desinformação e funcionando como um recurso educacional fidedigno. No entanto os *video abstracts* continuam a ser pouco explorados e estudados, mantendo-se no círculo académico da comunicação entre pares, indexados em revistas científicas ou nos seus canais de vídeo, não sendo muitas vezes promovidos para outros públicos.

Esta Tese de Doutoramento pretende explorar, pela primeira vez o universo dos *video abstracts* nas áreas de Ecologia e Ciências do Ambiente. Neste sentido o trabalho começa por fazer um enquadramento histórico do cinema científico, desde a sua génese até ao advento do documentário televisivo, apresentando nas raízes do vídeo de ciência pontos de convergência com as problemáticas do estudo. De seguida, é apresentado o estado da arte dos *video abstracts* nas áreas em questão. Identificaram-se vídeos em 29 revistas científicas com base nos critérios de impacto, representatividade e visibilidade. Criou-se uma amostra de 171 vídeos, de 7 editoras e 17 canais de vídeo. Cada vídeo foi analisado tendo em conta diferentes parâmetros. O passo seguinte envolveu 30 especialistas em vídeos de ciência que avaliaram 21 vídeos e preencheram um questionário de modo a identificar quais as características mais e menos importantes para um *video abstract* eficaz. Por último, para explorar como um *video abstract* pode ser usado em diferentes contextos, com diferentes objetivos e para diferentes públicos, 6 professores de Biologia e Geologia e 117 alunos do Ensino Secundário foram entrevistados e questionados, respetivamente, após a visualização de um *vídeo abstract*. Por fim, durante o processo metodológico, foram produzidos e aplicados dois *video abstracts* originais da investigação do Centre for Functional Ecology da Universidade de Coimbra.

Os resultados mostraram que um *video abstract* em Ecologia e Ciências do Ambiente deve ser curto, claro, objetivo, criativo, dinâmico e informativo. Além disso, deve conter imagens reais, animações (para desconstruir as ideias mais complexas), uma narração e som de boa qualidade. Os formatos disruptivos e profissionais têm mais sucesso do que os esforços tradicionais e amadores de comunicação da investigação científica, por isso é necessário investimento e planeamento. Trabalhar numa equipa multidisciplinar e ter uma estratégia em rede é fundamental. Na sala de aula o *video abstract* deve ser curto, com estilos variados e assente numa estratégia educacional mais ampla. A presença de investigadores nos vídeos inspira os alunos a seguirem carreiras científicas e cria novas pontes entre a academia e o ensino secundário.

No final, esta tese estabelece diretrizes de produção, que servirão como instrumento de orientação na comunicação científica a nível internacional, e propõe um conjunto de ações no sentido de melhorar a implementação do video abstract enquanto ferramenta de comunicação de ciência.

Palavras chave: Ciência Ambiental, Ciência e Tecnologia, Comunicação Audiovisual, Comunicação de Ciência, Ecologia, Educação Científica, História da Ciência, Meios de Comunicação, Resumos de Vídeo

Abstract

Video abstracts, i.e. audio-visual presentations of a scientific paper, are a trend in the universe of online science videos. They allow researchers to tell their stories using diverse formats and resources, exploring new partnerships and reaching new audiences. Also, they offer a unique guarantee of scientific rigour and accuracy while contributing to fighting misinformation and being reliable educational tools. However, video abstracts remain unexplored, used mainly for peer-to-peer communication, indexed in scientific journals or uploaded to video channels, and often not promoted to the general public.

This PhD thesis intends to explore, for the first time, the universe of video abstracts in Ecology and Environmental Sciences. The work begins by providing a historical framework of scientific cinema, from its origins to the advent of television documentaries, presenting in the roots of science video points of convergence with the problems of the study. Then, the state of the art in video abstract production was elaborated. Video abstracts in 29 scientific journals based on impact, representativeness and visibility criteria were targeted. A database of 171 videos from 7 publishers and 17 video channels was created, and each video was analyzed for different parameters. Secondly, 30 science video experts evaluated 21 video abstracts and completed a questionnaire to identify the most effective features to produce a compelling video abstract. Thirdly, to explore how a video abstract can be used in different contexts, with different objectives, and for different audiences, 6 Biology and Geology teachers and 117 high-school students were interviewed and questioned, respectively, after watching a video abstract. Finally, during the process, two original video abstracts of Centre for Functional Ecology of the University of Coimbra research were produced and used at different moments of the methodological plan.

Results showed that a video abstract in these fields should be short, clear, objective, creative, dynamic and informative. Also, it should have real images, animations to explain more complex or abstract ideas, narration and good audio. Disruptive and professional formats succeed more than amateur efforts to communicate scientific work, so investing and planning are required. Working in a multidisciplinary team and having a network strategy is crucial. The video abstract should be short in the classroom, with different styles, and implanted in a broader educational strategy. Lastly, the presence of researchers in the videos inspires students to pursue scientific careers and creates new bridges between academia and high schools.

Finally, this thesis establishes a set of production guidelines, which will serve as an orientation tool in science communication at the international level, and proposes a set of actions to improve the implementation of video abstracts as a science communication tool.

Keywords: Audiovisual Communications, Communications Media, Ecology, Environmental Science, Science Education, Science Communication, Video Abstracts, Science and Technology, Science History

1. General Introduction

1.1 Under the sky of scientific cinema

In 2022, an alleged being from another planet invaded movie theatres worldwide. "Nope" (Peele, 2022), Jordan Peele's third feature film, presented a threat hidden in the skies of Aguadulce, California. Two siblings, horse wranglers for Hollywood productions, tried to keep their ranch while the mystery thickened over their heads. This science fiction adventure was well received by the critics and the public, but it was its night scenes that generated more buzz, debate and curiosity. The colour, light and shapes were compelling and authentic. The most curious viewer, faced with such a spectacle and novelty, wondered how such an achievement had been possible. The answer lies in the hands of the Dutch cinematographer Hoyte Van Hoytema, who revolutionized the day-for-night technique (i.e. filming a night scene during the day (Bordwell & Thompson, 2013)). Hoytema, known for his work on “Her” (2013), “Interstellar” (2014) and “Ad Astra” (2019), told in an interview (Hart, 2022) that he managed to create something truly unique: he set up two chamber rigs, an ARRI Alexa 65, shooting on infrared mode, and a Panavision System 65mm film camera, filming on regular mode. The two cameras were on different but aligned axes, so each frame overlayed perfectly in post-production (Kodak, 2022). The infrared camera provided a monochromatic image where the sky was dark, while the 65mm camera captured colours and textures (Kodak, 2022). The overlapping of both cameras offers an authentic immersion experience in the darkness of the desert.

The most curious thing is that if, on the one hand, the film presents all these technological innovations in its production, on the other hand, it offers in its narrative a return to the early stages of scientific cinema. The Haywood siblings, lead characters of "Nope", are descendants of the jockey photographed on "Plate 626" from the Animal Locomotion series (1887) by Eadweard J. Muybridge (1830-1904). Muybridge, considered one of the fathers of scientific cinema (Tosi, 2005), acts here as a vital memory and spiritual guide. This English photographer became known for a series of photographs of a galloping horse in 1878, published in several scientific journals (Tosi, 2005). Like the brother and sister, who tried to find out what threatened them using only analogue devices (since the threat in the film disabled any electronic device), Muybridge also tried to answer a question by building his mechanism: Is it possible for a horse in any stage of its gallop to lift the four legs from the ground? (Tosi, 2005). The challenge was posed to him by former governor Leland Stanford, who intended to clarify this doubt and end the public debate (Elena, 1996). Stanford made available to Muybridge his ranch in Palo Alto, where he set up a wooden structure with 12 cameras lined up, fitted with electro-magnetic shutters and trip wires connecting the shutters to the ground of a racetrack, activated by the passage of the horse

(Cresswell & Ott, 2022; Pauwels, 2015). The images were captured against a gridded and numbered structure (Cresswell & Ott, 2022). This first set of images, titled "The Horse in Motion", showed that there are indeed moments where the horse has all four legs in the air (Cresswell & Ott, 2022). After this experience, Muybridge continued research on animal locomotion, impressing around 20,000 plates, many of which are present in the eleven volumes of his best-known work, published in 1887, "Animal Locomotion" (Elena, 1996), where the jockey shown in the movie appears. Although the Haywood lineage is fictional and the identity of the man riding that horse remains a mystery, the legacy of cinema as a tool for science endures. In this way, it is an innovation of nowadays that takes us back to the days when science and cinema went hand in hand, a chapter that continues to be of great importance not only for film historians but also for historians of science (Elena, 1996).

Scientific cinema emerged long before entertainment cinema (Tosi, 2005) and is described as the cinema produced by researchers, not only as a way of documenting their work but as part of it (Machado, 2014). It was thus born from a research perspective, exploring several scientific contents (Bellows et al., 2000), and not from a commercial viewpoint of editing and distribution (Machado, 2014). This cinema is also scientific as a method, as an instrument for choosing the object that will be studied (Ribeiro, 2002). Scientific cinema has impacted the very nature of filming and directing (Landecker, 2006). Over the decades, its meaning has expanded to include educational (Cunha, 2003) and training films, from specific subjects to documentaries for the general public (de Almeida et al., 2017). In the dissemination field, we can distinguish the teaching film, with educational purposes, often created to link movie production and scientific content, and the popularization film, which exposes a scientific theme to a lay audience and may have an important role in raising awareness (Ribeiro, 2002). Finally, another essential element is that scientific cinema worked as an engine for several technological improvements (de Almeida et al., 2017), simultaneously allowing the creation of a scientific imaginary because, beyond the tools, it was a way of disseminating among the public the advances of science (Oliveira, 2006).

Scientific cinema has two scientific roots: the study of image persistence on the retina and experimental research on the physiology of movement (at the end of the 19th century) (Ribeiro, 2002). Concerning the first, the works on the memory of retinal persistence presented by the English physician Peter Mark Roget (1779-1869) to the Royal Society of London in 1824 and the works of the Belgian physicist Joseph Plateau (1801-1884), who established in 1829 the principle of persistence of retinal impressions, stand out (Elena, 1996). Plateau invented the phenakistiscope in 1832, which, along with the zoetrope created by the English William George Horner (1786-1837), allowed the visualization of moving images (only illustrations and always with an entertainment objective) (Hentschel, 2014).

Still in retina research, we find the work of Pierre-Jules-César Janssen (1824-1907), a French astronomer who began his career studying the functioning of the eye and the problems of ophthalmology (Tosi, 2005). However, his contribution to scientific cinema was when, in 1874, he photographically recorded the transit of Venus across the Sun using a clockwork mechanism coupled to the camera and telescope, which recorded 48 images in 72 seconds on a single circular daguerreotype plate (Bonifácio et al., 2013; Tosi, 2005). The photographic revolver was the first instrument designed to automatically obtain a series of photographs, being described as the first precursor of modern film cameras (Bonifácio et al., 2013). When presenting his results, Janssen highlighted that it could be used to study animal movement (Hentschel, 2014).

The French physiologist Etienne-Jules Marey (1830-1904), inspired by the work of Janssen and Muybridge, became interested in the problem of movement in man and animals in 1868 (Elena, 1996). Marey first designed the photographic gun in 1882, allowing him to capture the flight of birds (Michaelis, 1955; Tosi, 2005). Later, he perfected the photochronographic camera until he decomposed the movement into many images. His works stimulated new research in the field of animated photography (Elena, 1996).

Scientists perceived cinema not only as a powerful tool for analysis and diagnosis (e.g. Kurt Boas used it as a lie detector from 1908 onwards) but also as an instrument of study and experimentation (e.g. Karl Marbe (1869-1953) used it in experiments on optical stimulation and visual perception) (León, 2010). As previously mentioned, scientific film, and its important capacity for recording, analyzing and documenting, was also helpful in teaching. In medicine, for example, doctors filmed their operations and used them as an educational tool (León, 2010). Among the pioneers is Eugene-Louis Doyen (1859-1916) (Bellows et al., 2000). In 1898, this French surgeon presented three films of surgeries during a meeting of the British Medical Association (de Almeida et al., 2017). In 1902, Doyen produced his best-known film, the separation of two Siamese twins (Elena, 1996). Pioneering efforts in French medical cinematography reached Germany and the United States of America, proving the value of films for training medical personnel (Hentschel, 2014). In the 1920s, zoology, embryology and anthropology were other areas where cinematography became popular, and film demonstrations became standard practice at peer conferences (Hentschel, 2014).

1.2 The return of the cine-scientist

In the first half of the 20th century, while cinema grew as entertainment, a group of science individuals promoted filmmaking as a legitimate research technique while producing content for non-specialized audiences interested in movies with scientific topics (León, 2010): it was the birth of the cine-scientist (Gouyon, 2016). The two most significant cycles of popular science film are associated with microcinematography (Gaycken, 2011). Firstly, by the hand of the British Francis Martin Duncan (1873–1961), who debuted in 1903 a series of films entitled "The Unseen World: A Series of Microscopic Studies, Photographed by Means of the Urban-Duncan Micro-Bioscope", where he explored the educational and dissemination value of various microscopic phenomena (Gaycken, 2011). Secondly, with the work of the French microbiologist Jean Comandon (1877-1970), who filmed for the first time in 1909, the organism responsible for syphilis (*Spirochaeta pallida*) (León, 2010) and proceeded with the first installation of microcinematography on the ultramicroscope for medical research with the support of Pathé Frère Society (Ribeiro, 2002). Microcinematography made it possible to visualize processes invisible to the naked eye, such as cells in the bloodstream, which brought new possibilities in sharing observations in the classroom and in the ability to observe phenomena in slow motion or fast-forward (Hentschel, 2014; Landecker, 2006).

Other notable film scientists include Wilhelm Pfeffer (1845-1920), Roberto Omegna (1876-1948) and Jean Painlevé (1902-1989). In 1900, Pfeffer used cinema and the time-lapse technique to capture the geotropic movement of plants (Michaelis, 1955). From 1898 to 1900, Pfeffer made four time-lapse films, one demonstrating tulips' growth, flowering and wilting (Gaycken, 2012). On the other hand, Omegna, one of the central figures of Italian scientific cinema until the end of World War II, focused his work on the micro world, creating entomological documentaries (de Ceglia, 2012). Between 1908 and 1910, Omegna carried out pioneering work with his film "La vita delle farfalle", where he presented, among other things, time-lapse sequences of the complete metamorphosis of an insect (Tosi, 2005). However, if one name stood out in the attempt to get the scientific film out of the scientific sphere and present it as a spectacle to the general public, it was the French Jean Painlevé (Ribeiro, 2002). In 1925, Painlevé presented his first scientific film, "L'ouef d'épinoche", at the Academy of Sciences. His most successful film with the public is "L'Hippocampe" (1934) (Ribeiro, 2002). His work focused, on the one hand, on research films in the strict sense of the word, with few comments and sound effects, and longer and more imaginative scientific popularization films (Cunha, 2003). Around two hundred films constitute Painlevé's visionary legacy, one of the most important in the development of scientific cinema (Elena, 1996). Painlevé's films remind us that cinema was scientific before it was fiction (Bellows et al., 2000). In addition to his work as a director, Painlevé worked as a curator and promoter of scientific cinema. As founder of the Institute of Scientific Cinema (ISC) (1930), he imported thousands of scientific films over the years, showing them in specific programs (Bellows et al., 2000). The gallery of famous film scientists also includes names such as Cherry Kearton (1862-1928), Percy Smith (1840-1922) and Jean Perrin (1870-1942) (Gouyon, 2016).

As cinema gained popularity and commercial visibility, scientific cinema became increasingly forgotten. Cinema took over fiction at the expense of science, and scientific cinema quickly became a marginal subgenre (Elena, 1996). After World War II, efforts to see filmmaking as a professional career meant that film scientists gradually disappeared. The relationship between science and films, directors and scientists changed drastically, evolving towards professionalization. In the 1950s, scientific films began to move from cinema to television (Gouyon, 2016). From this point onwards, it became increasingly difficult to be a scientist and a filmmaker at the same time (Gouyon, 2016). Scientists offered facts, and producers transformed them into products suitable for the public (Boon & Gouyon, 2014). However, scientists have not completely stopped using films to promote and carry out their science (Gouyon, 2016). An example is the "Encyclopaedia Cinematographica", a biological, ethnographic and technological collection of films started at the German Institut für den Wissenschaftlichen Film in 1952 (Wolf, 1974). Unfortunately, from 1960 onwards, the camera as a means of public science communication was no longer under the control of scientists (Gouyon, 2016). Television producers now claim to be on the same level as scientists when producing original material about the natural world (Singer, 1966).

Furthermore, nature documentaries and natural history television were conceived in a top-down model of science communication – the so-called deficit model (Burns et al., 2003) – viewers were seen as passive participants in the discussion and not as an integral part of it (Boon & Gouyon, 2014).

With the emergence of new technologies, the way scientific knowledge is represented on television has changed, but also on other emerging platforms, which are now essential for our daily lives (Espanha & Lapa, 2019). More than half of the world's internet users (5.18 billion people) (Statista, 2023c) use YouTube (Statista, 2023a) to watch online videos, with more than 500 hours of new content uploaded every minute (Statista, 2023b). In 2020, 65% of people in the European Union used the Internet to watch television or other videos (Eurostat, 2021). In this new post-pandemic reality, video has become a refuge from daily life problems and a source of constant learning (Hensler & Gardner, 2020).

Nowadays, video production is accessible to most people, leading to novel ways of content distribution (Espanha & Lapa, 2019). Indeed, the boundaries between professionals and amateurs, creators and viewers, became blurred (Bruns & Schmidt, 2011). This technological wave has created new possibilities for science communication and assigned new and complex challenges to its stakeholders (León & Bourk, 2018b). Researchers, scientific institutions and knowledge dived into these media environments (Brossard, 2013) with new and significant responsibilities (Bucchi, 2017). Traditional tools to communicate scientific outcomes, such as written papers

(Bentley & Kyvik, 2011), now coexist with audiovisual resources on modern distribution platforms (Kippes, 2021). Videos are one of these resources.

The online science video is a short audiovisual film with scientific topics that aims to reach a wider audience, using resources that adapt scientific features for the general public, maintaining their rigour and precision (León & Bourk, 2018b; Morcillo et al., 2016). It is characterized by a great diversity of formats and an increasing hybridization of genres (León & Bourk, 2018). It is in the science video arena that the video abstract appears. Despite being an underexplored genre, it has already been well-defined and described (Scott Spicer, 2014): a video presentation of a specific scientific article, which communicates the study framework, methods, results and future implications. They are the film version of the written abstract, i.e., audiovisual summaries of scientific papers (Berkowitz, 2013).

Just as Muybridge appears as a cornerstone of modern cinema concepts (in the previously mentioned movie "Nope") and as a reference in pursuing new solutions, video abstract also has its foundations in scientific cinema. Firstly, it presents itself with the triple purpose for which scientific film has been recognized over the years: (i) It is a video produced by researchers for researchers, from the laboratories and the research field to other colleagues and peers; (ii) it can be used as a learning tool to illustrate techniques, present themes or deconstruct ideas, whether in an educational context or in the context of conferences and scientific presentations; (iii) it is a tool for disseminating science from the scientific sphere to a lay public on these topics and for new audiences that usually do not have access to this kind of information. Secondly, the video abstract brings back the concept of the cine-scientist, the researcher who uses and masters the art of filmmaking and who himself transforms his research into a cinematographic object. With this type of content, scientists are once again invited to pick up the cameras, creating a new generation of scientists as filmmakers (Angelone, 2019). Thirdly, video abstracts are a step forward in the search for the balance between entertainment and scientific rigour. Despite cinema leading the viewer to a fictional experience, documentaries have found ways to legitimize themselves, using traditional resources, such as the presence of scientists in images and off-screen narration in the traditional style (León, 2010). Therefore, combining innovative and traditional elements is sought to balance credibility and entertainment (León, 2010). Similar to what happened with the scientific film, the video abstract also struggles with problems of credibility and affirmation. Scientific cinema was not recognized as a cinematographic genre nor considered an area of study (de Almeida, 2022); the same has happened with the reality of online science films (León & Bourk, 2018a). Finally, aligned with the previous arguments, the video abstract can help to demystify some preconceived ideas and stereotypes (e.g. scientists are middle-aged or elderly males who wear white lab coats and work indoors) (Ferguson & Lezotte, 2020; Ruiz-Mallén et al., 2018) that live in the scientific imagination and are amplified by fictional cinema (Kirby & Ockert, 2021).

At the same time, promoting new and innovative knowledge in Ecology and Environmental Sciences is fundamental for sustaining a healthy life. Nature is part of human existence, vital in food provision, energy, medicine, population well-being, and cultural integrity (Díaz et al., 2019). Natural diversity allows humanity to choose alternatives in a foggy and uncertain future. Across the globe, human activity has affected nature, with most ecosystems and biodiversity indicators showing a fast decline (Díaz et al., 2019). In this complex challenge, Science has to keep searching, investigating and trying to find new solutions. Researchers and experts must find new ways to reach different stakeholders and audiences outside the scientific sphere (Burrows et al., 2022; Dirzo et al., 2022). Video abstracts on these topics could be a powerful ally in achieving the goals of global agendas, contributing to a more ecologically literate audience (Boehnert, 2015) and creating new voices for everyday challenges (Dirzo et al., 2022).

Research on the role of online science videos in science communication is growing (Allgaier & Landrum, 2022; León & Bourk, 2018a). However, most of the samples rely on videos about pressing topics (e.g. climate change or vaccination), putting aside other areas and issues. Also, academic scientific videos do not share the same attention as popular science videos on YouTube. Videos produced by researchers, academia or other specialised stakeholders remain underexplored, with no guiding lines on best communication practices. So, this Thesis aims to explore, for the first time, the classification, conception and reception of video abstracts in Ecology and Environmental Sciences.

1.3 General objectives and methodological approach

The general objectives of the research described in the present Thesis were:

- Describe the state of the art in video abstract production, identifying and categorizing video abstracts present in an online environment in the areas of Ecology and Environmental Sciences;
- Understand which video content factors affect the popularity and reach of the scientific research;
- Identify the most and least valued features in a video abstract;
- Produce two original video abstracts based on research produced at the Centre for Functional Ecology of the University of Coimbra (CFE-UC);

- Explore the potential of video abstracts in Ecology and Environmental Sciences as an educational tool for science teachers and secondary science students;
- Propose future guidelines and a set of good practices for producing an effective video abstract in Ecology and Environmental Sciences.

The experimental work was organized into three key steps, as presented in Figure 1. Initially, an inventory of online video abstracts in Ecology and Environmental Sciences was made. The selection process originated a sample of 171 video abstracts, 17 video channels, 29 journals and 7 publishers. Descriptive and content metrics were collected for each video, and descriptive and statistical analyses were conducted. This step is described and thoroughly discussed in Chapter 2.

The second step comprised a sample selection of 21 videos, representative of the initial sample of 171 videos. A panel of 30 experts watched these videos and answered a survey. In the first part, the questionnaire intended to understand the viewing habits of specialists in science videos and their perceptions of video abstracts. In the second part of the survey, experts numerically and qualitatively evaluated each video. The answers were subjected to content analysis, resulting in 7 categories and 19 subcategories and illustrating what respondents liked most and least about the videos. This step is described and discussed in Chapter 3.

The third step of the research encompassed two moments of analysis. The first involved projecting one of the two produced video abstracts to 117 secondary students across six classrooms of the same school, who subsequently completed a questionnaire. Then, a second moment of analysis consisted of presenting the other produced video to six Biology-Geology teachers, who shared their experiences and thoughts through individual semi-structured interviews. In both cases, the results were subject to content analysis. This step is described and discussed in Chapter 6.

Along the process, two original video abstracts were produced based on the scientific outputs conducted by the CFE-UC research groups. The first article to inspire an audiovisual approach was "Metabolic effects of dietary glycerol supplementation in muscle and liver of European seabass and rainbow trout by ^{1}H NMR metabolomics", authored by researchers Ivan Viegas and Mariana Palma from the CFE-UC Marine and Coastal Ecosystems research group. Always in close collaboration with the researchers, the script writing, film production, film post-production and dissemination were carried out. This video was used and analysed in steps 2 and 3 (Chapter 3 and Chapter 6, respectively).

The second original video abstract was based on the article "Spatiotemporal Variation in Pollination Deficits in an Insect-Pollinated Dioecious Crop", authored by researchers Helena Castro, Sílvia Castro, Hugo Gaspar, Catarina Siopa, and João Loureiro from the FLOWer Lab of CFE-UC. Converting written information into video format followed the approach described in the previous paper. A comprehensive account of all aspects of producing this video, along with recommendations and key challenges, is provided in Chapter 4. Furthermore, this video was studied in Chapter 5.

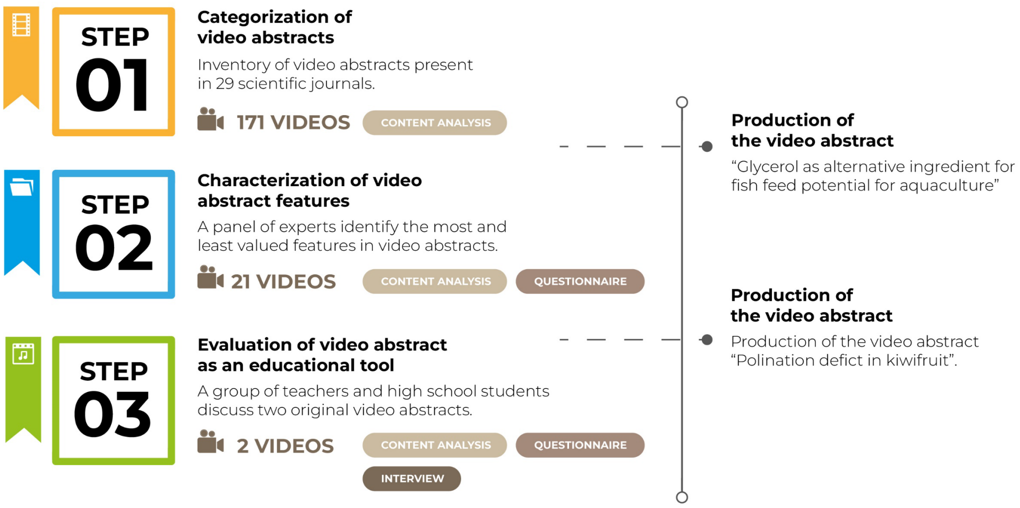

Figure 1. Main steps of the methodological work.

2. Audio-visual tools in science communication:

The video abstract in Ecology and Environmental Sciences

The work presented in this chapter was published in *Frontiers in Communication*.

Ferreira, M., Lopes, B., Granado, A., Freitas, H., & Loureiro, J. (2021). Audio-Visual Tools in Science Communication: The Video Abstract in Ecology and Environmental Sciences. *Frontiers in Communication*, *6.* doi.org/10.3389/fcomm.2021.596248

2.1 Introduction

Science communication is usually associated to the written press format (Bentley & Kyvik, 2011), and scientific papers continue to be the most used format in academia to disseminate the research produced (Jamali et al., 2018). However, with the rise of the internet and the science of information technology, the way science is communicated has witnessed profound changes. Nowadays, publications can benefit from these new communication tools that go far beyond written papers with graphs and tables (Jamali et al., 2018; Rodrigues & Godoy-Viera, 2016). Sharing results through audio-visual resources has gained an important role in this process: video recordings or live events, conferences, school classes, experiments and projects, each method having its own ability to illustrate practical knowledge in a much more effective way (Plank et al., 2017). Indeed, a wide range of audio-visual resources are available nowadays, with increasing adoption by the scientific community; amongst these resources, videos have gained special prominence (León & Bourk, 2018b).

Science online videos can be defined as short scientific audiovisual content that aims to reach a wider audience using resources that demystify science features for the general public while keeping its rigour and precision (García-Avilés & de Lara, 2018; Morcillo et al., 2016). It is not a standardized communication tool since it is characterized by a great variety of formats and an increasing mix of genres (Erviti & Stengler, 2016; García-Avilés & de Lara, 2018),

In this context, the video abstract, the main object of study for this paper, emerges as a relatively new genre in science communication, having been already well defined and described by Spicer (2014): it is a video presentation of a scientific paper, which communicates the framework of the study, the methods, the results, and the conclusions and future goals. It is the filmed version of the written abstract, i.e., audiovisual summaries of scientific papers (Berkowitz, 2013). Unlike conference and lecture videos, such as TED Talks (Shah & Marchionini, 2010; Sugimoto & Thelwall, 2013; Tsou et al., 2014), and experimental and protocol videos like the ones published in the Journal of Visualized Experiments (*JoVE | Peer Reviewed Scientific Video Journal - Methods and Protocols*, 2018; Rodrigues & Godoy-Viera, 2016), the video abstract allows one to present content in multiple formats: it can be an interview, a documentary, an infographic, a monologue or an overlap of all these formats. The creators of these videos use an array of analogical and digital tools without any specific guidelines (Plank et al., 2017); however, in some particular cases, journal editors have assigned rules and recommendations, and provide production and design tips to establish a defined model for the publication of a video abstract in a specific scientific area. These guidelines differ from area to area and may include technical specifications, review process, copyright, use of English and use of content, structure and tone (Scott Spicer, 2014). Cell Press, Springer Nature, Elsevier, Wiley, IOP Science, IEEE Xplore and

American Chemical Society are among the publishers that accept video abstracts as a complement to the published paper (Plank et al., 2017).

Furthermore, some of these publishers have established partnerships with specialized platforms in the production of multimedia content (e.g., Research Square (*Research Square*, 2019)). Through a set of paid services, researchers can see their work come to life in the form of a video abstract (2–3 min in length) or a video byte (1 min in length), using all sorts of techniques and animation. Also, universities and institutes have been promoting courses in science communication to instruct researchers and students on how to produce their videos (e.g., Filmmaking for Scientists, Popular Science Video Workshop, Low Budget Science Film Making Course) (Angelone et al., 2019; Chan, 2019; Plank et al., 2017). We are moving from a generation of "scientists-turned-filmmakers" to a generation of "scientists-as-filmmakers," researchers who integrate subjects on film production and directing into their academic training (Angelone, 2019). The growth of such initiatives reflects, in some way, the demand by the scientific community to communicate their research in a visual, modern and appealing way in order to increase the outreach and impact of their scientific publications.

The benefits of using videos as a science communication tool include the ability to describe scientific and complex processes in a more effective way; and the potential to increase research visibility, decrease the costs of training and experimentation and foster the reproducibility of methods and approaches (Jamali et al., 2018; Rodrigues & Godoy-Viera, 2016). While fifteen years ago, the video format had a single distribution channel, i.e., television broadcast, built on a unidirectional model, nowadays, with the advent of the internet, things have changed, and video producers can think about universal online distribution, without additional investment, in an increasingly low-cost system (Granado & Malheiros, 2015). Very few scientists are heard outside the television environment, and video abstracts can help to change that reality by bringing the message to a wider audience (Erviti, 2018). Also, previous studies have shown that scientific papers coupled with a video abstract are downloaded more and have more citations than papers without such an addition (Plank et al., 2017; Zong et al., 2019) and that optimized videos disseminate the scientific content to non-expert audiences in a more clear way, in comparison to written texts (Putortì et al., 2020).

Science video is a complex tool, a hybrid product that, like science communication itself, is based on different disciplines and knowhow, being interconnected with the universe of social networks and their users, who are today's producers (Bruns & Schmidt, 2011; Welbourne & Grant, 2016). Despite the need to create communities, produce unique and innovative content (Erviti & Stengler, 2016), work on new narratives (Angelone et al., 2019), maintain scientific rigour (Frances & Peris, 2018) and train researchers in these new areas (Angelone, 2019; Plank et al., 2017), the use of video abstracts for those purposes still presents some constraints. In particular, it is important to understand if a video abstract is suitable for all subjects, what models we should use as guidelines to produce a successful video abstract, what is the real effect of video abstracts on research dissemination and learning of sciences, and what are the best approaches for measuring these effects.

In pursuit of this purpose, an inventory of video abstracts present in 29 scientific journals was made, with an overall number of 171 video abstracts being selected, viewed and categorized. We did a general characterization using descriptive and content metrics. Also, we tried to understand what were the most important factors that affect the research popularity, measured by the number of citations per day, the value of Altimetric of the scientific paper and the number of views of the video abstract. Based on the literature review, we examined four content factors – video length, production, format and audio quality – for their influence on research popularity. Understanding the influence of these factors on research popularity will allow the producers to create more effective and engaging content. This is the first step towards a conceptual framework about video abstracts in Ecology and Environmental Sciences. In the next section, "Ecology and Environmental Sciences under the lens", we present the reasons for choosing this scientific area; then, in "Literature Review", we briefly review the preview works on video categorization, focusing on the content factors chosen for the analysis. In "Design and Methods", we describe the sampling and codification processes, as well as the descriptive and statistical analysis used. The "Results" are divided into five sections - general characterization, video length, production, formats and audio quality - where we do a global description and then analyse the content factors with the research popularity. Finally, in the "Discussion" and "Conclusions", we debate the main findings, point out the research limitations and establish new guidelines for future research.

2.1.1 Ecology and Environmental Sciences under the lens

The world's growing population has led to problems of rapid climate change, over-exploitation of our natural resources, degradation of natural habitats and biodiversity loss. Ecological and Environmental Sciences help us understand these issues and address some of the biggest environmental challenges that our planet faces. Over the past decades, these issues have cultivated a growing interest in academia, governmental agencies, and the general public. The EU Biodiversity Strategy for 2030 (European Commission, 2020) and the 2030 Agenda for Sustainable Development (United Nations, 2015) are goals and efforts that need to be supported by a communication matrix. Concepts such as visual literacy (Bucchi & Saracino, 2016; Krause, 2017; Rigutto, 2017; Trumbo, 1999) go hand-to-hand with others like environmental literacy, ecological literacy and eco-literacy (McBride et al., 2013) to create new tools and new responses to these problems. Moving images can transmit emotions and indorse engagement in the citizens, especially in the environmental areas where the visuals are used to promote behavioural change (León & Bourk, 2018b). Studies that explore the visual rhetoric, that try to "understand how images communicate, how they function in a social and cultural environment, and how they embody meaning" (Wright, 2011), start to show their importance: for example, Finkler et al. (2019) studied the impact of video on changing attitudes and good practices in whale watching. The authors concluded that following the viewing, almost all participants demonstrated their intention to choose a tour operator that promotes sustainable and responsible whale watching practices (Finkler et al., 2019; Finkler & León, 2019).

Studies dedicated to environmental videos have focused on specific and current themes such as fracking (Jaspal et al., 2014), environmental activism (Slawter, 2008; Uldam & Askanius, 2013) or climate change (Allgaier, 2019); thus, no work focuses specifically and transversally in the area of Ecology and Environmental Sciences. Given its potential for the production of highly visual video abstracts, these study areas are extremely relevant for pursuing the goals of this study.

2.1.2 Literature review

The video abstract raises new questions on evaluating the success of research communication and opens the door to new dynamics. Traditionally, written articles see their impact assessed through the number of citations (Thelwall et al., 2012) and, more recently, through new metrics such as Altmetric (Altmetric Limited, 2012). These can include "citations on Wikipedia and in public policy documents, discussions on research blogs, mainstream media coverage, bookmarks on reference managers like Mendeley, and mentions on social networks such as Twitter" (Altmetric, 2012). It is, therefore, important to take these two values into account when it comes to the popularity and scope of a written paper. Furthermore, the popularity of videos is directly associated with a series of metrics such as the number of views, viewing time, retention time, engagement, among other metrics. Many of these metrics are available to the public, but others are only for internal management by the author of the video, using tools such as YouTube Analytics. Video's popularity is associated with two kinds of factors: content factors, directly related to the production of the videos, such as length, format, and theme, and agnostic-content factors, such as the sharing network and recommendation systems (Borghol et al., 2012; Figueiredo et al., 2014). Although this is a dynamic function, the content factors seem to be the most informative and most used to understand what makes a video have more or less impact (Welbourne & Grant, 2016). Most of the studies on online video are recent and focus on studying these factors that can be altered, changed and modified by the authors, researchers, and producers.

Although most experts agree that online science videos should be brief, visually appealing and easy to see (García-Avilés & de Lara, 2018), it is vital to have an idea of what videos have been made and what factors can be improved. Realizing what kind of content can be effective and popular and who produces it seems to be mandatory questions for the future of the area (Allgaier, 2019). In fact, in the last decade, research efforts have focused on these two major topics. Categorization and content analysis was one of the first types of study to emerge and has been maintained over the years, highlighting documentaries, reports and animations as the most present and most popular formats (Morcillo et al., 2016; Plank et al., 2017; Thelwall et al., 2012). One of the most recent classifications suggests 18 different formats, divided into two major groups: television formats - videos that were initially broadcast on television and then uploaded online - and web formats - videos produced from scratch to the internet (García-Avilés & de Lara, 2018). Video blogs, TV news stories and TV features or documentaries were the most frequent video formats used in science communication (García-Avilés & de Lara, 2018).

Form and content are directly related to the production and its actors. The type of channel and, by default, the production contexts are particularly important when we examine video popularity (Welbourne & Grant, 2016). Léon & Bourk (2018) identify media companies as producers of more than half of the analysed videos, in contrast to the scientific institutions that produce much less; however, both are more represented by traditional formats such as news and documentaries (Erviti, 2018). The most experimental and emerging genres are in charge of non-professional users and their entitled User Generated Content (UGC) (Erviti, 2018), content that, despite being less numerous, is more popular in science communication (Welbourne & Grant, 2016).

In the production process, other elements, adding to the narrative format, have to be taken into account. First, it is important to understand the ideal length of a video. The average video length on YouTube is 11.7 minutes (Statista, 2020a). Depending on the category, the video length can vary a lot, from 24.7 minutes in "Gaming" to 6.8 minutes in "Music" (Statista, 2020a). Also, looking at the most popular video content categories that year, we can assume that shorter videos are not the most popular ones (Statista, 2020b). So, it is important to adapt the length of our film to the area, category and target audience. Concerning the sound, recent findings suggest that good audio quality is in the researcher's or reporter's interest and that the technical quality of recordings can affect the evaluation of the research (Newman & Schwarz, 2018). The average quality of the audio and the narrator's voice in popular science videos are good and very good, showing values of production and a certain degree of professionalism in this feature (Morcillo et al., 2016). Scarce literature on the effects of length and audio quality on video popularity and the future research tasks on producing a video abstract led us to include these two features in our study.

2.2 Design and Methods

The first stage of the work involved restricting the research to Ecology journals and ensuring that only journals with a high reach that is the impact factor - a metric that evaluates the frequency with which a paper is cited in a given year or period in a specific journal - were used. Thus, according to the Journal Citation Reports 2018 (“2017 Journal Impact Factor,” 2018), the top 40 journals of Ecology in terms of impact factor were selected (Appendix A, Table A1). The journal with the highest impact factor was "Trends in Ecology & Evolution" (15.938), and the one with the lowest impact factor was "Behavioral Ecology" (3.347). From this selection, only five scientific journals, from the same publisher (Wiley), used video abstracts with their papers and on their video channels. Since this sample represented a set of less than a hundred videos, in a second stage, the research field was extended to Ecology and Environmental Sciences. Thus, 24 extra scientific journals from 6 different publishers (Springer, Springer Nature, Nature, AAAS, Cell Press and New Phytologist Trust) were added (Appendix A, Table A2).

After that, a thorough search on the webpages of scientific journals and in their video channels was made. No limitations were imposed on the length or the use of still images in the videos, thus including hybrid formats such as the "video article" (Vázquez-Cano, 2013), the "audioslide" (W. Yang, 2017) or the "video byte" (*Research Square*, 2019) in the definition used for video abstract. All the videos that did not fit this definition were excluded. In the final stage, the research was extended using keywords in search engines, to the researcher's personal pages, social networks and specific platforms associated with the production of science videos, such as Research Square. This process resulted in a corpus (database) of 171 videos, from 17 video channels (from YouTube and Vimeo platforms), 29 journals and 7 publishers (Table 1) (Appendix A, Table A3).

Table 1. Number of video abstracts by video channel, scientific journal and publisher.

Publisher	Channel	Journal	Number of videos
Wiley	Functional Ecology	Functional Ecology*	23
	American Museum of Natural History	Functional Ecology*	1
	Journal of Ecology	Journal of Ecology*	18
	Ecography	Ecography*	13
	Journal of Animal Ecology	Journal of Animal Ecology*	10
	Wiley	Ecohydrology*	1
	Wiley	Environmental Toxicology and Chemistry	1
	Wiley	Fisheries Magazine	2
	Wiley	Ecology and Evolution*	1

	Wiley	WIREs Water*	1
	Wiley	Global Change Biology*	1
	Research Square	Land Degradation & Development*	1
New Phytologist Trust	New Phytologist Trust	Plants, People, Planet*	9
Springer	Research Square	Sustainability Science	1
	Springer Videos	Ambio	1
Springer Nature	Research Square	Parasites & Vectors	1
	BMC	BMC Biology	1
	BMC	BMC Evolutionary Biology	1
	BMC	BMC Zoology	2
	BMCseriesJournals	BMC Zoology	1
Nature	Research Square	Nature Climate Change	2
	Eltahir Research Group at MIT	Nature Climate Change	1
	Nature Videos	Nature Climate Change	1
	Nature Videos	Nature Ecology & Evolution	2
	Nature Videos	Nature Physics	1
	Nature Videos	Nature	5
	Nature Videos	Nature Genetics	1
	Nature Videos	Nature Communications	1
	Nature Videos	Nature Plants	1
	Scientific Reports	Scientific Reports	6
AAAS	Science Magazine	Science	13
	Science Magazine	Science Advances	3
	Miguel Araujo	Science Advances	1
Cell Press	Current Biology	Current Biology	43

*Journals with video abstracts published on their official web pages.

The categorization of the video abstracts (Appendix B) was based on the grid analysis presented by Morcillo, Czurda and Trotha (2016), on technical bibliography (Bordwell & Thompson, 2013; Vachon, 2018) and a pre-analysis of the videos (Coutinho, 2018). Data coding, considering the characterization of each video abstract constituting the corpus, was made manually and was divided into three steps (Morcillo et al., 2016):

1. Collection of general metrics for each video:

(a) video title;

(b) channel name;

(c) number of subscribers of the channel;

(d) number of likes;

(e) number of dislikes;

(f) number of views;

(g) number of comments;

(h) length of the video: measured as the complete duration of the video;

(i) video age: in number of days from the date of publication to the date of data collection.

2. Collection of general metrics of scientific papers associated with the video abstracts:

(a) number of citations;

(b) Altmetric value;

(c) publication date;

(d) number of days online;

(e) scientific field;

(f) country of origin of the first author.

3. Collection of content factors for each video:

(a) production: amateur (a video produced by the author(s)/researcher(s) with limited resources), semi-professional (a video that mixes professional with amateur resources, normally associated with a university or research centre) or professional (a video produced by a media company, producer or science magazine);

(b) number of narrators: a specific number or no narration;

(c) gender of narrators: female, male or no gender;

(d) type of narration: first-person narration or third-person narration;

(e) type of thumbnail: a miniature of a frame, designed titles or any other option;

(f) shooting location: exterior locations, interior locations or both;

(g) number of takes used in the film;

(h) shots used: extreme long shot, long shot, medium-long shot, medium shot, medium closeup, closeup, extreme closeup;

(i) video format: animation (video that uses animation techniques, such as motion graphics, stop motion or whiteboard animation), documentary (live footage video that presents its themes in a factual and informative way, using numerous clips and different techniques, similar to a tv documentary or reportage), dynamic presentation (video with still images and titles animations, normally with music instead of narration), monologue (video in which the author, improvising or following a script, speaks directly to the camera on a scientific topic) or simple presentation (video that is mostly shaped by still images, narrated like a slide presentation);

(j) intro description: design and characteristics of the opening credits;

(k) outro description: design and characteristics of the closing credits;

(l) additional elements: maps, graphics, diagrams or others;

(m) sound design: the presence of background music, sound effects or others;

(n) audio quality: measured as the narrator's voice quality (good, bad or no narration).

As the initial coding process was carried out by just one person, we decided to strengthen the analysis. Therefore, a group of 30 coders was invited to analyse a representative sample of the corpus. The group had researchers from exact and social sciences and professionals from audiovisual, marketing and education fields. The sample of 21 videos (12% of the total) was representative of the main characteristics under study. After the coding, we measured the agreement between the coders using the Fleiss Kappa measure (Coutinho, 2018) for three of the four content factors used in our correlation (production, format and audio quality). The values obtained were all below 0.3, which represents a poor agreement between coders (Coutinho, 2018). To improve reliability, the categories were redefined and reformulated, as described above. A new coding process was led by all the authors of the paper. The key content factors were independently coded, and the values obtained varied between a strong (0.83 for video format and 0.80 for video production) and a good agreement (0.72 for audio quality).

All the links and web addresses from the selected papers, journals, videos, and channels were also collected (Appendix A, Table A3).

Descriptive analyses were made for the number of video abstracts per year (from 2010 to 2019), publishers of the scientific journals associated with each video, production, additional elements, shooting location, the number of takes, shots used, intro and outro descriptions, number and gender of the actors/narrators, type of narration and the video format. Generalized linear mixed models (GLMMs) were used to explore the effect of production, video format and audio quality (given as the narrator's voice quality) on video length, number of views per day, number of citations per day of the corresponding scientific paper, and Altmetric, including scientific journal as random factor. Because the variance of the random factor was lower than the variance of the residuals, the random factor was removed, and generalized linear models (GLMs) were used (Bolker et al., 2009). A Poisson distribution with a log link function was used in video length and Altmetric, and a Gaussian distribution and an identity link function were used for number of views per day of the video and citations per day of the corresponding scientific paper.

All analyses were performed in R software version 3.0.1 (R Core Development Team, 2016), using the packages "ggplot2" for graphics build-up, "car" for Type-III analysis of variance (Fox et al., 2012), "lme4" for generalized linear models and generalized linear mixed models (Bates et al., 2015) and "multcomp" for multiple comparisons after Type-III analysis of variance (Hothorn et al., 2016).

2.3 Results

Table 1 shows the number of video abstracts for each video channel, scientific journal and science publisher. Of this set, only ten journals have their videos published on their official web pages, in addition to their video channels.

2.3.1 General characterization

Between 2010 and 2018, the number of video abstracts produced increased sevenfold, and the growth rate stayed more or less constant (Figure 2). The small number of video abstracts uploaded in 2019, compared to the previous year, is directly related to the last date of data collection (7 September 2019).

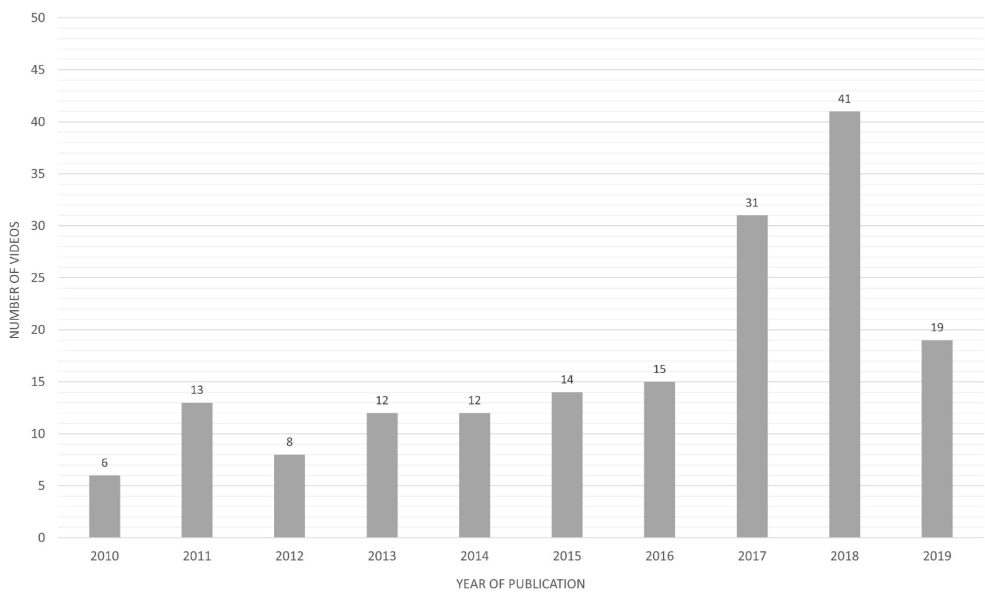

Figure 2 - Number of video abstracts per year of publication (from 2010 to September 7th, 2019).

Wiley is the publisher with the most videos associated (43%), followed by Cell Press (25%) and Nature (13%). Almost half of the studied videos have a duration comprised between 1 and 3 minutes (25% between 2 and 3 minutes and 22% between 1 and 2 minutes). Videos with 4-5 and 5-6 minutes correspond to 12% and 13% of the cases, respectively. Longer videos account for approximately 19% of the cases, and there is a decreasing number of videos with increasing length (Figure 3A).

Looking at production contexts there is a prevalence of amateur videos (50%), created by the researchers/authors of the work. Professional videos, produced by a media company or producer, come in second place, representing 38% of the surveyed videos. Videos that mix professional with amateur resources, defined as semi-professional videos, are the least frequent (12%) (Figure 3B).

Almost half of the surveyed videos (47%) mix the use of still images with moving images. Also, the sole use of moving images (33%) prevails over the sole use of still images (20%). The most used additional elements were graphs and maps. In the videos where film shooting is included, the majority is made outdoors (42%) or combines indoors with outdoors footage (45%). Videos shot exclusively indoors are a minority (13%). Furthermore, 85% of these videos have a story with more than three takes, and 66% include the use of more than one shot. The intros and outros of the videos are mainly based on a simple composition of titles or credits, which can appear solo, with still images or with videos.

Most of the voiceover is done by a single narrator/researcher (73%), followed by videos with no narration (12%) and videos with two narrators (10%); videos with three and four different narrators are residual (Figure 3C). Regarding the way the story is narrated, the majority of the videos (61%) present a third-person narrator instead of a first-person narrator (18%) (Figure 3D). As for the adopted format, most of the videos tell their story in more traditional ways, recurring to the documentary style (46%) or simple presentations (23%). More disruptive formats, like animations (16%) or dynamic presentations (11%), have a small representation, and monologue is the least used format (Figure 3E). Finally, more than half of the researchers who narrate the videos are male (57%), while females appear less represented (36%); the joint narration is not so popular (7%).

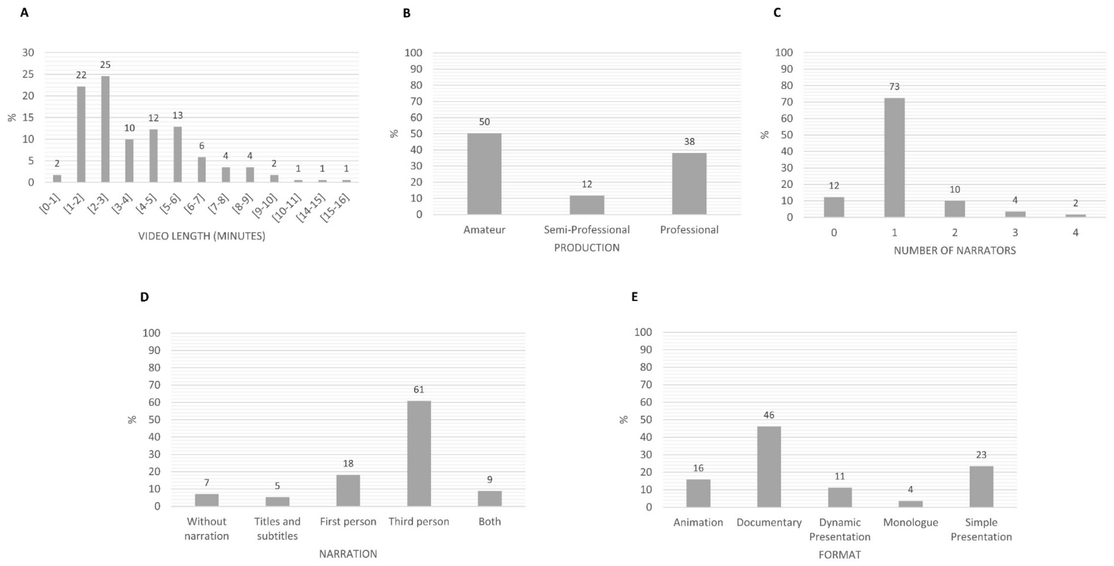

Figure 3 - Proportion of video abstracts (%) according to the video length (A), the type of production (B), number of narrators (C), type of narration (D) and video format (E).

2.3.2 Video length

Videos with 2-3 minutes length presented the highest number of views per day, and the respective scientific papers presented the highest number of citations per day (on average) (Figures 4A and 4B). Therefore, there seems to be a clear preference for shorter content, with a tendency for the abovementioned variables to decrease as the running time of the videos increases. Statistically significantly differences were detected among the production types (χ22, 168 = 37.34; $P < 0.001$, Table 2), with shorter videos being significantly associated with professional productions; on the other hand, amateur and semi-professional productions are significantly longer, with no significant differences being observed between both production types (Figure 4C).

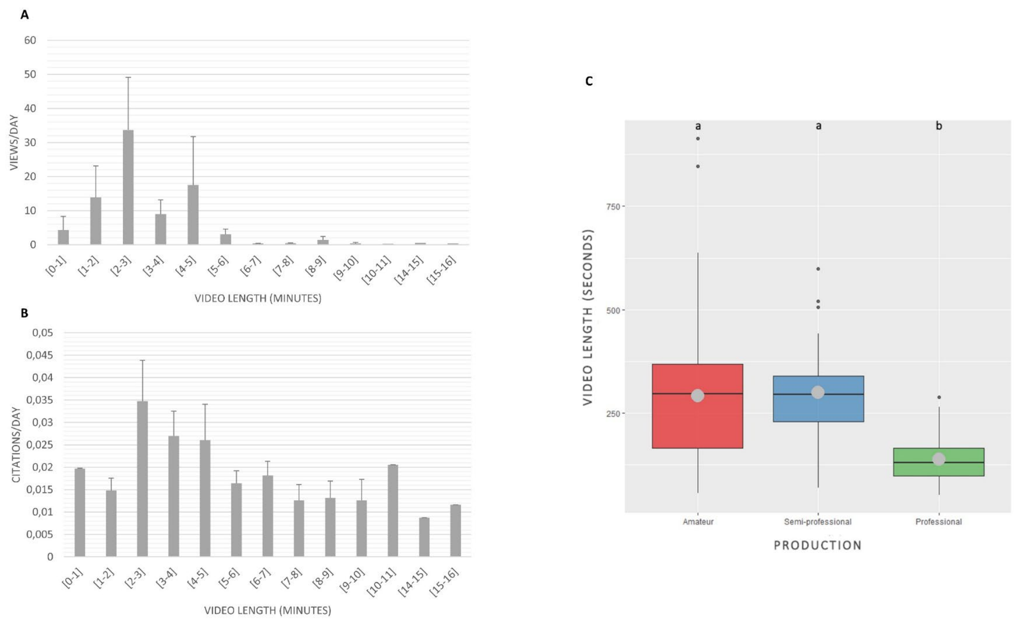

Figure 4 - Video length according to the number of views per day (A), the number of citations per day (B) and production type (C). In A and B values are given as mean and standard error of the mean. In C, the lower and upper hinges of each boxplot correspond to the first and third quartiles (the 25th and 75th percentiles) and whiskers extends from the hinge to the largest value no further than 1.5 * the inter-quartile range. Medians are depicted as a horizontal line within the boxplot, means as a gray bullet and outliers as black bullets (for visualization purposes online, some of the outliers are not depicted in the graphic); different letters represent statistical differences at $p < 0.05$.

Table 2. Statistical results from Generalized Linear Models of the effect of production, video format and audio quality (given as narrator's voice quality) in video length, number of views per day of the videos, and number of citations per day and Altmetric of the corresponding scientific paper. Statistically significant differences are highlighted in bold.

Factor	**Variable**	**Df**	χ^2 **values**	***P* value**
Production	Video lenght	**2,168**	**37.34**	**<0.001**
	Number of views per day	2,168	0.22	0.801
	Number of citations per day	**2,168**	**8.00**	**<0.001**
	Altmetric	**2,168**	**9.93**	**<0.001**
Video format	Number of views per day	4,166	0.40	0.810
	Number of citations per day	**4,166**	**3.34**	**0.01**
	Altmetric	**4,166**	**4.89**	**<0.001**
Audio quality	Number of views per day	2,168	0.76	0.470
	Number of citations per day	2,168	3.43	0.415
	Altmetric	**2,168**	**4.52**	**0.01**

2.3.3 Video Production

Videos with professional (n = 65) and semi-professional (n = 20) production presented more views per day on average than the amateur productions (n = 86), but the differences were not statistically significant (χ22, 168 = 0.22; P = 0.801; Table 2) (Figure 5A). Also, the median values of views per day were lower for videos with semi-professional production in comparison with those with professional production. The same trend was observed for the number of citations per day of the respective scientific papers, with the highest average values being obtained for professional production, but in this case, videos with professional production led to a significantly higher number of citations than amateur production (χ22, 168 = 8.00; P < 0.001; Table 2), with semi-professional productions presenting intermediate values not differing significantly from the other productions types (Figure 5B). For the Altmetric value of the publication, statistically significant differences were obtained among the three production types (χ22, 168 = 9.93; P < 0.001; Table 2), with professional videos leading to statistically significant higher Altmetric values than semi-professional and amateur productions. Amateur productions led to the lowest Altmetric values, and semi-professional productions presented intermediate values (Figure 5C).

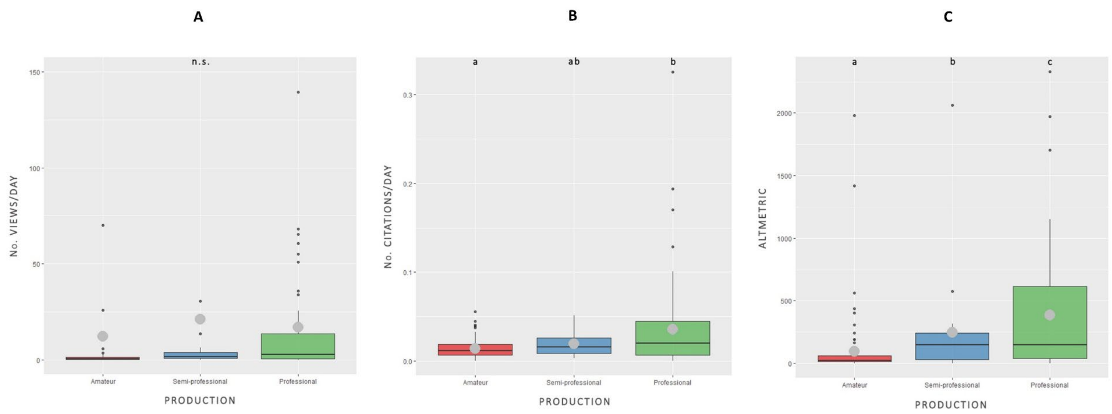

Figure 5 - Video production according to the number of views per day (A), and number of citations per day (B) and Altmetric values (C) of the corresponding scientific paper. The lower and upper hinges of each boxplot correspond to the first and third quartiles (the 25th and 75th percentiles) and whiskers extends from the hinge to the largest value no further than 1.5 * the inter-quartile range. Medians are depicted as a horizontal line within the boxplot, means as a gray bullet and outliers as black bullets (for visualization purposes online, some of the outliers are not depicted in the graphic); different letters represent statistical differences at $p < 0.05$.

2.3.4 Video Format

The formats with the highest average number of views per day were the documentary (n = 79), simple presentation (n = 40) and animation (n = 27), but no statistically significant differences were obtained among video formats (χ24, 166 = 0.40; P = 0.810; Table 2). It should be noted that simple presentation format presented some outlier values that might have influenced the average values, but presented median values similar to monologue (n = 6) and dynamic presentation (n = 19) formats (Figure 6A). Statistically significant differences were obtained for number of citations per day ($\chi 24, 166 = 3.34$; P = 0.01; Table 2). Animation and documentary formats are highlighted with the highest average number of citations per day, but significant differences were only obtained between animation and dynamic presentation and between animation and simple presentation (Figure 6B). For the Altmetric, statistically significant differences were obtained among video formats ($F4, 166 = 2876.74$; $P < 0.001$; Table 2), with animation format leading to higher Altmetric values than the other formats; however, significantly higher values for the animation format were only obtained when compared with the values obtained for dynamic and simple presentations, which are among the lowest ones (Figure 6C).

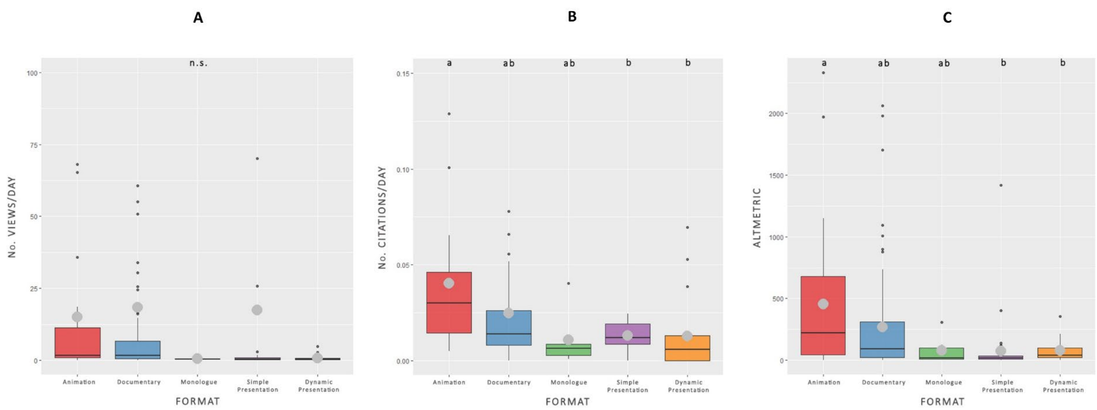

Figure 6 - Video format according to the number of views per day (A), and number of citations per day (B) and Altmetric values (C) of the corresponding scientific paper. The lower and upper hinges of each boxplot correspond to the first and third quartiles (the 25th and 75th percentiles) and whiskers extends from the hinge to the largest value no further than 1.5 * the inter-quartile range. Medians are depicted as a horizontal line within the boxplot, means as a gray bullet and outliers as black bullets (for visualization purposes online, some of the outliers are not depicted in the graphic); different letters represent statistical differences at $p < 0.05$.

2.3.5 Audio Quality

Videos where the quality of the narrator's voice is bad (n = 28) had a higher average number of views per day than the videos with good (n = 125) or no narration (Figure 7A), despite no significant differences were obtained among the three groups ($\chi 22, 168 = 0.76$; P = 0.470; Table 2). It should be noted that this was probably influenced by some outlier values in videos where the quality of the narrator's voice is bad as the median value is the lowest one, being even lower than that obtained for videos with no narration (Figure 7A). On the other hand, the number of citations per day and the Altmetric value of the corresponding scientific paper showed higher average values when the videos had good narration (Figures 7B and 7C, respectively). However, such differences were only statistically significant for the Altmetric value (χ22, 168 = 4.52; P = 0.01; Table 2). For the number of citations per day, despite the tendency referred above, the values were not significantly different (χ22, 168 = 3.43; P = 0.415; Table 2).

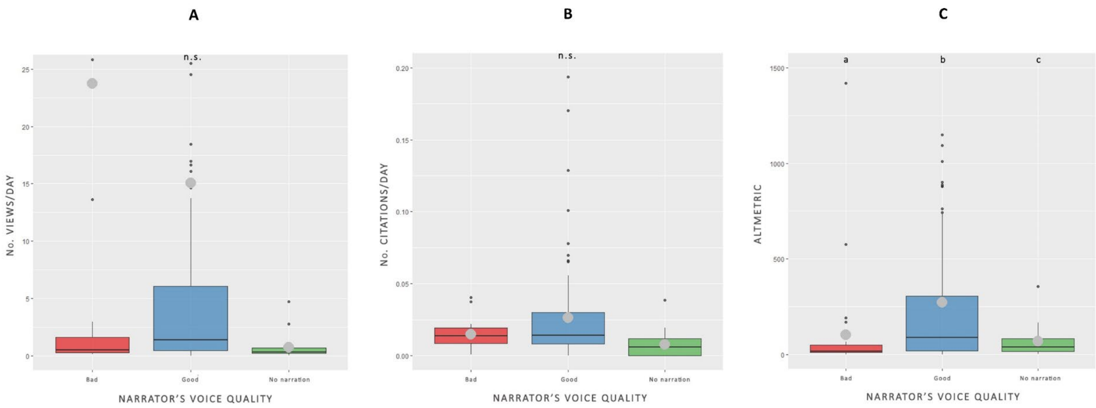

Figure 7 - Narrator's voice quality according to the number of views per day (A), number of citations per day (B) and Altmetric values (C) of the corresponding scientific paper. The lower and upper hinges of each boxplot correspond to the first and third quartiles (the 25th and 75th percentiles) and whiskers extends from the hinge to the largest value no further than 1.5 * the inter-quartile range. Medians are depicted as a horizontal line within the boxplot, means as a gray bullet and outliers as black bullets (for visualization purposes online, some of the outliers are not depicted in the graphic); different letters represent statistical differences at $p < 0.05$.

2.4 Discussion

The results of this study highlight the fact that the use of video abstracts in Ecology and Environmental Sciences is a complex and dynamic process. Our corpus presented us with very different approaches towards the production of a video abstract in this area: from a single researcher in his office to professional documentaries, from still images of the fieldwork to ingenious animations, from long presentations to very short explanations. This enormous variety of elements represented a huge challenge in the processes of content analysis and categorization. It is difficult to design a typology that represents such diversity (García-Avilés & de Lara, 2018). Our study provides relevant information to understand how this genre is evolving and contributes to establishing new directions towards more effective audio-visual communication.

The study sample and its detailed analysis revealed a strong dispersion and disorganization of the contents: videos from the same publisher and the same journal are often uploaded on different channels, showing a lack of a real communication strategy (Table 1). This is in line with previous studies in the field of video production, that revealed no or small articulation between the different offices of an institution and the various outputs, suggesting that a single and stable language is lacking (Santos & Santos, 2014) and that it is necessary to create a strategy for disseminating videos in an online environment (Erviti & Stengler, 2016). Effective dissemination implies a strategy, that in itself requires contacts, time and money (Vachon, 2018). When a film is planned, it is crucial to include promotion as an independent task and think about it from the beginning. As researchers, the communication can be under our responsibility or be in charge of other professionals (e.g. science communicators or journalists in communication offices); the important thing to ensure is a focused voice, that determines when, how and where. It is vital to collaborate with all the institutions involved in the research (e.g. universities, research centres, research groups, science journals, science centres, and newspapers) to upload the video to one unique platform, and spread the word from there. This is particularly important when we want to measure popularity metrics, being more rigorous and reliable if all the data come from one platform.

Despite this disorganization, the annual growth of video production follows the positive trend described, in general, for online scientific videos (García-Avilés & de Lara, 2018) (Figure 2). This evolution demonstrates a growing involvement of the scientific community and its partners with this dissemination tool and represents a clear sign of a growing interest in these new ways of communicating science. Also, although the methodology for surveying the video abstracts in Ecology and Environmental Sciences was based on exhaustive research on the webpages of scientific journals, video channels, search engines, social networks and other relevant platforms, some interesting content may have gone unnoticed.

Unsurprisingly, most video abstracts followed classic models, rooted in television, such as documentaries and reportages (Lloyd Spencer Davis & Léon, 2018; Welbourne & Grant, 2016): an individual, indirectly narrating a story or presenting research. It is possible that these specific areas (Ecology and Environmental Sciences) also amplify the use of these formats, once there is a great tradition of nature documentaries, very rooted in popular culture. The dominance of moving images and a certain complexity of production – in the number of takes, in the mix of indoor with outdoor shooting and in the type of elements used – are strong examples of this style. In contrast to what was observed by Erviti (2018), the bigger expression of amateur videos, and the so-called User Generated Content (UGC), does not represent, in this sample, more experimental content (Erviti, 2018). This probably reflects the need for specific training in these areas (Angelone et al., 2019; Plank et al., 2017; Vachon, 2018). In advanced courses in the area of science video production, after coming into contact with new ways of storytelling, most researchers opt for these alternatives, instead of the linear narratives they previously were aware of (Angelone et al., 2019). In the eyes of the public, disruptive genres such as motion graphics seem to cultivate greater interest, as reflected in the number of citations per day and Altmetric of the associated papers. However, the more traditional formats and narratives prevail largely. This can also be related to the fact that this kind of expository style is believed more (Davis et al., 2020). Also, the audience of these videos may be an engaged one, with peers and people with a university education, with whom the infotainment style is not so effective (Davis et al., 2020).

With this study, it seems clear that the most recommendable length for video representations of scientific works in Ecology and Environmental Sciences, taking into account the video (given as the number of views/day) and paper (given as the number of citations/day) outreach, is between two and three minutes. This average length is also associated with professional contexts. Professional and semi-professional productions also usually led to higher video and paper outreach. This possibly reflects better content dissemination mechanisms (reflected in high Altmetric values), actors with more experience in the field and the establishment of stronger bridges between audio-visual content and written content. Despite the relevance of this data, further research regarding video length (Welbourne & Grant, 2016) and production values, using a larger amount of samples and other variables, such as the impact of video-abstracts in science learning (Slemmons et al., 2018), is needed.

Although previous studies have shown that ensuring good audio quality should be in the researcher's interest (Newman & Schwarz, 2018), in our case, the quality of the narrator's voice, given by the general audio quality, was not a determining factor for video viewing. However, it had a positive impact on the scientific reach of the written paper, measured as the Altmetric. As happens with some of the other results, strong conclusions should be viewed with caution, as factors such as the reach and effort that each researcher and journal have invested in promoting its video, variables that are very difficult to measure, may prevail as explanatory variables. For future work, once audio quality is a difficult metric to quantify, we recommend the use of quantitative metrics like the number of words per minute (Morcillo et al., 2016).

Another variable that could help to clarify some of the results we have obtained is the audience retention. This measure tells us how many people are still watching a video during video playback, indicating when viewers stop watching (e.g. YouTube Analytics). Understanding the viewer's interest throughout the video can give us insights into what segments are working well and what sections need to be improved. Also, if the number of views measures popularity, it fails to translate impact or ensure that the content was viewed in its entirety; unfortunately, such data is only available for the authors/owners of the videos. Future research will focus on the production of our own video abstracts in the area of Ecology and Environmental Sciences, and this will enable us to evaluate these metrics, allowing us to explore new content data and new visual features. Due to time constraints and research purposes, not all the visual components were coded and interpreted. These elements can be explored on a visual rhetoric approach (Finkler & León, 2019), exploring the different elements of the science storytelling, for example, creating and testing two different versions of the same video abstract, where only one feature differs.

Furthermore, there is also a series of non-controllable variables that were not taken into account in this study and that can somehow affect the results, including the characteristics of the video channels (number of subscribers) and the scientific papers (number of authors, presence of international co-authors, number of characters in the title and the abstract, number of keywords, references and pages and funding). Future studies considering all these variables are highly recommendable.

2.5 Conclusions

This work intends to be the first step in the characterization of video abstracts in Ecology and Environmental Sciences and bring added value to the general characterization of scientific videos. Along with previous works (Morcillo et al., 2016), the intention is to describe and classify the state of the art, working mostly with outreach metrics. However, as the use of video abstracts is still a very recent tool, it still lacks clear and definitive guidelines that sometimes lead to improper use of the type of content considered. Such a lack of theoretical framework inevitably leads to subjectivity not only in the type of content but also in the evaluation process. To fill these gaps, a separate study on creating a validation model for video-abstracts in these scientific areas is under development. We hope that this future instrument of research will allow us to validate some of our coding categories and contribute to establishing a stronger model of an effective video abstract in Ecology and Environmental Sciences.

3. Tools to communicate science: looking for an effective video abstract in Ecology and Environmental Sciences

The work presented in this chapter was published in *JCOM – Journal of Science Communication*.

Ferreira, M., Granado, A., Lopes, B. and Loureiro, J. (2023). Tools to communicate science: looking for an effective video abstract in Ecology and Environmental Sciences *JCOM 22(04)*, A07. https://doi.org/10.22323/2.22040207

3.1 Context

3.1.1 Online science videos: a world to explore

A recent study of YouTube preferences concluded that, despite Entertainment and Music being the most searched categories, videos from Science and Technology are among the top trending videos (Dubovi & Tabak, 2021). An online science video is a short film that spreads scientific topics to a vast audience on the Internet (Welbourne & Grant, 2016), keeping rigour and accuracy (García-Avilés & de Lara, 2018).

Online science videos feature a wide variety of producers and formats (Erviti, 2018; Erviti & Stengler, 2016; García-Avilés & de Lara, 2018), making them versatile tools that are, in many cases, difficult to classify. Morcillo (2016) identified a wide variety of genres and subgenres, a moderate production complexity and a high editing and storytelling density that point to sharp professionalism in online science videos (Morcillo et al., 2016). Garcia-Avilés & De Lara (2018) classified online science videos into 18 different formats, grouped into television formats - produced for this purpose and then uploaded online - and web formats - explicitly produced for the Internet. This categorization demonstrates the flexibility and autonomy of videos: one can have an interview, a debate, a documentary, a monologue, an experiment, an infographic, or a mix of genres (García-Avilés & de Lara, 2018). Interview videos are less popular than vlogs, while animations are the most popular (Velho et al., 2020). Huang & Grant (2020) concluded that a popular science video on YouTube is usually an emotionally engaging story that answers a science-related question, having some twists and revelations along the way.

The Videonline Project (2018) described media companies as the producers of more than half of the science videos they analyzed (826 videos about climate change, vaccines and nanotechnology), in opposition to videos produced by scientific institutions and non-professional users (Erviti, 2018). More recently, studies pointed out that presenters who do not belong to any scientific institution, despite having an academic background, were responsible for the most successful science communication videos on YouTube (Boy et al., 2020; Donhauser & Beck, 2020). Debove (2021) analyzed 622 French science channels and concluded that science communicators are primarily young males with higher education who talk about topics they know about (Debove et al., 2021). Also, most of them worked alone and took the audiovisual production of science as a hobby, not having any specific training in the field (Debove et al., 2021). Finally, Velho & Barata (2020), who analyzed the "Science Vlogs Brasil" project, established by 39 science channels on YouTube, described the channel owners as young male teachers with higher education in Exact Sciences, Earth Sciences and Life Sciences.

As authors of their work, researchers are key figures in transposing written science into audiovisual media (Smith, 2020). They remain connected to institutional channels (Erviti, 2018) but are increasingly challenged to effectively transfer their knowledge and communicate to various audiences (Maynard, 2021). Therefore, researchers, seen by the public as more trusted and experienced presenters (Ruzi et al., 2021), are challenged to pick up the camera, replacing media professionals. Researchers who became filmmakers say that producing a movie is similar to field research (Olson, 2018). As in science, they also have to "collect observations, shape them into a story and distribute the product" (Kwok, 2018). Some authors listed the questions that a researcher needs to ask before engaging in such a task (e.g., what equipment is required) (Brennan, 2021) and the necessary steps to produce a science video (i.e., identify the topic, write the script and storyboard, record the voiceover, film the scenes, edit the movie, look at the last details and upload it on YouTube) (Maynard, 2021). At the same time, several workshops and guidebooks are available to provide students and researchers with the necessary tools to produce their own science videos (Angelone, 2019; Bell, 2020; Chan, 2019; Kwok, 2018; Olson, 2018; Plank et al., 2017; Vachon, 2018)

3.1.2 Video abstract: a swiss army science video

In this myriad of contents and players, video abstracts are a differentiating solution that can fulfil several roles. As its name suggests, a video abstract is an audiovisual summary of the written abstract, a film containing all the scientific paper elements, from the introduction to further recommendations, including the methods, results, and discussion (Berkowitz, 2013; Scott Spicer, 2014).

Despite the growing number of specialized companies creating this kind of product, most focusing on animation (e.g., Research Square, SciPod, Promoshin), video abstracts still lack a distribution strategy in the digital environment. These videos continue to be used mainly for peer-to-peer communication, indexed in scientific journals or uploaded to video channels, and, in many cases, are not promoted to other audiences (Ferreira et al., 2021; Ruzi et al., 2021). On the one hand, they are essential for students and researchers to demonstrate complex processes that are difficult to reproduce by writing (Jamali et al., 2018); for instance, JoVE (Journal of Visualized Experiments) protocol videos cited in other papers and mentioned on Twitter with practical and methodological purposes (Jamali et al., 2018; Xu et al., 2018). Also, a video abstract could positively impact academic dissemination and, eventually, article citations (Bonnevie et al., 2023; Shaikh et al., 2022; Zong et al., 2019). On the other hand, video abstracts have the potential to expand narratives to new audiences, platforms, and networks (Kippes, 2021),

Bredbenner & Simon (2019) evaluated, through a survey, the comprehension and enjoyment of the audience when exposed to different kinds of summaries of the same scientific paper. The authors concluded that video abstracts are more successful than the original and graphical abstracts in achieving audience understanding and satisfaction with the scientific topics. Furthermore, video abstracts guarantee accuracy and credibility compared to other online science videos. This is particularly important as, in recent years, the democratization of online videos has brought excessive content and misinformation (Allgaier, 2019; Rosenthal, 2020). In Brazil, for example, in recent years, pseudoscience channels have grown proportionately more in views and subscriptions than scientific dissemination channels (Fontes, 2021). The effective use of online science videos requires a delicate balance between achieving an informative yet entertaining narrative without compromising scientific rigour (Pavelle et al., 2020). As video abstracts are a production arising from institutes and universities, they can act as a guarantee stamp, similar to what happens, for example, in the ScienceVlogs Brasil project, which created a badge to ensure the scientific quality of its videos (Velho & Barata, 2020). This guarantee opens opportunities for high schools and other educational institutions to explore these science videos as educational tools (C. Almeida & Almeida, 2021; Beautemps & Bresges, 2021; Moreira & Nejmeddine, 2015; Rosenthal, 2020). High school teachers have recognized that a video abstract could be used in the classroom as an essential and valuable tool integrated into a broader pedagogical strategy (Ferreira et al., 2023) (Chapter 6).

3.1.3 Video abstract in Ecology and Environmental Sciences

Across the globe, human activity has affected most ecosystems, with biodiversity indicators showing a fast decline (Díaz et al., 2019). Direct drivers (including fishing, harvesting, and land use change) and indirect drivers (including overpopulation growth and human-induced climate change) are creating irreversible losses, putting global agendas at risk (e.g. the economic, social and environmental efforts of the Sustainable Development Goals) (IPCC, 2022; Díaz et al., 2019). Communicating new and innovative knowledge emerging from ecology and environmental sciences is fundamental for sustaining a healthy planet. Research on the role of online videos in communication about science and the environment is growing (Allgaier & Landrum, 2022). However, academic scientific videos do not share the same attention as popular science videos on YouTube. Videos produced by researchers, universities, or specialized companies remain underexplored by researchers, with no guides to best communication practices. Moreover, to our best knowledge, no studies have explored video abstracts' classification, conception and reception.

This study takes a multidisciplinary approach and explores for the first time the reception of 21 video abstracts of Ecology and Environmental Sciences by an expert panel, identified through their recognised foundational knowledge of science videos. Specialists from four main groups – (1) Research; (2) Science Management and Communication; (3) Marketing, Design and

Multimedia; and (4) Education – embody important visions and unique pathways to different audiences. Our main goals were:

(i) Comprehend the multiple potentialities of video abstracts in scientific dissemination;
(ii) Identify the most and least valued features in video abstracts;
(iii) Explore the characteristics of the video abstracts taking into account reception metrics;
(iv) Propose some future guidelines for producing an effective video abstract.

This approach enabled us to explore the potential of the video abstract as a communication tool among peers and a dissemination/education resource for the student community.

3.2 Methods

The research design comprised three main steps: selecting a sample of 21 video abstracts from a broader corpus of 171 videos, developing and applying a questionnaire to 30 evaluators and conducting a content analysis of their responses.

In previous work, using impact factor as a selection measure, 171 video abstracts from 17 video channels, 29 academic journals and 7 publishers were identified and categorized (Ferreira et al., 2021). Of the 40 journals of Ecology with the highest impact factor, according to the Journal Citation Reports 2018 ("2017 Journal Impact Factor," 2018), only 5 used video abstracts. So we broadened the study to include the field of Environmental Sciences alongside Ecology, which allowed us to add 24 more journals to the sample. According to our definition of a video abstract, the sample we collected was drawn from scientific journals' websites and video channels. We also extended the search to researchers' webpages, social networks and specific science video production companies.

From that sample of 171 videos, 20 video abstracts representing different formats, types of production, duration, and sound quality were selected using purposive sampling (Palys, 2008) (Table 3). Beyond the journals, publishers and formats represented, we tried to embody all variations inherent to each video (the same journal can have many videos with the same structure, while the opposite can also happen, i.e., a journal channel can have few videos, but where each video presents differences within the same format as animations with different styles). Thus, this selection process ensured the diversity of the videos as a whole.

After categorising the videos and reviewing the literature, we also created an original video abstract. The video, based on the scientific paper "Metabolic effects of dietary glycerol supplementation in muscle and liver of European seabass and rainbow trout by 1H NMR metabolomics" (Palma et al., 2019), was written by researchers of the Centre for Functional

Ecology (CFE) at the University of Coimbra. We added the video to the sample (video nº171). This add-on allowed us to explore the evaluation and classification procedure, gathering individual and valuable data comparable to a group of similar videos.

Table 3. Viewed videos by the evaluators.

Video Nº	Duration	Journal	Editors	Format	Title/Link
11	04:00	Functional Ecology	Wiley	Documentary	Does Ecotourism in the Bahamas affect Tiger Shark Movement and Behavior? https://youtu.be/9iFl7BxbnXQ
16	02:20	Functional Ecology	Wiley	Monologue	The effects of weather on dispersal behaviour of free-ranging lizards in tropical Australia https://youtu.be/TDC_wG_sR1Q
17	05:38	Functional Ecology	Wiley	Documentary	Hovering on a high fructose diet: hummingbirds can fuel expensive flight with glucose or fructose https://youtu.be/TGczsWrCre4
23	01:10	Functional Ecology	Wiley	Documentary	To know a scorpion by its tail: the tail strike of scorpions differs between species https://youtu.be/7dHsNmqs8Bs
33	08:20	Journal of Ecology	Wiley	Simple Presentation	Julie Messier - Interspecific integration of trait dimensions at local scales https://youtu.be/xAHLsLUd_XM
53	03:22	Ecography	Wiley	Documentary	The mismatch in distributions of vertebrates and the plants that they disperse https://youtu.be/NGkLXD5Uvms
68	04:55	Current Biology	Cell Press	Documentary	Establishing beneficial plant-fungal symbiosis https://youtu.be/DrsNuwOnoEM
75	05:06	Current Biology	Cell Press	Documentary	Coral Reef Fisheries and Habitat Degradation https://youtu.be/U8TQoCykaKU
64	05:32	Current Biology	Cell Press	Documentary	Chivalrous insects https://youtu.be/Bzxs6pqTrII
89	01:54	Current Biology	Cell Press	Documentary	Mapping Earth's Diminishing Marine Wilderness/ Curr. Biol., Jul. 26, 2018 (Vol. 28, Issue 15) https://youtu.be/yUYPSAhpqBA

93	04:32	Current Biology	Cell Press	Documentary	Vocal Turn-Taking in Meerkat Group Calling Sessions/ Curr. Biol., Nov. 8, 2018 (Vol. 28, Issue 22) https://youtu.be/nF3JUzdmG2Y
84	01:57	Current Biology	Cell Press	Animation	Fish Biodiversity Loss in a High-CO2 World/ Curr. Biol., Jul. 6, 2017 (Vol. 27, Issue 14) https://youtu.be/fUMPQ4ODQJ8
171	03:51	Metabolites	MDPI	Animation	Glycerol as alternative ingredient for fish feed - potential for aquaculture https://youtu.be/rhk1taqRlOo
106	03:55	Nature	Nature	Animation	Handing on a sustainable future https://youtu.be/xrXyRJV96mk
99	02:28	Nature Ecology & Evolution	Nature	Documentary	How to help pollinators in cities https://youtu.be/JsypVU8VkS4
110	02:43	Nature	Nature	Animation	How many trees are there in the world? https://youtu.be/jqdOkXQngw8
116	02:28	Scientific Reports	Nature	Animation	Common pesticides pose threat to seed-eating songbirds https://youtu.be/i5rkN154PO8
121	02:00	Plants, People,Planet	New Phytologist Trust	Dynamic Presentation	Hydnora: the strangest plant in the world? Flora Obscura with Chris Thorogood https://youtu.be/4l3pftfCy_w
136	04:25	Science Advances	AAAS	Documentary	Araújo et al. 2019. Standards for distribution models in biodiversity assessments. Science Advances https://youtu.be/iS31WaKMW_Y
143	02:39	Science	AAAS	Documentary	Megarafting animals rode from Japan to US and Canada after the 2011 tsunami https://youtu.be/L3QGiPpXaC0
153	02:53	Ecohydrology	Wiley	Animation	A 3-in-1 tool for climate change and resiliency assessments https://youtu.be/ddcuq5tgHHQ

We adopted the expert panel method, where a forum of specialists in a given field share their experiences and opinions (Galliers & Huang, 2012). To create the expert panel, we searched for experts with professional experience linked to the processes inherent to video abstract production. So, we created four primary areas of interest: (i) Research; (ii) Science Management and Communication; (iii) Marketing, Design and Communication; and (iv) Education. These four main fields covered the complete life cycle of a video abstract – from paper to YouTube – and gave us a global perspective of the video abstract as a science communication tool. The aim of bringing together this expert panel was to provide us with powerful insights into knowledge production and academia, science communication among peers and new audiences, audiovisual language and good practices of design, as well as ways to use the video as an educational tool.

Through our professional network, we obtained a list of fifty names and invited them all to participate in the study via email. Thirty experts showed interest and were available to participate in the study. The group comprised individuals between 29 and 45 years old and educated (with graduation, MSc, and PhD degrees) in Biology, Philosophy, Sociology, Environment, Education, Data Science, Design, Geology, Journalism, Chemistry, Multimedia and Mathematics (Appendix C). We brought together a unique and specialized panel representing a wide range of professions, including researchers, science communicators, science managers, educators, teachers, videographers, designers, data scientists, and marketing and entertainment show technicians.

We invited the panel of experts to complete a questionnaire, which consisted firstly of two closed questions (using a Likert Scale) and one open-ended question about viewing habits and video abstract importance (Appendix D). The first closed question aimed to understand how often the group watched science videos. The second closed question asked if a video abstract benefited research dissemination. If the answer was yes, the participants had to justify their choice.

The evaluators then watched the 21 science videos. The videos were ordered randomly. The expert panel were not informed that one of the videos was produced by the researchers to avoid biasing the results. Informed about our definition of the video abstract and the factors we were evaluating, we asked the expert panel members to rate each video numerically from 0 to 10 (0 as the worst and 10 as the best score). The total viewing time was 72 minutes. Next, we asked the evaluators to view the video abstracts in sequence, from video 1 to video 21, with some breaks if necessary. Using Microsoft Excel, we analyzed the video rating responses and looked for patterns in the quantitative data by comparing the video ratings with the video duration and the number of views per day.

Finally, we asked the evaluators two open-ended questions: what did you like most, and what did you like least about each video abstract? Then, we performed a content analysis using the MAXQDA software to analyze the answers. The first goal of the content analysis was to organize the responses into a system of categories that would translate the fundamental ideas present in the data (Amado, 2000). We conducted an inductive analysis of the responses and produced an analytical grid containing all categories and subcategories. We analyzed 1260 response units, later divided into 1740 units of analysis. The process produced 7 categories and 19 subcategories (Appendix E).

3.3 Results

3.3.1 Video abstract as a science communication tool

Almost half (43%) of the evaluators stated that they viewed science videos occasionally, 23% rarely, and 20% watched them regularly.

Most of the respondents (83%) thought that the existence of a video abstract could be helpful for research dissemination. The twenty-five positive answers justifying this choice were analyzed. Forty-four registration units were identified and divided into four main categories. Table 4 presents the results of this analysis.

Table 4. Content analysis results in the answers on why consider the video abstract a vital tool to disseminate scientific information.

Category	Record units	Examples
It increases message range and audience diversity.	19	"It is a vehicle for transferring information from a more technical scientific publication to a wider audience (…). It democratizes information." "It is a means of disseminating knowledge that can reach a wider audience, promote public access to science, and foster more inclusive and participatory citizenship practices." "To enhance the attention in online social networks." "It makes outreach immensely easier." "Possibility of dissemination by different types of audience, being more physically accessible to most of the population."
		"It is one of the most effective ways to show the value of science." "Facilitates the understanding of the message (...)."

It conveys the message in a clear, innovative, effective and appealing way.	16	"A video abstract is a novel way to present and spread information about your research." "This format allows, in a fast and appealing way, to pass an objective message with the main results of the work (…)." "Video is the most consumed media format on the internet today, being the best way to convey any type of message, capturing the viewer's attention to the topic in question in the best way."
It allows for greater content plasticity.	5	"This more malleable quality allows it to acquire shapes beyond a traditional abstract, work as a scientific document or call for attention, closer to the advertising language, or as a business card for a research or institution." "Possibility to animate general results and conclusions." "It allows you to use schemes, images, and animations that otherwise (in the scientific article) would not be possible."
It has potential as an educational tool.	4	"It is easier to capture students' attention with these videos. It is much better than the usual PowerPoint presentations because they can show locations and interviews on the subject." "(…) these types of videos could prove to be powerful tools that allow the output of research articles from the niches of the University and Research Centre, starting to function as another important teaching tool, in different contexts and for different types of publics."

Two categories dominated the answers. The first was the capability to reach a larger and more diverse audience. So, issues such as citizenship, science democratization, active participation, and awareness were mentioned. The second category focused on how science videos convey the message. According to members of the expert panel, video abstracts simplify complex scientific procedures, valuing science and bringing researchers closer to the public. It is a fast, effective, innovative, dynamic, clear and appealing way of getting the scientific message to the "outside world". The video abstract was perceived to be a facilitator. Expert panel members noted that various production options make video abstracts a chameleon-like product, adapted to different realities and needs. Finally, the video abstract was mentioned as an attractive tool to be used in the classroom and a possible bridge between high schools and universities.

3.3.2 Evaluation of the video abstracts and trends with other parameters

Figure 8 presents the average ratings of each video abstract. The average rating score given to the 21 video abstracts was 6.63 ± 1.6. The three highest-rated videos (in dark blue) had ratings above eight points, 8.20, 8.27 and 8.83, respectively. The video we produced (in green) had the sixth-highest rating score, with 8.07 points. The lowest-rated video had 2.90 points, and three more videos had a rating score below 5 (in orange).

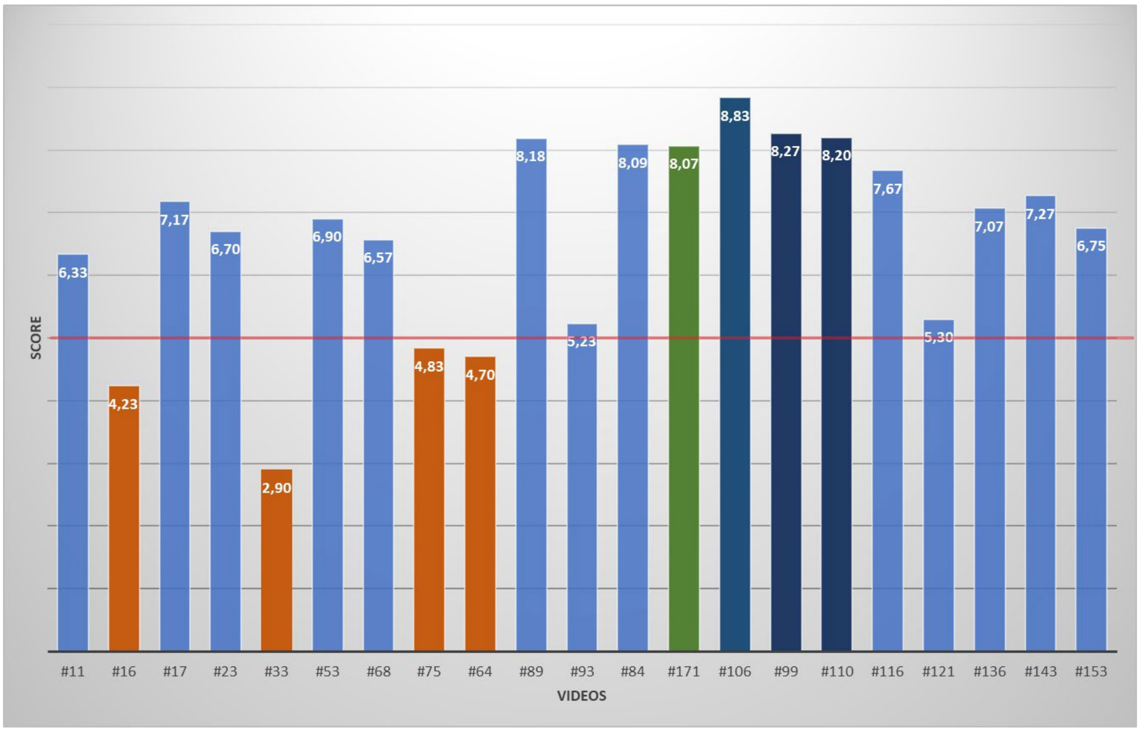

Figure 8: Average video rating score by viewing order (from left to right).

The average duration (in seconds) of the 21 videos was 217.5 ± 101, and the three highest-rated videos ran below 240 seconds (Figure 9 and Figure 10). The video we created and included in the analysis was close to the average length, representing a middle point in terms of length (Figure 10). The video with the lowest rating score was the most extended video of the set (500 seconds) (Figure 9 and Figure 10). Also, two of the videos with low rating scores (4.83 and 4.70) are two of the longest in the set (306 and 332 seconds, respectively) (Figure 9 and Figure 10).

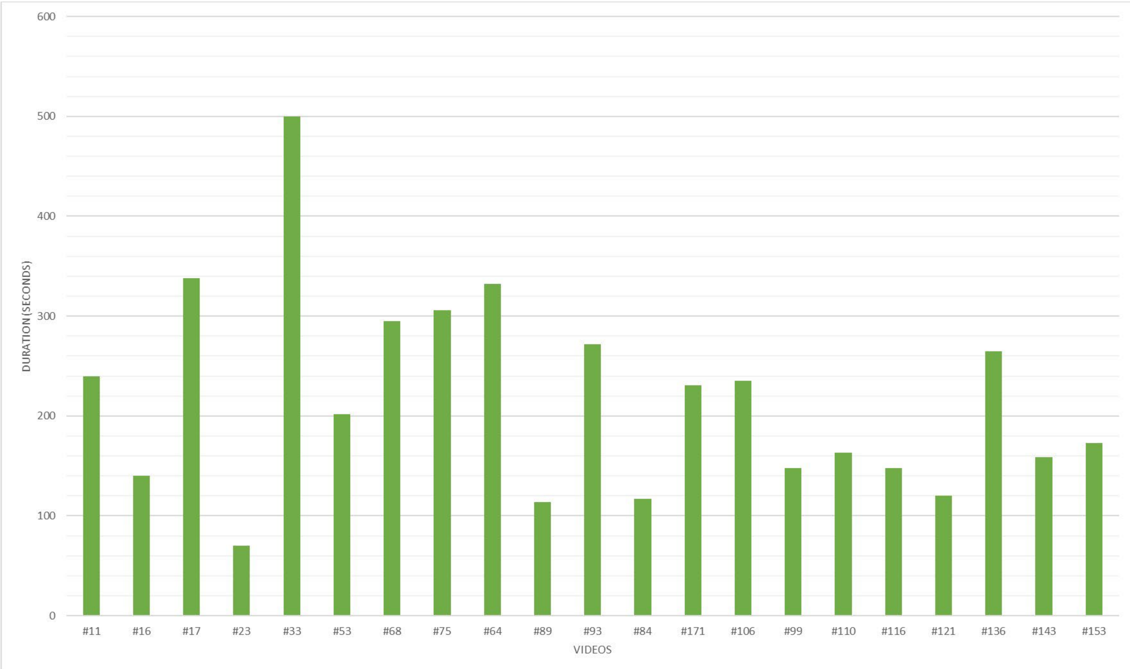

Figure 9: Duration of the watched videos (in seconds).

Figure 10: Average video rating score by duration ascending order, from left to right.

The attractiveness of shorter videos is reflected in views per day. The average number of views per day for the video set was 16.2 ± 41.7 (Figure 11), and the three highest-rated videos (106, 99 and 110) were among the ones with the most daily views (Figure 11 and Figure 12). Furthermore, except for video 64, all the other videos with the lowest scores had an average number of views per day below 1 (Figure 11 and Figure 12). The shortest video (70 seconds) was the most watched daily (171 views per day). Conversely, the longest video (500 seconds) was the third least-watched video in the set (0.3 views per day).

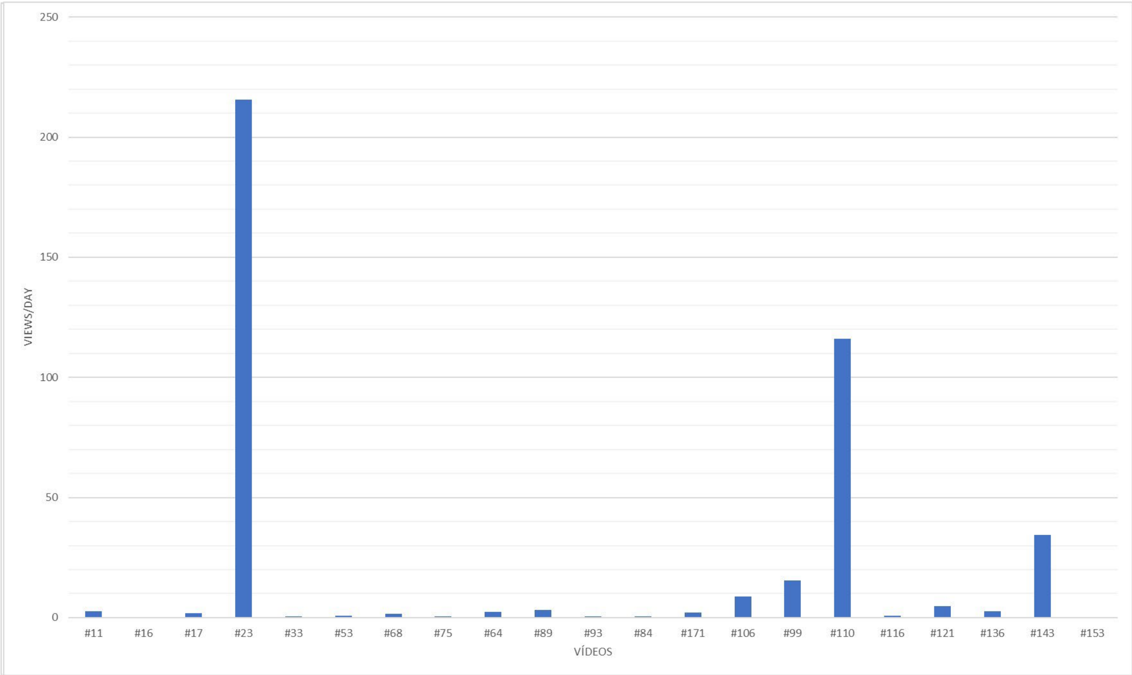

Figure 11: Number of views per day of the videos (collected on march 8, 2022).

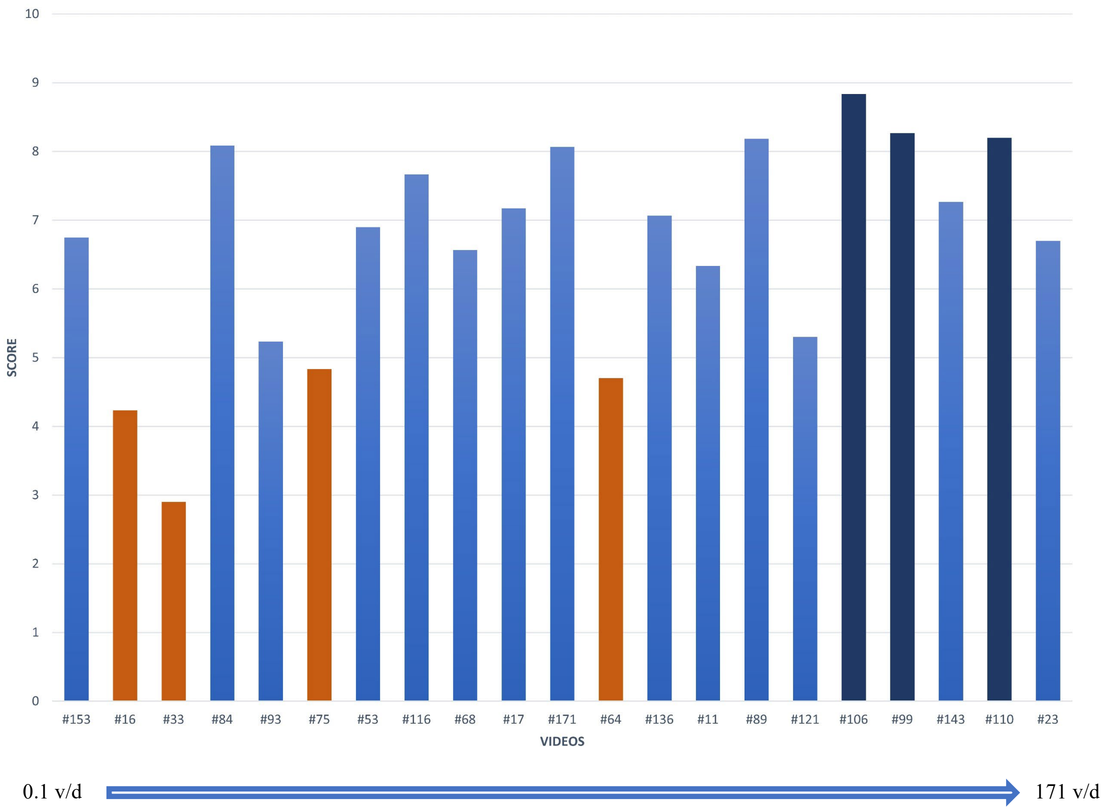

Figure 12: Average video rating score by views per day ascending order, from left to right.

The three videos ranked highest by expert panel members were professional productions from the journal Nature, uploaded on the Nature Videos YouTube channel. All three videos have a third-person narration and use stop-motion animation techniques or real footage to tell their stories. Conversely, the videos with the worst ratings were all amateur productions based on slide presentations or monologue formats. In general, the evaluators classified the quality of the image and sound as bad in videos that they rated poorly.

3.3.3 Video abstract in Ecology and Environmental Sciences: the most and least appreciated factors

After collecting expert panel member responses from the prompt about the factors they most appreciated about each video abstract, we identified nine hundred and twenty registration units from the content analysis.

Visual resources stand out in the proposed categories (Figure 13). Expert panel members emphasised the images, the footage and their features. The category least mentioned by the expert panel was audio. The production category came in second place, comprising all the processes of video conception and its features. The script writing and all the steps related to the editing process - rhythms, transitions, different environments - played a leading role in the positive viewing experience, according to the expert panel members. The expert panel used commonplace terms to highlight general characteristics of video quality. The most commonly recurring words used to describe a compelling science video were clear, concise, original, dynamic, and compact (Figure 14). The third category most mentioned by expert panel members was the topic of the video. The characteristics of the message, the idea and the information conveyed in the video were the most commonly described qualities contained in this category. Also, the specific moments of the video (e.g. conclusion, introduction, results) were highlighted positively. The factors concerning narration and presentation were in the penultimate place; the expert panel focuses on the qualities of the speech, the narration and the narrator.

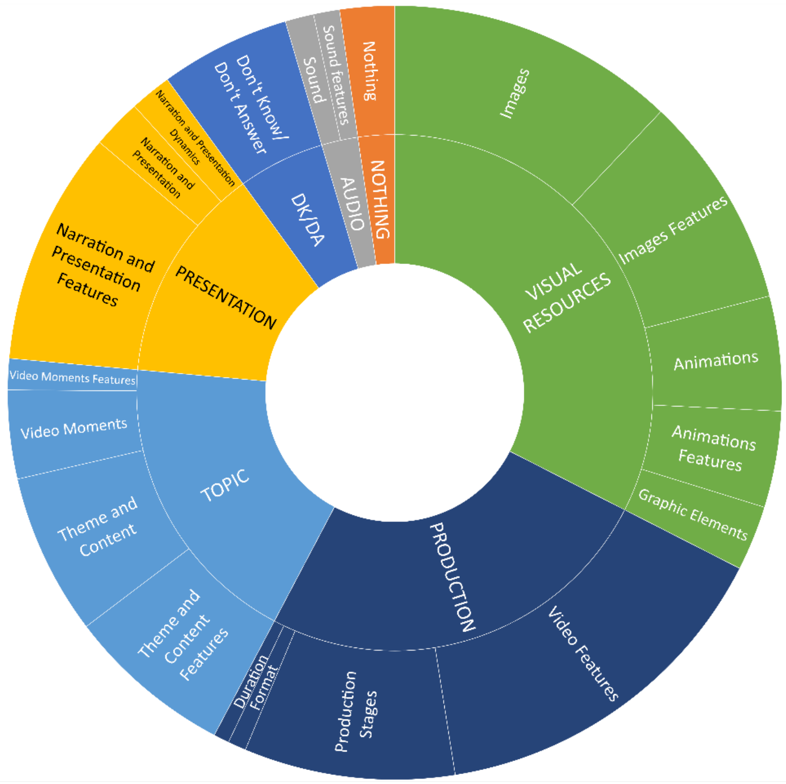

Figure 13: Most appreciated factors by the evaluators.

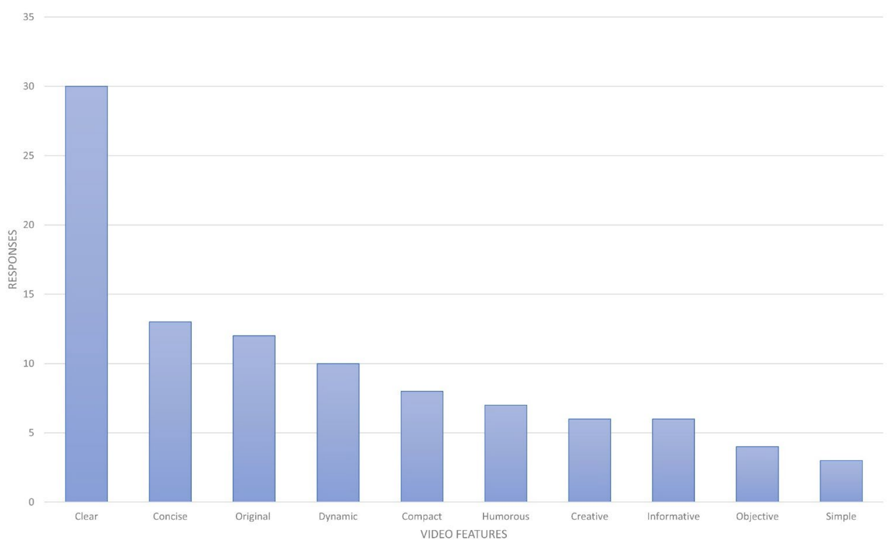

Figure 14: Most mentioned words in the "Production - Video Features" category.

The content analysis to the question "What did you like least about the video?" resulted in eight hundred twenty-six registration units.

The categories identified in responses to this question are more equally distributed when compared to the categories described in the previous section (Figure 15). The most mentioned category covered production procedures. The format and duration were most referred to as being least attractive. The expert panel indicated that the least desirable qualities of the video abstracts were a lack of quality, clarity and objectivity, the monotony and being too specific. The least liked qualities of the videos that expert panel members mentioned next were specific aspects of the videos, with the images and the graphic images being the most mentioned. The presentation and the audio were in third and fourth places, respectively. The sound and its features were more commonly noted in response to the prompt about what panel members liked the least, compared to what they liked the most, perhaps indicating that good sound quality goes unnoticed, but the bad sound quality is noticed as particularly problematic. Lastly, in the set of responses to this question was the topic, which had fewer mentions to this question compared to the question asking about the positive qualities of the video.

Figure 15: Least liked qualities noted by the evaluators.

3.4 Discussion

In this study, we set out to identify the most and least valued features of video abstracts in Ecology and Environment Sciences and provide future guidelines for producing effective video abstracts. The discussion is organized into three main sections: (i) the advantages and potentialities of the video abstract; (ii) the current popularity metrics and future ways to improve the video abstract, and (iii) a deeper look at the key categories that emerge from our analysis. To sum up, Figure 16 summarises the main findings and offers a good practice scheme for video abstracts in Ecology and Environmental Sciences.

3.4.1 A word to say in science communication and science education

The expert panel (Table 4) highlighted several resources (e.g. photos, diagrams, graphics, maps or animations) that video creators could use to raise awareness about a scientific topic and complement traditional media. The flexibility feature in this new digital environment is common to all science videos (Erviti & Stengler, 2016; García-Avilés & de Lara, 2018). However, we were interested in exploring the new possibilities that the specific context of video abstract production brings, particularly within the audiences.

As shown in Table 4, the benefits of the video abstracts to reaching a larger and more diverse audience were recognized by panel members, thus promoting dialogue and participation (León & Bourk, 2018b). As mentioned in some of the responses, video abstracts offer the possibility to increase the democratization of science and citizen science participation. This can be a helpful addition as recent studies have shown that, on the one hand, videos without institutional gatekeeping and that explore new formats lack the contextual dimension of science (Vasquez-Muriel & Escobar-Ortiz, 2022). On the other hand, universities seem to be more prone to marketing than to creating a dialogue with the public (Weingart, 2022), moving to a (de) centralized communication of science (Entradas, 2022). In this model, the institutes and research centres are where science communication and its dialoguing roles (Bucchi & Trench, 2021) have a space to grow (Entradas, 2022). Video abstracts in Ecology and Environmental Sciences, and their research, settle down on a problem to be solved, presenting findings and solutions, with the final goal of sustaining a healthy life on planet Earth. As tools sprouted in the institutes and research centres, transversal to dissemination, dialogue and participation, they could have a central role in the social conversation around science (Bucchi & Trench, 2021)

Also, the evaluators recognized (Table 4) that video abstracts ensure scientific rigour, often absent from online science videos, as also highlighted by Velho & Barata (2020). This scientific insurance presents a possible added value for educators and teachers (C. Almeida & Almeida, 2021; Moreira & Nejmeddine, 2015), who could use the videos in their classrooms as an alternative to more traditional resources (Ferreira et al., 2023) (Chapter 6). At the same time, demystifying certain misconceptions about science could attract and approach new students to a scientific career (Fiolhais, 2016) and align with both the promotional goals of the universities and the dialoguing roles of the research centres discussed above. Further research on the sci-comm applications of video abstracts at research institutes and their impact on audiences is recommended.

3.4.2 A short video resulting from long and collaborative work

Despite no clear pattern and proportionality between the duration and the established rank (Figure 10), there are two interesting correlations involving the running time of the videos: the shortest video (nº. 23) had the most views per day. In contrast, the longest video (nº. 33) had the lowest rating overall (Figure 9 and Figure 10). Also, the six videos with the best scores (nº. 89, 84, 171, 106, 99 and 110) are all below four minutes long (Figure 9), which is in line with the recommendation of our previous paper (i.e., the ideal length for this type of content is between two and three minutes) (Ferreira et al., 2021) (Chapter 2). Short videos strengthen long-term information retention, although it depends on the viewer's gender (Slemmons et al., 2018). Also, a study on user engagement showed that video length is inversely proportional to view counts, and longer science videos receive fewer views on average (S. Yang et al., 2022). Therefore, we recommend short video abstracts without compromising the scientific content from the data explored here.

Another factor not directly proportional to the rank established by the expert panel was the number of views per day (Figure 12). Although the three best-ranked videos are among the top five most watched and two of the least-ranked videos are among the top three least-watched videos, there was no evident correlation among the total sample (Figure 11). This variation confirms that views are an imperfect measure: Yang et al. (2022) showed that videos with higher view counts have lower engagement regarding average view duration and average percentage viewed (S. Yang et al., 2022). Understanding and increasing user engagement with the videos is fundamental to more effective science communication (S. Yang et al., 2022). Future studies on YouTube data, e.g. average retention time or views by age and gender, are recommended to understand the actual dynamics of visualization and engagement. It will be fruitful to go beyond visualization metrics to assess and identify compelling science videos, e.g., new algorithms are needed to highlight rigour and quality in science videos presented on platforms like YouTube (Hoang, 2020). For example, the algorithm could privilege scientifically certified videos (e.g., from scientific journals, universities, and research centres) and highlight relevant topics in the scientific/political agenda (e.g. biodiversity loss). Furthermore, informative, rigorous, original and dynamic features could be evaluated in YouTube surveys for each video and highlighted in recommendations. Also, social networks such as Twitter can be understood as new areas of interest (Xu et al., 2018) that can bring fresh inputs to the video's abstract reality.

Finally, production emerged as another important factor as the top-rated videos (n.º 106, 99 and 110) are all professional productions; instead, the lowest-rated videos (n.º 16, 33, 75 and 64) are all amateur productions (Figure 8). The videos rated as being most effective have good production values, with editing dynamics, as an alternative to a simple lecture, which is in alignment with

Thelwall et al. (2012) argumentation. These results support the recommendation that although a researcher can produce a video in a low-cost model (Brennan, 2021; Maynard, 2021) and that training sessions are important for researchers to improve their communication and creative skills (Angelone, 2019; Angelone et al., 2019; Plank et al., 2017), teamwork, like the one found in professional productions, is fundamental to achieving an effective result that qualitatively translates scientific research (Ferreira et al., 2023) (Chapter 4). Writing the script, planning the filming sessions, meeting with researchers, collecting images in the field, searching online resources, and editing different film versions, are all processes that require group commitment (Velho & Barata, 2020). It is not enough to upload the video online to be effective (Finkler & León, 2019). A strategy for implementing and disseminating these videos in the online environment is needed (Erviti & Stengler, 2016). As in general science communication, a synergy of efforts among researchers, communication and media offices, science communicators, and other stakeholders is ideal (Kalmár & Stenfert, 2020). A future recommendation comprises the implementation of networks, not only operational, where a channel with video abstracts recommend and disseminates other channels with rigorous and captivating content, but also emotional, where authors promote the co-construction of knowledge and creation of communities with their audiences (Erviti & Stengler, 2016; Morcillo et al., 2016; Rosenthal, 2020).

3.4.3 Key categories for an effective video abstract

Images were the most liked category in the visual resources section (Figure 13). It is interesting to highlight that the positive comments focused on the specific features of the images. That is, images by themselves, comprising all the videos, footage and photos, positively impacted the viewers. This strength confirms that video abstracts, like most science videos, must first be visual and present differentiating visual value (Olson, 2018). Ecology and Environmental Sciences are privileged fields where it is relatively easy to catch impressive footage. The predisposition of the expert panel towards visuals confirms this (Figure 13). As well as in the Visual Resources category, the theme and content by themselves were only pointed out in the positive reviews, reinforcing the intrinsic value of these topics to our expert panel. In the future, it will be interesting to explore two other sides of the content features: first, to understand, in the Ecology and Environmental Sciences fields, what specific areas give rise to more engagement with the audiences and second, to promote comparative studies in or with other sciences (e.g. can a video abstract in a not so visual and appealing field compete with a video abstract about the natural world?).

Beyond the intrinsic power of images and topics, the experts highlighted animations as one of the most appreciated. Also, from our experience, the specialized companies producing video abstracts tend to rely mostly on animated solutions (e.g. Research Square, Science Office, Promoshin). Boy (2020) showed, using views per day, that YouTube genres like presentation films and animations are much more popular than traditional and institutional formats like explanatory narrative films and expert films (Boy et al., 2020). However, explanatory narrative films perform better in knowledge transfer and attentional control (Boy et al., 2020).

Interestingly, although these choices appear to be in conflict, they could represent a new way of representing science: using powerful images rooted in the documentary legacies (León, 2010) but also using animation or a mix of genres. Watching the five best-ranked videos, we found a combination of both styles, proving that a balance between authentic images and animation would be a good choice. Video abstracts could merge these two formats: the more classic ones, linked with television, like expert films or explanatory narrative films, with formats more connected to digital platforms like animations (Boy et al., 2020). Davis and co-authors (2020) proved that an infotainment version of their video, rather than the expository version, was more effective for an audience not engaged with science (Davis et al., 2020). Video abstracts could walk on this line and be an effective science communication tool, balancing the informative/traditional and the entertaining/innovative (Pavelle et al., 2020).

Production was the second most-liked category (Figure 13). The first highlights were the video features (Figure 14) mentioned by the panel and grouped into: i) Clarity; ii) Objectivity; iii) Creativity; iv) Dynamism, and (v) Information. A video abstract has to be clear, concise and compact. Furthermore, it must convey ideas accurately in an objective and simple way. This aligns with the conceptual model of SciComercial video, which aims to produce content that, among other characteristics, is simple and concrete (Finkler & León, 2019). Creativity and novelty are also important when we think about our video (Erviti & Stengler, 2016), associated with more widespread and disruptive formats like animation (Ferreira et al., 2021), as already discussed above. Linked to creativity is the humorous tone that was referred to as one of the most liked features and showed that humour could make a difference (Erviti & Stengler, 2016). Finally, the dynamism aligns with the evidence that more static formats, such as slideshows (e.g., video nº. 33), were not appreciated (Figure 8) and were not seen as actual video abstracts. Also, the more extensive expression of the subcategory Format on the least appreciated features shows us that monologues and simple presentations were poorly received (Figure 15).

Production phases were also referred to, focusing on the editing process. This choice sustains the importance of having, on one side, a design with all work steps and, on the other, the possibility to work with specialized professionals. Editing is like directing a movie for the second time (Vachon, 2018) and could change a movie's complete perception and reception; it should not be depreciated.

Presentation was the category appearing most prevalently in the most and least favoured (Figure 13 and Figure 15). The narration features were the most mentioned, showing that a good narration and a good narrator are recognized. Narration and the presence of a research presenter are also ways a science video legitimizes itself with the audience (León, 2010). A video abstract that presents the scientist explaining their research acquires authenticity, a central element in the success of a science video (Kaul et al., 2020). The importance of a good voice is linked with the audio category. As stated in previous literature, sound is rarely mentioned when it is good (Figure 13) (Vachon, 2018). When it is not good, the sound is a critical negative factor in the viewing experience (Figure 8). This finding aligns with the conclusion that research is less positively evaluated when the sound is terrible (Newman & Schwarz, 2018).

Finally, the score of our video was very favourable compared to the rest of the sample. The positive reviews highlighted the diversity of content, clarity and editing. These results show us that working collaboratively, using resources available by the institutions (e.g. university), and mixing different formats (e.g. interview, documentary, animation) are winning formulas. In the future, researchers can consider producing videos based on the following proposed guidelines (Figure 16) towards a more effective way of communicating science.

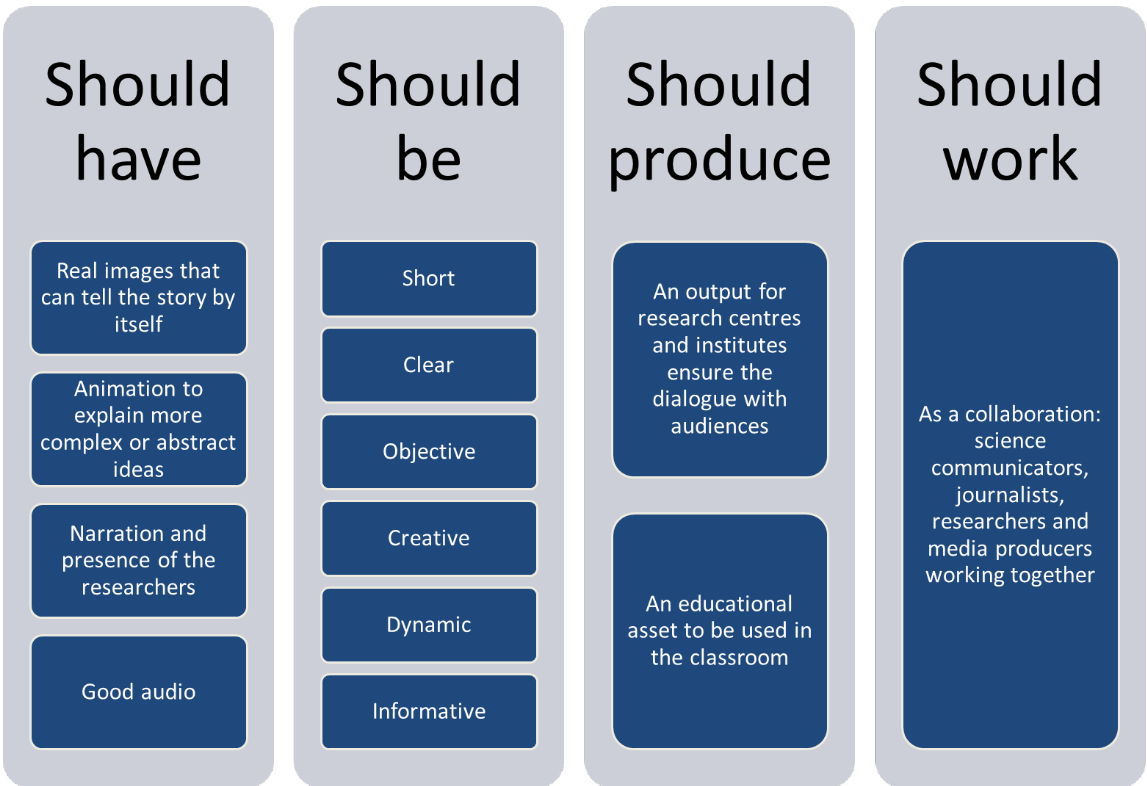

Figure 16: The main features proposed to a video abstract in Ecology and Environmental Sciences.

3.5 Constraints

Like other reception studies, there was no opportunity to conduct discourse analysis on the comments associated with the videos: nine videos had no comments, so we could not compare this measure of viewer participation with the contributions from our panel experts for each video. In addition, working with a specific panel of specialists had limitations. It was not possible to generalize the effects to a general audience. Also, the content factors of these video abstracts cannot be applied to other scientific areas. Lastly, the selection of the 21 videos and content analysis was performed by a single researcher, which can bias the results regarding representativeness and reliability.

4. Video Abstract Production Guide

The work presented in this chapter was published in *Frontiers in Communication*.

Ferreira, M., Lopes, B., Granado, A., Siopa, C., Gaspar, H., Castro, H., Castro, S. & Loureiro, J. (2023). Video abstract production guide. *Frontiers in Communication, 8,* 1060567. doi.org/10.3389/fcomm.2023.1060567

4.1 Introduction

Science videos offer novel and exciting ways of communicating scientific topics (García-Avilés & de Lara, 2018). However, as researchers, we must ensure scientific rigour in these new formats, especially in an era with an excess of popular content and misinformation (Rosenthal, 2020). Video abstracts, i.e., filmed versions of the written abstract of a scientific paper (Berkowitz, 2013; Scott Spicer, 2014), have the potential to maintain trustworthiness while connecting the researchers and the institutions with new audiences (Kippes, 2021). Having scientists promoting their work in a video can also encourage middle school students to pursue careers in science while demystifying some preconceptions about science and its stakeholders (Ruzi et al., 2021). Beyond all the workshops and courses (Angelone et al., 2019; Chan, 2019; Plank et al., 2017) that give researchers the media tools needed to produce their movies, a new body of work provides first-person testimonies about this process (Brennan, 2021; Krebs et al., 2020; Maynard, 2021; Smith, 2020).

This practice insight adds to those contributions and gives a unique team perspective on producing a video abstract. As science communicators, researchers and videographers, we are working on a project to understand the potential of video abstracts in Ecology and Environmental Sciences (Ferreira et al., 2021). During the work, along with different researchers, we produced two video abstracts, with the final goal of evaluating them from science communication and educational perspectives. Although studying their effects was important, the production process was also full of valuable lessons and should not be dismissed as an important output. So we propose the exploration of one of those videos, adapted from the paper "Spatiotemporal Variation in Pollination Deficits in an Insect-Pollinated Dioecious Crop", written by researchers from FLOWer Lab (CFE - Centre for Functional Ecology, University of Coimbra) and published on 22 June 2021 in the journal Plants (Castro et al., 2021).

With this practical guide, we intend to build a helpful tool for all the researchers and communicators that want to initiate themselves in video abstract production. While sharing our experience, we list along the way the main steps to take, good practices advice and some other tips that could be considered.

4.2 Production Stages

4.2.1 Selecting the paper

Before production starts, it is essential to select the main topic. In the specific case of a video abstract, we have to choose a scientific paper. We took into account three factors when selecting the article. The first one relies on the bonds established with the researchers. Being updated on the research unit's scientific production and aware of future works can be a challenging task. One way is to promote communication services among all research groups. So, if a researcher has some ongoing projects with an audio-visual potential, he/she will contact the communication office. Our experience tells us that researchers and groups more aware and skilled in science communication are the ones who usually accept most of these challenges. We worked with researchers from FLOWer Lab, who were used to communicating science. The second factor to consider is the paper's topic. Similarly to a press release, where we evaluate some findings to promote in the media, the video abstract also needs this kind of assessment. From our point of view, ensuring that the video is innovative, up-to-date, and has a solid visual component is important. One strategy is while reading the abstract try to visualize the concepts. We chose a paper with current and popular topics, i.e., pollination and biodiversity loss, directly linked with the UN Sustainable Development Goals (SDGs) (United Nations, 2015) and with great visual potential. The last aspect to consider is the release date. For planned dissemination, it helps a synchronous release with the corresponding paper. So, our choice should preferably point to unpublished papers, already near the submission stage.

4.2.2 Writing the script

The traditional format for a movie script splits the action into chapters and scenes. There are some rules for writing a regular screenplay and some software that can help with that task (e.g., Celtx (Celtx Inc., 2022), Final Draft (Cast&Crew, 2022), and Trelby (Gulecha, 2022)). For this purpose, we followed the traditional structure of a scientific paper (Vachon, 2018): introduction, methods, results, discussion and conclusions. Accordingly, we elaborated our film with the same structure. We used the six formula question (adapted from Chan, 2019) to answer these questions about the research:

1. What is the problem?
2. Can you provide more details about the problem and why it is a problem?
3. What are you doing to solve the problem?
4. What have you found out?

5. What is the impact of the research? Why is it important?
6. What is next for your research?

This strategy uses the answers as a starting point for the script. From this stage onwards, the work is done closely with the researchers: we created an online working group to discuss the several versions of the script using a table to deconstruct the complex ideas and replace the jargon. We registered the predicted duration according to the measure of 150 spoken words per minute and added some keywords to help us ensure that the main topics were covered. Thus, two additional columns were created beside the column with the text (i.e., the answer to each question): one for the estimated length and the other for relevant keywords.

Once the script was ready, we decided what footage to get.

> "Just as a scientist has to collect data, a filmmaker has to collect film. Which can be very tedious. But it is the same basic process. If your interview says the forests are dying, you have to go find film of dying forests to show your viewers in order to get them to really grasp what is being said." (Olson, 2018)

We placed the images required to illustrate the text in a final column. In this stage, we were realistic and creative about what we could shoot and which royalty-free resources could be used. Which footage do we already have? Which footage will we have to get? Will it be necessary to obtain any license? Table 5 shows part of the grid that we applied.

Table 5. Script grid using the six-formula question (adapted from Chan, 2019).

Question		Time	Text	Keywords	Scenes
What is the problem?	What is pollination, and why is it important?	43 sec	Pollination is the simple transfer of pollen from the anthers to the stigmas, culminating in fertilization; however, this important ecosystem service is far from being simple, as plants rely on mutualistic interactions with animals to carry its pollen. We currently know that the yield and quality of over 75% of crops worldwide is directly affected by animal pollination, and the area	Pollination Food production	Images of the pollination process as a simple tutorial. Animation? For example – we can have images of different crops (e.g., sunflower, pear, apple, cherry, kiwi). General images of orchards, pollinators, and pollinators. Wide shots.

	occupied by pollinator-dependent crops has increased over the last decades. Pollination is, therefore, an important biodiversity-dependent service supporting food provisioning.	Interview?

From our experience, this writing stage is perfect for planning the budget and deciding what paid resources will be used. Once we had our final narration, we copied the text section to a new document and rehearsed the reading. It is necessary to balance the essential information with the desired length. The definition used for a science video implicitly considers a short-length content (García-Avilés & de Lara, 2018; Welbourne & Grant, 2016). Indeed, our previous work recommended 2-3 minutes as the ideal length for this kind of videos (Ferreira et al., 2021), and it was shown that short videos could strengthen long-term information retention (Slemmons et al., 2018). However, each video has its own dynamic, goals and target audience, so more studies and information are necessary to fully ascertain the most appropriate length. Having said this, we tried to produce a script for the shortest video possible without compromising all the fundamental information and rigour.

4.2.3 Producing the video

Our production stage comprised six key moments: narration recording, on-site film shooting (kiwi orchard in this particular case), interview recordings, film shooting in the laboratory, animation development, and online searching for images and videos free of royalties.

One of the authors, João Loureiro, was the chosen narrator. We taped the voice-over on a laptop using the external microphone KIMU Pro (Krom, 2021) and the free audio software Audacity (Audacity Team, 2021). We recorded two to three takes for each paragraph to have some backup audio files and a wider range of choices.

Before filming, we prepared our camera (Canon EOS 760D) settings. We usually selected a frame rate of 25p and a resolution of 1920x1080 pixels to shoot in high definition. We tried for our images to have the same resolution, so the viewer does not spot differences. In the editing software, it is possible to adjust the resolution (from a higher resolution to a lower one), but it is preferable to be consistent from the start. For the web, since most screens nowadays are HD, the best advice is to shoot in a higher resolution than 1280 x 720 pixels (Leonard & Kurniawan, 2022). Also, there is no point in uploading a 4K or 8K video to YouTube if most of the screens where it will be seen do not have that resolution (Vachon, 2018). Furthermore, much more space will be needed to store the files, and the work in the editing software will be much slower when using such high resolution (Vachon, 2018).

We scheduled two filming sessions on the kiwifruit orchard, one when the kiwifruit was flowering and the other some months later during the fruiting season. We filmed various shots (e.g., wide shots, mid shots, close-ups) and recreated some experiments and sample collection in the field with the researchers. It is important to shoot some cutaways: footage of something relevant that allows to cut between two shots that do not quite match or to provide some context (Vachon, 2018).

Our first interview (four questions) with the author Sílvia Castro occurred in the orchard. For that, we used an external microphone. If possible, one should not rely on the camera's microphone because, in many cases, the quality is not the best for such purposes. Also, one should try to collect a minute or two of the natural sound of the space where the filming is occurring. This could be important to help solve editing problems. The second interview (six questions), with the author Helena Castro, was conducted in the laboratory and was filmed by the communication team from the Communication Division of the University of Coimbra. From our perspective, in closed spaces, it is important to choose a background that says something to the audience about the interviewee and the research. Also, look for places well-lit where it is possible to avoid noises and interruptions. We wrote a set of possible questions not shared in advance with the interviewees to keep their reactions and answers spontaneous. Only the main topics were provided in advance. While filming an interview, remember that the person in front of you is usually unfamiliar with the camera. The lens can be intimidating, so we tried to provide a relaxed environment and repeat the take as many times as needed. Usually, we shoot 3-4 takes for each question. From our understanding, the more takes we collect, the better, especially for the editing, where some problems not precepted during filming day could arise (e.g., interviewees looking directly at the camera instead of the interviewer) (Vachon, 2018).

After the interviews, we scheduled an afternoon with the authors Helena Castro, Catarina Siopa, and Hugo Gaspar to recreate on film some of the paper's laboratory methods: identifying pollinator species and measuring and weighing the kiwi fruits.

The use of motion graphics (animations) came from the need to present some concepts in a simple and comprehensive way. Graphic designer André Ferreira was in charge of producing two animated clips. After his first read of the script (Table 5), we discussed what kind of elements were most suitable to animate. We opted to illustrate two scenes, one about the pollinator's decline and its causes and the other showing the kiwi production area in Portugal and the location of the orchards used in the study. Two software were used for this task, one to illustrate, Adobe

Illustrator (Adobe, 2022b), and the other to animate, Adobe After Effects (Adobe, 2022a). The latter allowed to animate the elements drawn with Adobe Illustrator. This process of asset creation and post-production animation took approximately 8 hours to be done. Videos that are entirely infographic might take weeks to produce[1].

Lastly, we searched online for free stock videos to enrich our catalogue. We started the search with our keywords and refined it into more specific concepts. Different stock footage providers (e.g., Pexels (Canva, 2022), Videvo (Videvo, 2022), and Videezy (Eezy Inc., 2022)) offered the ideas and concepts we could not get on camera. Also, it was necessary to select the background music. We bought the music "Colourful Dots"[2] on the website PremiumBeat (Shutterstock, 2021), but there are other free options that can be explored (e.g., YouTube Audio Library, Free Music Archive (WFMU, 2022)). Search for the mood and genre that suits your film best and follow the suggestions of similar tracks the website provides.

4.2.4 Editing the video

Before editing, organize all your material so that its usage is practical, intuitive, and accessible. We present an example of our folder organization:

- PROJECT: where we kept all the versions of the projects containing our work baseline. We saved daily copies with the date (e.g., Pollination 2020-06-04 Proj) to quickly return to previous versions if necessary.
- RUSHES: all the images we used for editing, including interviews, cutaways, animations, and field or laboratory footage.
- SOUND: all the audio resources like music, narration or ambient sound.
- RENDERS: final versions of our film, which we produced by reviewing and modifying after sharing and having feedback from colleagues and friends.
- RESOURCES: all extra material that will go into the film, such as photographs, titles, logos, animations, and other resources linked to the movie, such as licenses, notes, and scripts.

With all the data organized, it was time to review our footage and take some notes. In each sequence, we wrote what worked and what did not, what we liked best, and what could work as a transition to another shot. We suggest creating a detailed plan with the moments where the points of interest show up in each sequence. An accessible software that the person feels comfortable using is also recommended. We used Adobe Premiere Pro 2022 (Adobe, 2022c)[3] but some software with free versions have similar performance and features as paid ones (e.g., iMovie (Apple, 2022), DaVinci Resolve (Blackmagic Design, 2022), and HitFilm Express (FXhome, 2022)). With all the assets organized, we started the post-production process. The narration and interviews were the first files to be imported into the timeline. In doing that, we create an audio structure that respects the order of the script. Once we had an audio track with the correct rhythm, we added the music and started to drag in the footage.

In this stage, we tried different approaches. Trial and error are part of the process. Also, from our practice, taking some breaks and returning to your project with a fresh look is crucial. Once we had our first version, which took one week to produce, we shared it with the researcher's team and started to discuss possible ways to improve it. Our movie had six versions until we were completely satisfied with the final result. From the first version to the last one, the changes were mainly in the aesthetic and number of titles and the display of some scenes. We add a new split-screen scene layout and a google earth travelling shot. Our final version (Figure 17) was 5 minutes and 20 seconds long.

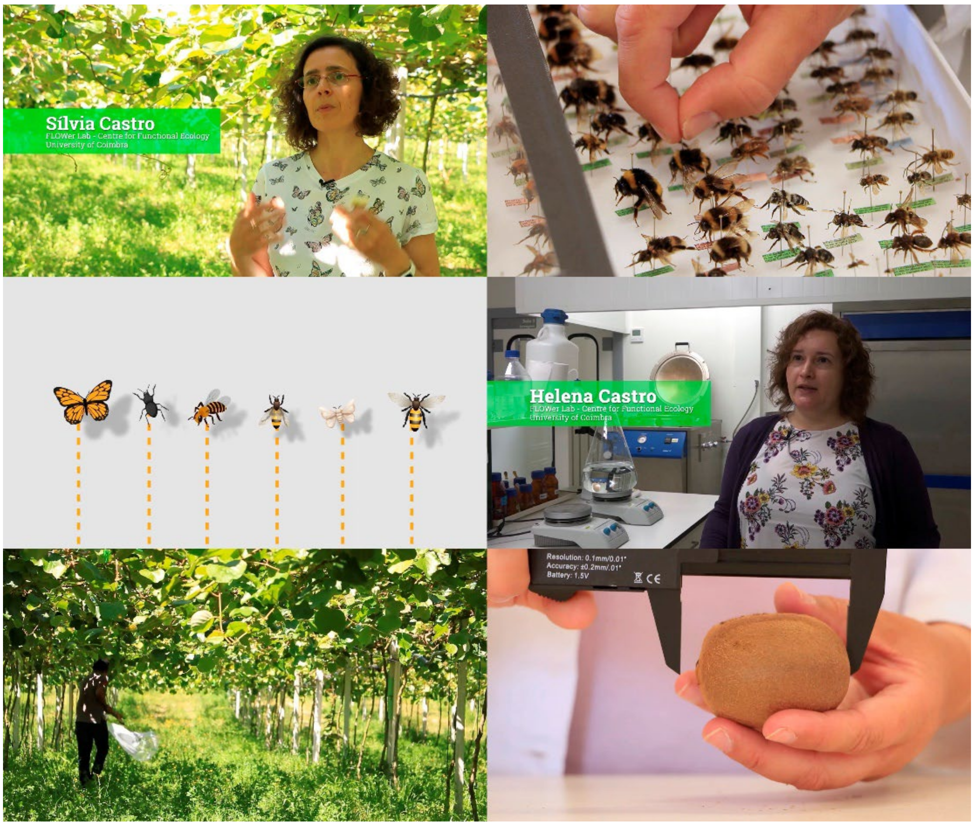

Figure 17: Screenshots from the final version of the video abstract.

4.2.5 Promoting our film

The video was uploaded and launched on CFE YouTube Channel on 14 September 2021 (Ferreira, 2021). We produced a specific thumbnail for the video and titled it "Pollination deficit in kiwifruit". This shortened title delivered the message more concisely because the paper's original title was too long and not very appealing for dissemination purposes (Bell, 2020).

After an online presence of ten months, the video achieved 1055 views and a watch time of 35.5 hours. By exploring the video analytics available in the YouTube Studio control panel, we can study audience retention, a measure that helps to see how often each moment the video is being watched as a percentage of total views (Bell, 2020). Rewinding and re-watching can result in values higher than 100%. The average view duration was 2:01 minutes, less than half its length, and the average percentage viewed was 37.7%. Also, 62% of the viewers are still watching at around 0:30 minutes, which is typical for these videos. Another available measure is the relative audience retention, which shows the video's ability to retain viewers during playback by comparing it to all YouTube videos of similar length. These data help us to understand the viewers' behaviour.

YouTube was not the only social network where the video was uploaded. There was a planned dissemination strategy between the communication office and the researchers. The Instagram, Facebook, Twitter and Linkedin accounts from CFE, FLOWer Lab and the researcher's personal pages worked in unison to disseminate the video. Also, we associated the movie premiere with the celebration of the Ecology Day (14 September). We previously registered our film release as one of the activities on the official platform created to promote Ecology worldwide. Finally, the video was also uploaded on the paper's main page in the journal "Plants" (https://www.mdpi.com/2223-7747/10/7/1273).

4.3 Discussion

The low-cost and do-it-yourself paradigms (Brennan, 2021; Maynard, 2021), supported by learning tools for filmmaking (Angelone, 2019; Angelone et al., 2019), are important drivers in the academic science video universe. Although, and not forgetting the efforts of user-generated content (Erviti, 2018), our work with video abstracts showed that professional and semi-professional formats that blend different genres and styles (e.g. animation) are more popular than amateur productions (Ferreira et al., 2021; Thelwall et al., 2012; Raphaela M. Velho & Barata, 2020). So, in the search for a more compelling video abstract in Ecology, with an informative and entertaining narrative that does not forget the rigour (Pavelle et al., 2020), researchers could join efforts with science communicators, designers, journalists and media producers, using the resources available at their institutions and universities (Smith, 2020). Our case study promoted the knowledge exchange between the different players involved: on one side, the researchers learned new tools and technics to communicate their science, and on the other side, the communicator/producer had scientific support throughout the process (e.g., to choose the most appropriate images of the study species). Planning all the presented steps – writing, producing, editing and promoting – from the start is vital. For example, to disseminate our video is not enough to upload it online (Finkler et al., 2019). It is a strategy that requires time, contacts and resources (Erviti & Stengler, 2016; Vachon, 2018).

Each stage of the production process had its own setbacks. Matching the script with the desired length, finding the ideal footage from the online providers, guiding the interviewee along the interview or editing the final video version were some of the main challenges. Also, being able to in-depth analyze the analytics of the video is one of our goals for future work. Understanding audience behaviour on different social media (not only on YouTube) (Kaul et al., 2020; Pavelle et al., 2020) will allow us to explore new models and procedures.

Science video as an area of study has grown in the last decade (Rosenthal, 2020), and methodological approaches to video production are needed: in different formats, scientific areas, topics and intervenients. This work intends to be a testimony and example of creating a video abstract from scratch. Exchanging experiences between researchers who embark on the audio-visual adventure allows us to grab new pieces to this global puzzle and challenging task.

5. Video abstract as a science education tool:

a case study in Ecology

The work presented in this chapter will be published in the book "Mobile learning: from pedagogy to practice"

Ferreira M., Loureiro J., Granado A., Lopes B. (2023) Video abstract as a science education tool: a case study in Ecology? In: Watts D.M. (ed.) Mobile learning: from pedagogy to practice. Cambridge, Cambridge Scholars Publications (in press).

5.1 Introduction

5.1.1 From science video to video abstract

In the last few years, online video has stood out as one of the key digital transformations when we look at the media landscape evolution (León & Bourk, 2018b): by 2022, online videos will make up more than 82% of all consumer internet traffic, an increase from 75% in 2017 (Cisco, 2017). More than 2 billion logged-in users visit YouTube every month, and every day people watch more than 1 billion hours of video (YouTube, 2020). Furthermore, 6 out of 10 people would rather watch online videos than television (O'Neil-Hart & Blumenstein, 2016). These new tools represent novel possibilities in many fields of modern society, and science communication is no exception (León & Bourk, 2018b). As researchers we can go beyond the traditional formats and share our results through audio-visual media like online science videos (Jamali et al., 2018; Plank et al., 2017; Rodrigues & Godoy-Viera, 2016), characterized by a great variety of producers, formats and an increasing mix of genres (Erviti, 2018; Erviti & Stengler, 2016; García-Avilés & de Lara, 2018; Welbourne & Grant, 2016). One example of a multi-format science video is the video abstract: a video presentation of a scientific paper, that communicates the framework of the study, the methods, the results, and the conclusions and future research (Scott Spicer, 2014). It simply is the filmed version of the written abstract (Berkowitz, 2013). The videos can be produced by researchers, institutions or professional companies, using different tools and ways of telling the stories, from traditional documentaries to inventive animations (Ferreira et al., 2021; Plank et al., 2017) (Chapter 2).

In the last decade, with the expansion and growth of video abstracts (Ferreira et al., 2021), journal editors have assigned guidelines and rules for publication. Also, some of these publishers (e.g., Springer Nature) have established partnerships with specialized platforms (e.g., Research Square) ("Research Square," 2019). These paid services convert complex research into attractive, concise and thorough video abstracts.

Previous studies have shown that scientific papers coupled with a video abstract are downloaded more and have more citations than papers without such an addition (Plank et al., 2017; Zong et al., 2019). Also, some works revealed that this media could change viewers' attitudes towards a specific scientific theme (Finkler et al., 2019; Finkler & León, 2019) and that optimized videos disseminate the scientific content to non-expert audiences in a clearer way, in comparison to written texts (Putortì et al., 2020).

Although there are already studies with videos that have educational traits - like TED Talks (Shah & Marchionini, 2010; Sugimoto & Thelwall, 2013; Tsou et al., 2014), the methodological videos of the Journal of Visualized Experiments (*JoVE | Peer Reviewed Scientific Video Journal - Methods and Protocols*, 2018) (Rodrigues & Godoy-Viera, 2016) and the videos present in MOOCs (Reutemann, 2016) – and works that address video production at a university level (Erviti, 2018; Santos & Santos, 2014), no study has evaluated the potential that video abstracts have in science communication beyond academia, namely in science communication for students, inside and outside the classroom. We believe that it is equally important to understand the dual role video abstracts have, both in science dissemination amongst peers and in science learning amongst secondary/pre-university students.

5.1.2 Connecting the classroom

Science education has gone through profound changes over the past few decades. On the one hand, teaching science is no longer restricted to school: internet, television, science centres and museums, science festivals, summer universities and open laboratories offer a wider spectrum of science-related activities in addition to regular classrooms (Dierks et al., 2016). On the other hand, it is undeniable that both formal and informal teaching and learning of sciences are necessary and complementary (Fiolhais, 2016). Without the school, without the sequential transmission of scientific knowledge, and in the absence of methodologies to gain that knowledge, the information obtained by other sources will reveal itself as fragile and fragmented (Fiolhais, 2016). Today, more than ever, it is important that educators and science communicators work together and establish bridges and dialogues (Baram-Tsabari & Osborne, 2015) in order to attract students in quantity and quality to science and technology (Fiolhais, 2016). Furthermore, media education should be regarded as a long-term process where the school has a determinant role, capacitating the students to an informed consumption of knowledge (Espanha & Lapa, 2019).

Despite notable advances in the last decades, international comparisons (Bauer & Howard, 2014) and evaluations (e.g., PISA) (Lourenço et al., 2019) revealed that Portugal is still behind the scientific culture indices of other developed countries (Marçal & Fiolhais, 2019). Adding to that, there has been a lack of harmony between the policies that promote the use of new technologies and the use of media in schools that remain restricted (Espanha & Lapa, 2019). A 2015 study showed that despite the massive use of media by the students, only a few showed high levels of media literacy, that is, only a few were able to critically analyse and understand the information (Pereira et al., 2015).

In 2019, about 80.9% of the Portuguese households had an internet connection (Cardoso & Baldi, 2020). About 73% of the population stated that it uses the internet at least once a week, against the European average of 84%. If we look only at the group between the ages 16-24, the number rises to 99% (PORDATA, 2020). The inquiry Kids Online (2018), which used a sample of 1974 children and teenagers (aged between 9-17), showed that, in 2018, 87% of the inquiries used the smartphone as the main device to access the internet, against the use of the laptop, that decreases to 41%. With the connection and the tools in place, it is now necessary that all the actors involved embrace the challenge. Lastly, we cannot forget the impact that the pandemic has had on the quick and immediate implementation of new technologies in schools: in a short period, teachers and educators have had to learn how to implement communication software (most of which is new to them), apps and media in the classroom (Carvalho, 2020). The effects of this "revolution" will be perceived in the next few years. One thing is sure: today, more than ever, audio-visual tools are essential elements in lifelong education.

5.1.3 Video abstract in Ecology and Environmental Sciences

The work presented in this chapter is part of the project "Communicating Science through video: The Use of video abstracts on dissemination and learning of Science (s)", which aims to evaluate the global impact of science communication through the use of video abstracts, and that is being conducted in the Centre for Functional Ecology (CFE) of the University of Coimbra (Portugal). CFE has a strong focus on raising public awareness of biodiversity conservation and the challenges of sustainable development, in line with the UN 2030 Agenda for Sustainable Development (European Commission, 2020) and the EU strategy to halt biodiversity loss. Also, the CFE is fully committed to the implementation of an Open Science agenda, always trying, ultimately, to bring students to higher education, to science and technology, and to Ecology. In order to achieve this objective, video abstracts can play a crucial role once they unite concepts such as visual literacy (Bucchi & Saracino, 2016; Krause, 2017; Rigutto, 2017; Trumbo, 1999) environmental literacy, ecological literacy, ecoliteracy (McBride et al., 2013), scientific literacy (Granado & Malheiros, 2015) and media literacy (Espanha & Lapa, 2019). They can work as an open door to real science and researchers, clarifying doubts and demonstrating their importance.

In this study, by implementing an online questionnaire to a group of secondary school students, we aimed to understand how well the video abstracts work in disseminating and educating about science. The main goals of this work are:

(i) Understand how students relate to the disciplines they attend in the domain of Natural Sciences (namely: 'Biology' – 12th grade and 'Biology & Geology' (10th and 11th grade);

(ii) Understand how students connect with online science videos;

(iii) Identify potential differences in the learning processes between reading the written text (traditional research paper abstract) and watching the corresponding video abstract;

(iv) Comprehend the importance and effectiveness of the video abstract as a tool to ease science dissemination and education.

5.2 Methods

Based on the results of Ferreira et al. (2020) (Chapter 2), who compiled, described and characterized a list of 171 videos on Ecology and Environmental Sciences, a video abstract of a specific paper, published by CFE researchers, was produced. The choice of the scientific paper was based on the following criteria: (i) the paper cannot have been published yet; (ii) the topic had to be in line with one or more of the 17 Sustainable Development Goals; and (iii) the research author must be receptive and active in the science communication process. Taking this into account, the paper "Metabolic Effects of Dietary Glycerol Supplementation in Muscle and Liver of European Seabass and Rainbow Trout by ^{1}H NMR Metabolomics" from the researchers Ivan Viegas e Mariana Palma from the research line of "Marine and Coastal Ecosystems" of CFE, published in 20/02/2020, was selected. The written abstract is presented below.

INTRODUCTION: The sustainable development of aquaculture is still dependent on the substitution of fishmeal for alternative ingredients, especially for carnivorous fish species. Glycerol has already been used as an alternative energy source in farmed animals' diets, sparing amino acids to other functions such as growth. Carnivorous fish such as rainbow trout (*Oncorhynchus mykiss*) and European seabass (*Dicentrarchus labrax*) are important aquaculture species in Europe and relevant for diet optimization studies.

OBJECTIVE: Evaluate the effects of dietary glycerol supplementation in rainbow trout and European seabass muscle and liver metabolome.

METHODS: Rainbow trout and European seabass juveniles were fed diets with 0%, 2.5% and 5% glycerol. Muscle and liver were collected and tissue aqueous fraction was extracted. 1H 1D nuclear magnetic resonance spectra were acquired for each sample and its metabolite profile was assessed. Mutivariate and univariate statistical analysis were applied. The energy charge and the lactate/alanine ratio were determined in muscle samples.

RESULTS: Both species showed more variations in muscle metabolite profile than in liver. Rainbow trout muscle was more affected by the diet with 5.0% glycerol while European seabass muscle presented more variations in the group fed with the 2.5% glycerol diet. Regarding liver, rainbow trout showed fewer differences in its metabolic profile than European seabass. No differences were observed in energy charge between experimental groups in both species.

CONCLUSION: Albeit rainbow trout seems to be more suitable to be fed with these dietary glycerol percentages, the tested diets have the potential to be used in aquaculture production.

The video went through all stages of pre-production (converting the written abstract to a script and writing down all the required footage), production (filming all the scenes) and postproduction (editing the film). All steps were conducted with the help and opinion of both authors of the paper and taking into consideration specialized bibliography (Chan, 2019; Finkler & León, 2019; Vachon, 2018). Once produced, the video was uploaded to the CFE YouTube channel (https://youtu.be/rhk1taqRlOo) and disseminated through all social media and formal platforms. In six months, the video had 610 views. This means 610 potential learning experiences in science.

A questionnaire was produced to understand the impact of the video on the learning processes and on the interest in science of secondary students (Appendix F). Due to the pandemic and the restrictions implemented by secondary schools, the questionnaire, initially conceptualized for a face-to-face presentation, was adapted to the online format. It was written in Portuguese and divided into three different sections:

- Part 1: Student's relationship with the discipline of Biology-Geology and with science videos. This segment was composed of 9 questions, 3 of them presented on a 5-point Likert-type scale.
- Part 2: Comprehension of the topics presented in the written abstract and/or in the video abstract. This second part intended to analyse the difference between the two groups. It was composed of 5 questions, four open-ended questions and a grid with 12 statements, where the participants had to choose the degree of agreement using a 5-point Likert-type scale. The questions aimed to understand not only the knowledge about the topic presented in the research, but also the attitudes and interests in science, more specifically, science in Portugal.
- Part 3: Understanding of the research presented in the abstracts (written and audio-visual) and specific opinion about the video abstract. After the viewing of the videos, the students were confronted with a questionnaire about its content as well as their preferences. It was composed of 6 open-ended questions and one numeric question that asked the students to classify the video abstract from 1 to 10.

The Portuguese education system is divided into sequential levels: Pre-school Education, an optional cycle for children from 3 to 6 years; Basic Education, with 3 sequential cycles; and Upper Secondary Education, a 3-year cycle (10th, 11th and 12th) which includes different types of courses. The discipline of Biology-Geology is inserted in the common structure of the Scientific-Humanistic Course in Science and Technology. It is a biennial discipline (10th and 11th grades), where the main objective is to expand knowledge and skills related to these scientific areas. The Biology subject for the 12th year is one of the options of the specific training component of the same course and aims to deepen the knowledge built in previous disciplines.

The questionnaire was distributed to a convenience sample of 117 biology secondary school students, 56% female and 44% male, ages 15 to 18, from one School in Tondela (Central Region of Portugal). The sample was composed of 6 different classes from 3 different years: 47 students from 10th grade, 38 students from 11th grade and 32 students from 12th grade. Two versions of the questionnaire were created to understand the impact of the video: version one (n = 55), where the students, in part 2, read the written abstract and saw the video abstract, and version two (n =62) where the students, in part 2, only read the written abstract. The latter group only saw the video abstract in part 3. Both versions of the questionnaire were applied online, with the support of the teachers in the context of an online classroom.

5.3 Results

The presented results were divided into four sections. First, we evaluated student's favourite disciplines and most used study materials. In the second section, we analysed the role of online science videos in the student's daily life. Thirdly, we presented the data about the video abstract visualization, and in the last section, we explored this visualization by looking at the differences between two groups of students.

5.3.1 Scientific subjects and study materials

In a first stage, we looked at the relationship of the sample students with different subjects and disciplines. To the question: "What is your favourite discipline in the present school year?" most (90%) of the students selected only one discipline per answer, while the remaining 10% had their preferences distributed through two, three or four disciplines.

Mathematics was the favourite discipline of these students, and then, in second place, Biology (Biology-Geology and Biology) (Figure 18). The subsequent choices, like Chemistry-Physics, Philosophy and Physical Education, presented identical values. There was a clear predominance and preference for the Formal and Natural Sciences, with Humanities and Social Sciences appearing in second place (Figure 18).

When we asked: "How do you like each of the following subjects?" most of the students liked or liked a lot of both disciplines (English and Biology). More students disliked more English subjects than Biology subjects (Figure 19).

Looking specifically at the discipline of Biology-Geology, we saw that the school manuals and the school notes are the most used tools of study (Figure 20). 65% and 63% of the students said that they frequently use the school manuals and notes (very often), respectively. On the other hand, webpages were used often and very often by more than half of the students. Also, in the new media field, online videos were predominantly used sometimes and often. Other books and other options are the ones that presented the lowest degrees of usage (Figure 20).

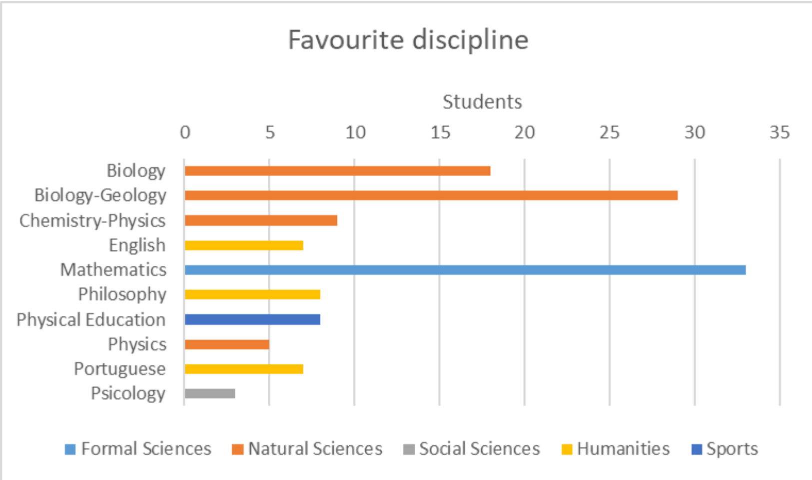

Figure 18. Favourite discipline in the present school year.

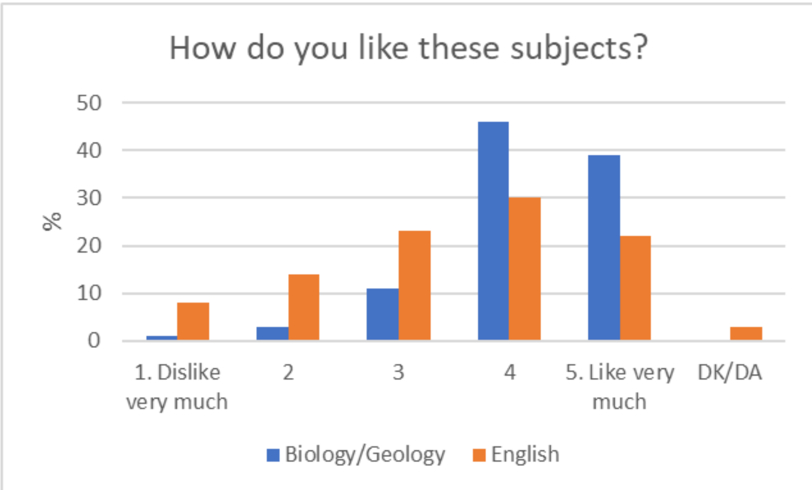

Figure 19. Students' preferences about the disciplines of Biology and English.

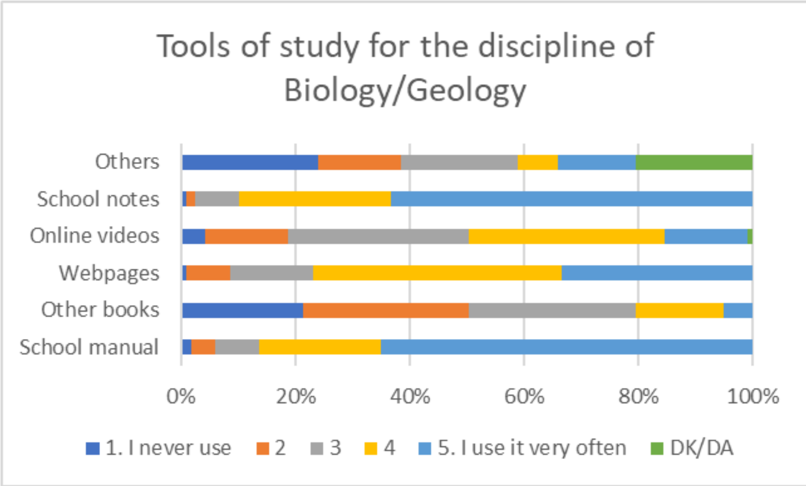

Figure 20. Tools used by the students for the study of the discipline of Biology-Geology.

5.3.2 Science online videos

The inquiry results show that 79% of the students watched online videos, most of them educational (Figure 21). In this group, videos that answer questions, explain and summarize the subjects, and that are presented as a lesson or recommended by the teacher were the most watched. Some students mentioned Jubilut, an educational channel about Biology, as an example of this type of video. The "Entertainment" and the "Music" categories were in second and third place, respectively. "Science and Technology", "Gaming", and "How to and Style" were also among the choices of the students (Figure 21).

61% of the students watched science videos from time to time (Figure 22), and half of the sample did it because they were looking for support in understanding school subjects. Curiosity and interest in different areas and subjects were also presented by the students as reasons to watch science videos (Figure 23).

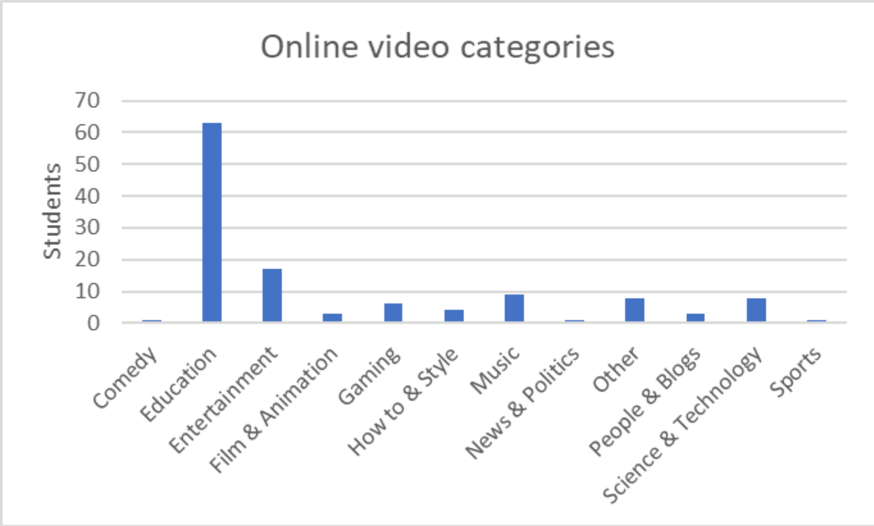

Figure 21. Online video categories viewed by students.

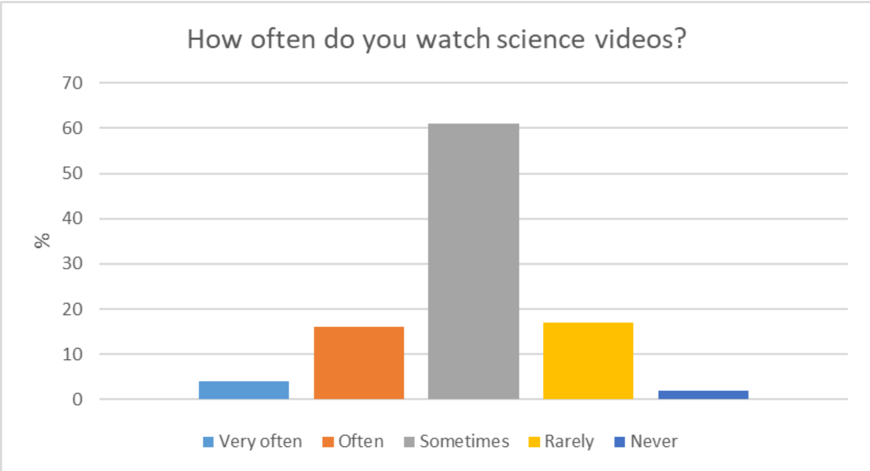

Figure 22. Frequency with which students watch science videos.

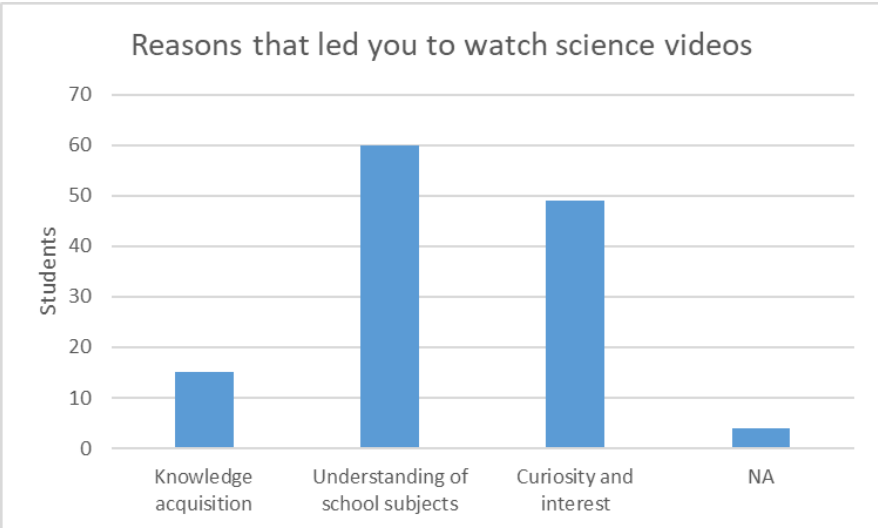

Figure 23. Reasons that led students to watch science videos.

5.3.3 Comprehension of the research and the video contents

After watching the video, the students were asked what they had learned. Almost 30% found out that there are new sources of food and alternative diets, mentioning several times the glycerol molecule (Figure 24). Aquaculture and the researched species (rainbow trout and European seabass) were pointed out by 19%, and only 7% of the students reported the study results. In this way, more than half of the sample learned information directly related to the research: main topic, objectives, results and conclusions (56%). Broader and more implicit themes, such as environmental and economic sustainability, were in third place, with 10% of the answers. Lastly, the cluster associated with the researchers and the scientific method was the least mentioned. Despite a great deal of student involvement, about 5% said they had learned nothing, and 10% did not answer or said they did not know.

Looking at the students' opinions and preferences, we observed that the positive feedback (Figure 25) was bigger than the negative feedback (Figure 26). More students talked about the things that they enjoyed in the video, producing more categories in comparison to those who talked about the things that they did not enjoy. On the positive side, most of the students (19%) indicated the clear and concise explanation as their favourite aspect of the video. They pointed out that the video communicates the ideas in a short, simple and comprehensive way. 8% of the students highlighted the enjoyment of being behind the scenes and seeing all the real scientific processes. Other categories related to the scientific method were also pointed out by the students (3%), including the researchers' explanation, the study's quality and the fact that this was a national research. In general, the students preferred topics related to the scientific themes and the way that they were presented, compared to the research itself and the researchers. It is also important to note that 21% of the sample did not understand the question and answered it out of context. Additionally, 17% of the students did not know or did not answer when confronted with their favourite aspects of the video abstract.

The characteristics least appreciated by the students (6%) were directly related to the quality of the narration and the narrator's accent. Among the other factors that students did not like, we can highlight: the use of living organisms (3%) and their dissection (3%), the English narration of the film (3%), and the lack of more experimental examples (3%). It is important to say that 37% of the inquiries did not point out negative aspects of the video and that 32% did not know or did not answer.

Lastly, the students were challenged to classify the video, from 1 to 10, 1 being "Very bad" and 10 being "Very good". The average obtained from all the scores was 7.81.

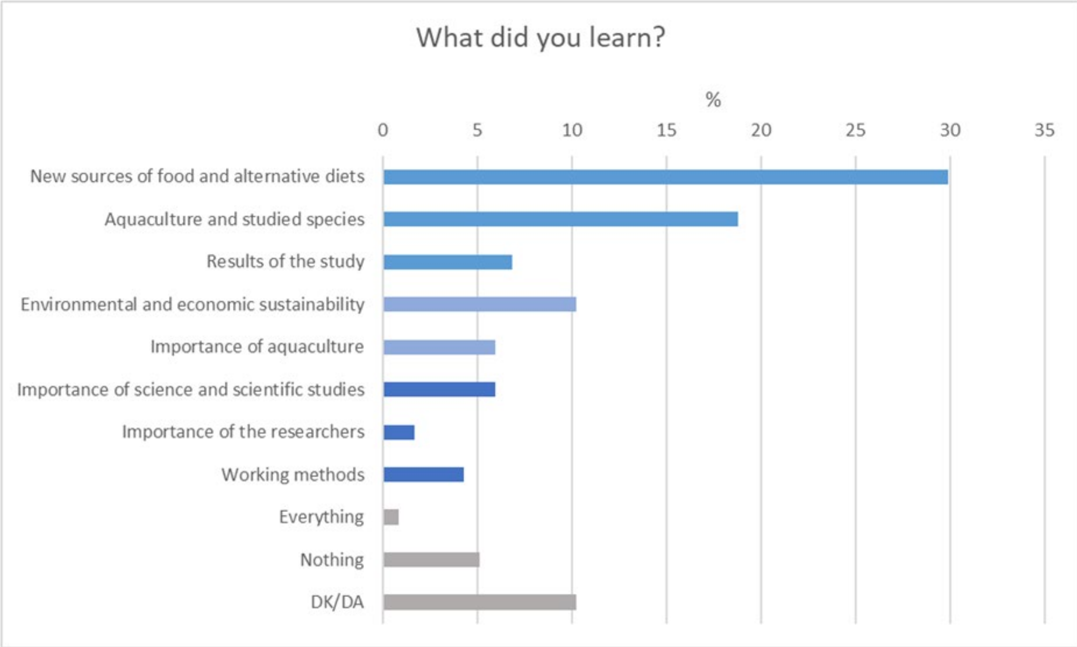

Figure 24. Scientific content that the students learn with the video.

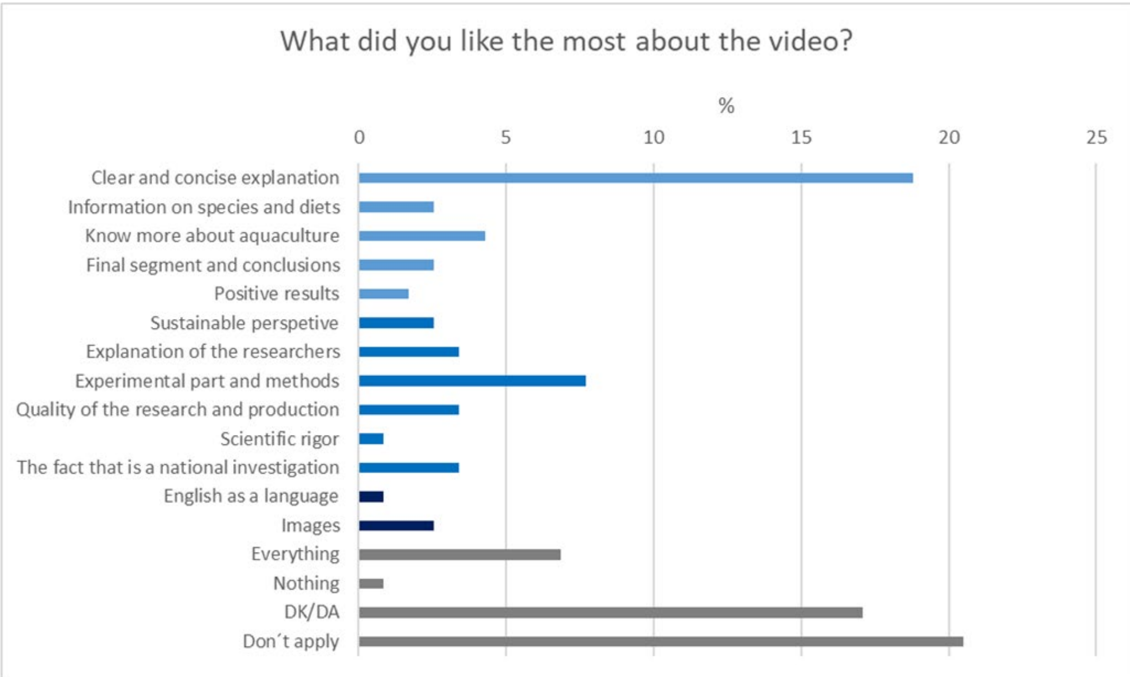

Figure 25. Favourite aspects of the video abstract by the students.

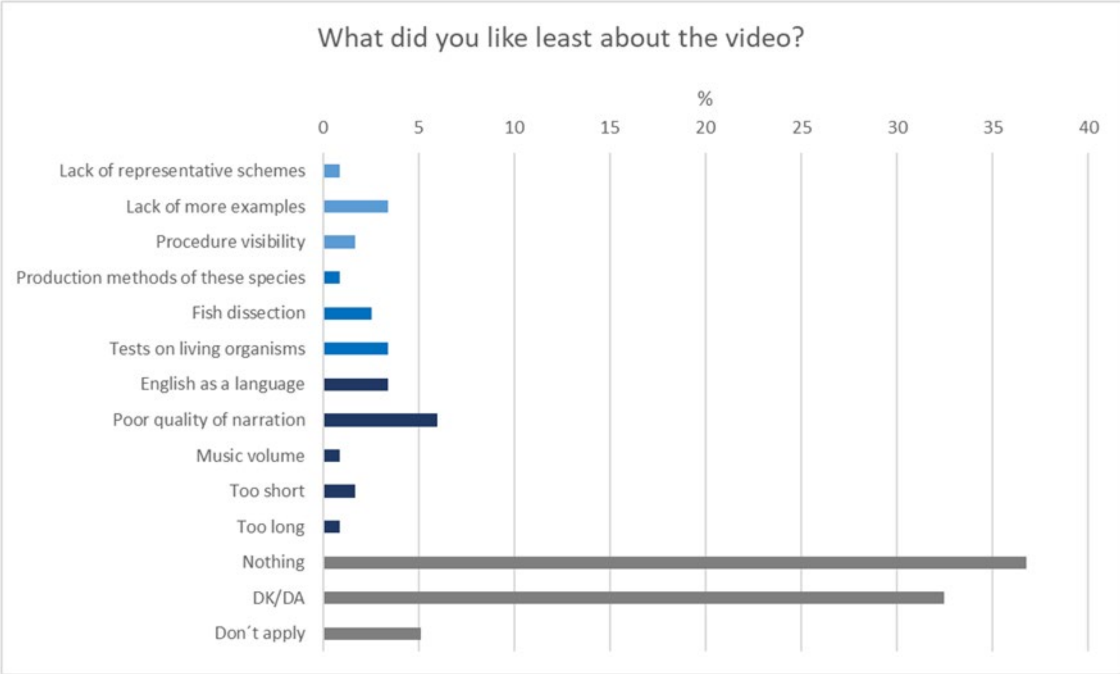

Figure 26. Deprecated aspects of the video abstract by the students.

5.3.4 Comprehension of the scientific contents

Lastly, in this part of the research, the sample was split into two: students who had access to the written abstract and to the video abstract (n = 55) and students who only had access to the written text (n = 62). They had to give their opinion about a series of statements, from "totally disagree" to "totally agree". The grid was divided into four areas: (i) aquaculture and research subjects; (ii) research methods and researchers; (iii) benefits and importance of Science; and (iv) benefits and importance of science communication. From the 12 questions in the grid, we choose 4, one from each area, to represent the observed main patterns.

Firstly, looking at the main area of research, both groups agreed that aquaculture is an important source of human food (Figure 27A). The group that saw the video showed a little bit more certainty, with more answers totally agreeing with the statement. Analysing the second area, the replicability of the scientific methods, was the sentence that raised more doubts: 13% on the group that saw the video and 27% on the group that only read the written text (Figure 27B). Most of the students (from both groups) agreed or totally agreed that Science allows us to solve global problems (Figure 27C). However, the group that only read the written abstract showed a little bit more uncertainty than the other group. Finally, when we look at the importance of science communication in society's development, positive feedback is maintained: most of the students agreed or totally agreed (Figure 27D).

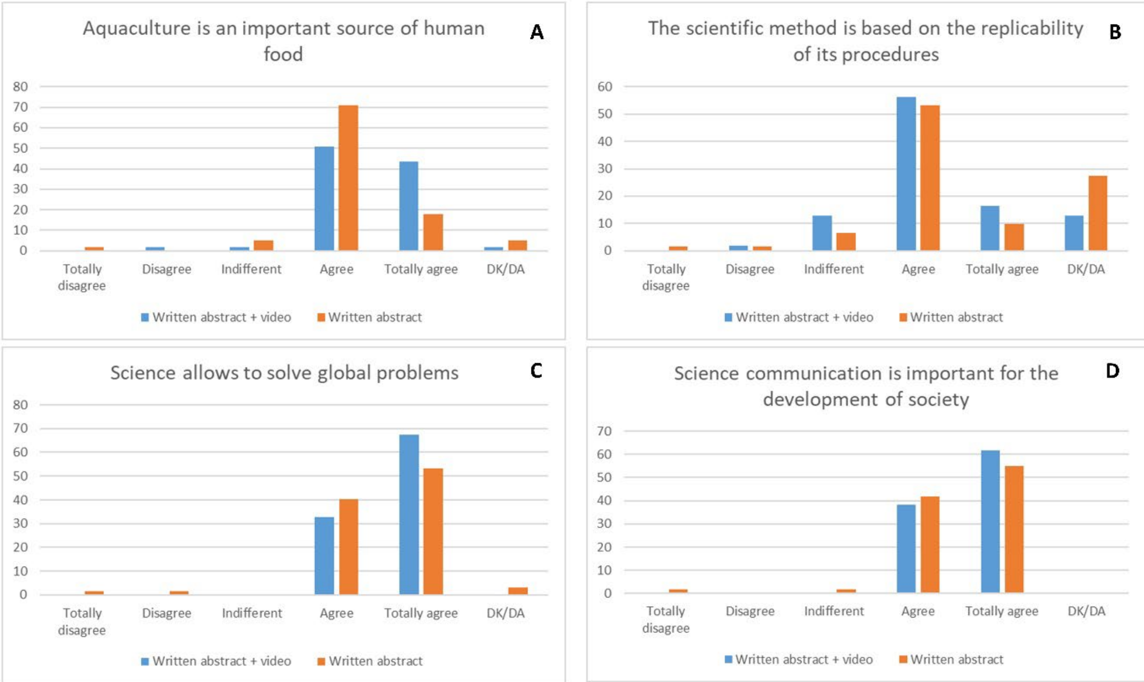

Figure 27. Students' positions on several statements related to the research.

5.4 Discussion

Regarding the scientific areas and the different study tools, we showed that the students' favourite subject was Biology (Biology and Biology-Geology). Looking only at the subject of Biology-Geology, most students reaffirm their preference, saying that they like it or like it a lot. These results reflect the academic choices of these teenagers, who, in the transition from the 9th grade to the 10th grade, chose the Scientific-Humanistic Course in Science and Technology, in which they are currently integrated. These disciplines, more linked to the natural and the exact sciences, will give them access to the desired higher education courses, which, in this case, are closely related to the areas of health, engineering and biological sciences. Also, the fact that the questionnaire was applied in a Biology classroom context may have influenced the choices. As for the tools and study materials students use, traditional options, such as school textbooks and notes, continue to be the most requested. Browsing internet sites and watching online videos comes in second place as the most used, ahead of the option of using other books. This demonstrates that, despite the global adoption and incorporation of new media, traditional content and methods continue to be the most used by the students, which may reflect the resistance presented by the teaching class in the introduction of these technologies in the classroom (Espanha & Lapa, 2019).

Exploring the online video dynamic, 79% of the inquiry watch this kind of content, a percentage that is in line with recent studies in this area (Ponte & Batista, 2019). When asked about the most consumed type of videos in the online environment, more than half of the students pointed to educational videos, often recommended by teachers, helping them to understand the subjects presented in the classroom. Such a strong dominance of educational videos, compared to the most popular genres such as entertainment and music (Statista, 2023c), is surprising. We can try to explain this fact by the use of other platforms, instead of video platforms, for the consumption of entertainment and music. Also, the classroom context can influence, once again, these answers. Focusing the lens on science videos, more than half of the students watch them occasionally; routine and daily consumption are not the majority options. This is in line with previous results: in view of study and school homework, it makes sense that, if these contents are used to understand the school topics, they would not be consumed on a daily basis as they act as more specific and punctual tools students use to solve problems. This confirms that selected science videos can be an effective complement to the classroom (Higgins et al., 2018; Pecay, 2017; Rosenthal, 2020). But video abstracts and their mobile possibilities bring these dynamics to an all-new level. First, being a video produced by a researcher, a research centre or a university, it guarantees the rigour of the scientific content (Frances & Peris, 2018). The students can watch the videos of that author or channel autonomously and independently, steadily or on the move, outside the school, keeping the standards of scientific rigour and learning. Second, working on a regional scale and promoting scientific research on the schools nearby the institutes, research centres and universities opens a bridge to the backlot of the science videos. After watching the video on the classroom, the teacher and researchers can promote an integrated tour to the laboratories and other science locations featured in the video. To see the real science and the real actors, using the videos as audio-visual guides, can shorten the barriers between the schools and the universities. Also, the fact that this is a Portuguese research was mentioned by some students as a favourite aspect of the video. One of CFE's goals is to produce new ways of making its science reach, not only peers but also secondary school students, increasing their interest in Ecology and Higher Education. In contrast to the university institutional videos, video abstracts are intended to work not only as a broad tool for attracting students but also as a specific mechanism to show them Ecology in the field, scientific research as a career, as an option and a way of personal fulfilment. Third, these videos can transmit emotions and promote engagement (León & Bourk, 2018b), changing viewers attitudes on environmental issues (Finkler & León, 2019). This can build, outside the classroom, a sense of citizenship, individuality and responsibility.

Looking specifically at our video abstract and the learning processes, it is encouraging to note that there is a wide spectrum of answers covering the specific topic of the video, the importance of the study in a global context and the Science itself. What the students most learned was directly linked to aquaculture and new sources of food. They discovered the existence of this practice and its mechanisms, which informed us about the importance of producing videos on topics not so addressed by the media, such as aquaculture. We are interested in finding new stories that deviate a little from hot topics such as climate change, keeping in mind the sustainable development goals and the educational programmes. Adding to this, the results of the study have little expression in the obtained answers. On the one hand, this can prove what was previously mentioned - the importance of the main topic – on the other hand, it indicates that the way of presenting the results needs to be improved. The cluster about the scientific method and the importance of the research turned out to be the least mentioned, perhaps because these topics are more prone to subjectivity and because the experimental and methodological procedures are not described in detail in the video. However, when we asked what the students would have preferred to see on screen, the methods and procedures came as a second choice. Although they did not recognize this as a learning step, laboratories and their experiences increased their interest.

Considering the aspects that they liked the most, a "clear and concise explanation" stood out from all the other answers, which demonstrates that the adopted video style, where a third-person narration is interspersed with interviews, is effective. Regarding the negative aspects, more than half of the students did not respond or said that they had nothing to point out. This is good, but it can also represent some fear of exposure and negative criticism. As the video's weakest points, the students pointed out the quality of the narration, the fact that it was in English and the manipulation of living organisms. These are all factors that we will take into account in the production of the next video: improving narration, perhaps with a professional narrator, trying out a Portuguese version with English subtitles (and not the other way around) and removing experimental images that may disturb some viewers.

Finally, looking at the experimental section of the questionnaire, in which two groups were created, there was a slight tendency in the topics of aquaculture and the scientific method, in which the group that read the abstract and saw the video was more in agreement and presented fewer doubts than the group that only read the abstract. Issues related to the importance of science and science communication seem to arouse a greater convergence. In other words, more transversal and universal themes may not be amplified or modified by the way the message is transmitted.

It is important to mention the fact that the survey was carried out in an online environment presented some obstacles and led to some constraints in data analysis: by being autonomous, with no contact with the researcher, to present the research or to clarify some doubts, students did not assign the necessary value to the task. Many responses were copied from other sites or other colleagues, and some questions were not interpreted correctly. This leads us to reflect on the importance of face-to-face dynamics for this kind of presentation.

Although we did not obtain clear differences between the two communication models - written and audio-visual - it is quite evident that the video abstract has enormous potential in this context. Most students stated that they consume online videos, the majority of which are educational videos, to clarify doubts about classes and the contents taught. However, they presented a wide spectrum of assimilated content and demonstrated very positive feedback about the media used. Thus, there was a clear predisposition for this type of content that can be used and expanded by video abstracts:

(i) In the classroom, taking new technologies and new media to the school, establishing partnerships and strategies with teachers and always framing the subjects with curricular programs;

(ii) In the context of a university's research centre, promoting national research, unique and new, and interest in science among secondary students, thus attracting teenagers to these areas;

(iii) In a mobile online context, connecting the previous dots, enabling the production of a repository of rigorous, innovative and practical scientific content, which can be viewed anywhere at any time. Assuring the rigour of the scientific message allows the students to watch the videos outside the classroom and discuss them in new environments. Also, presenting national research breaks the stigma of inaccessibility, and with a school tour, it is possible to discover the places and actors of the video.

Building all these bridges is an enormous challenge. On the one hand, there are already clear actions that we can take on a future video abstract, such as improving the quality of the narration and involving the school teachers in the process of choosing the scientific article and producing the video. On the other hand, there are many investigative paths yet to be explored, focusing on content factors and mobility. Since the video will always work as a complement to the abstract and the written paper, it will be interesting to address visual rhetoric, producing, for example, two versions of the same video, where only one factor is changed, enabling us to measure its influence (e.g., producing a video in English and another in Portuguese, producing a video with the presence of the researchers and another without them). Also, comprehending the effects of the moment, place, and form of visualization on the science communication process looks crucial. It will be important to test video abstracts in different environments, outside the classroom, and understand their impact in the processes of learning and assimilation of the scientific message. All of these efforts will allow us to build a more effective, useful and modern video abstract.

6. New strategies in Science Education? The use of video abstracts in Ecology and Environmental Sciences in the classroom

The work presented in this chapter was published in *Revista APEduC-Investigação e Práticas em Educação em Ciências, Matemática e Tecnologia*.

Ferreira, M., Loureiro, J., Granado, A., & Silva-Lopes, B. (2023). New strategies in Science Education? The use of video abstracts in Ecology and Environmental Sciences in the classroom. *Revista APEduC-Investigação e Práticas em Educação em Ciências, Matemática e Tecnologia, 4*(1), 13-26. doi.org/10.58152/APEduCJournal.316

6.1 Introduction

In the past two years, a more powerful tide caught up with the rise of new technologies and their role in societies. A pandemic burst onto the shore of our lives, abruptly changing how we communicate, work, and live. All activities and sectors were affected, and so was Science, particularly in how it is produced, transmitted, and taught. The widespread confinement of the population meant that many researchers had to leave their laboratories and fieldwork stagnant. With their employees forced to work from home, the primary producers of scientific knowledge, like universities and institutes, had to readjust their goals, strategies, and funding. The same happened with formal teaching, where face-to-face classes evolved overnight into distance learning. This transition triggered profound changes in the day-to-day functioning of schools and their actors, leading to an inevitable increase in the use of technology (Pedro et al., 2021). Many devices associated with non-formal education, such as television and computers, had to be now structural elements of formal education (Dierks et al., 2016). Previously, both types of education were already regarded as necessary and complementary. Actors from both "worlds" agreed on the creation of bridges and further dialogue (Baram-Tsabari & Osborne, 2015) to attract more students to Science and Technology, sustaining a developed society (Fiolhais, 2016). Science and media education are essential components in this lifelong learning continuum, from preschool to active citizenship, which encompasses formal and non-formal education (Espanha & Lapa, 2019; Fiolhais, 2016; Hazelkorn et al., 2015). However, despite previous efforts to converge both systems of education, the COVID-19 pandemic served as a turning point in favour of online education worldwide, and it has implemented profound changes in the foundation of the education systems. A study from The National Education Council (Portugal) states that “the emergency remote learning situation may have triggered more changes in a short period than the discourse on innovation in education over the years” (National Education Council, 2021, p.182).

In Portugal, the Portuguese Government suspended twice (in March 2020 and January 2021) all classroom teaching and training activities at all levels of education. These new rules forced schools to replace presential time - 26 hours per week of face-to-face compulsory instruction - with online teaching and home-schooling, promoted most of the time by teachers and parents (OECD, 2020). Distance learning imposed new practical and theoretical methodologies built on more autonomy for the student, with new digital tools leading the way (National Education Council, 2021). However, not all schools and teachers were prepared for this transition (OECD, 2020). It is therefore important that these technologies are kept after the COVID-19 pandemic, and new training sessions about educational innovation are promoted, looking not only at the digital proficiency of the teachers but also the levels of confidence to use digital tools in their pedagogical, methodological, evaluative and professional practices (Pedro et al., 2021).

Hundreds of learning technologies are available to teachers (Bower & Torrington, 2020), and video is one of them. In the follow-up of previous work (Ferreira et al., 2021), in which we identified and categorized a series of video abstracts in Ecology and Environmental Sciences, we discussed our science video with Biology and Geology teachers. Recurring to a set of interviews, we were driven by the question: How can a video abstract operate as an educational resource in the classroom? So, the main goals of this study are:

(1) Characterize student's and teachers' behaviours towards science videos;
(2) Evaluate the potential of a video abstract as a pedagogical tool in the classroom;
(3) Understand the key factors that, according to teachers, a video abstract should have to work as an educational video.

This work brings new insights into the universe of science videos and proposes new strategies and collaborations to the educational environment. It explores for the first time the features of a video abstract in a classroom context, leading to new possibilities between students and scientists.

6.2 Literature Review

An online science video is a quick tool that aims to deconstruct scientific topics while maintaining rigour and accuracy (García-Avilés & de Lara, 2018; Morcillo et al., 2016). It can have different producers, purposes and formats and bears a growing mix of genres (Erviti, 2018; Erviti & Stengler, 2016; García-Avilés & de Lara, 2018; Welbourne & Grant, 2016). Researchers have studied the educational value of videos for decades (Kohler & Dietrich, 2021). In a classroom, teachers can use two types of videos: (i) non-narrative videos like scientific videos, technical videos, and documentary videos, presented with the explicit intention of instructing, and (ii) fictional narrative videos, which have pedagogical potential, despite not having been built from scratch for that purpose (Moreira & Nejmeddine, 2015). From a didactic point of view, videos can be used in different ways and work as a source of information, motivation, and form of expression (Moreira & Nejmeddine, 2015).

Recent studies tried to understand what makes a compelling science educational video and establish practical guidelines. Almeida and Almeida (2021) created and evaluated natural science videos with teenagers and teachers. The authors concluded that teenagers appreciate, among others, these dimensions: the use of an onscreen host, a relaxed style of speech, the use of plain and straightforward language, short-length videos, the integration of different kinds of animations, the use of fast-paced editing and the integration of music or sounds effects (C. Almeida & Almeida, 2021). A large-scale study that applied a questionnaire to 5,000 participants of all ages also established a catalogue of 17 rules for a successful video. The authors emphasized that it is crucial to integrate experts on the video, specify sources, and use real-life footage or animations instead of showing only the presenter (Beautemps & Bresges, 2021). Style, format, and quality are essential parameters in an educational video (Castillo et al., 2021). Beyond successful educational videos, another kind of science video presents itself as a potential didactic resource: the video abstract. This film version of the written abstract of a scientific paper features the framework, the methods, the results, and the conclusions of the study (Berkowitz, 2013; Suzanne Spicer, 2017). The creators of these videos can be the researchers, the science communication units, the communication offices or specialized companies. These producers have at their disposal a vast group of tools (e.g. images, videos, animations, graphics, and music) that can be used in flexible and inventive ways (Plank et al., 2017). The video abstract shares some characteristics with other science videos as it simplifies scientific processes, expands the research scope and encourages scientific discourse. They can be more successful than written and graphical abstracts in understanding scientific topics (Bredbenner & Simon, 2019). Also, they can expand narratives to new audiences, platforms, and networks (Kippes, 2021). However, it is a unique tool because, as an academic peer-reviewed video, it ensures scientific rigour. In a world where misinformation and pseudoscience are real threats (Allgaier, 2019; Fontes, 2021; Rosenthal, 2020), a resource like a video abstract can provide students, parents, and educators with actual scientific knowledge. Despite its positive input in disseminating scientific papers among its peers and the general public (Plank et al., 2017; Zong et al., 2019), no work has assessed its potential in science communication beyond academia.

6.3 Methodology

We structured our research into two stages. The first stage included the pre-production, production, post-production, and dissemination of a video abstract. The second stage involved semi-structured interviews with six teachers and alums students of the *Master in Biology and Geology Teaching in the 3rd Cycle of Basic and Secondary Education* at a public University in Portugal to understand the possible uses of a video abstract in the classroom.

6.3.1 Video abstract production

We developed the video over five months. The first step was to choose a paper that had not been published then. So, we started to exchange ideas with different research groups and laboratories. The research from FLOWer Lab (Castro et al., 2021), a research group at the Centre for Functional Ecology (CFE) of the University of Coimbra focused on plant-pollinator interactions, met our goals. The team converted the written abstract into a movie script in the pre-production stage. During some meetings, the researchers and the authors of this paper produced several screenplay versions. This writing used the six-question formula (Chan, 2019) to translate the paper's structure better. Working as a team, we tried to answer the six questions from the researcher's perspective. The answers worked as the text used in the narration. We structured the information in a grid with questions, predicted length, text, key concepts, and shots needed. Once we fulfilled the criteria set out in the grid, we had our narration and footage to produce our movie.

Several moments of recording constituted our production work: (i) voice-over (narration) recording; (ii) two filming sessions, one in the kiwi orchard and the other in the laboratory; (iii) filming the kiwi orchard at two different periods in the year, one with the kiwi tree flowering and the other some months later with the kiwi tree in the fruiting season; and (iv) recording in the laboratory to replicate some moments of the methodology used in the research. There was a series of constraints on what we could film in this process. So we searched online stock video sites to complement the fieldwork footage. Also, we produce small animations to illustrate some concepts about pollination and kiwi orchards distribution.

With all the footage, narration, and music selected, we edited our video. This process led to several interactions with the team about the aspects that could be improved. Entitled "Pollination deficit in kiwifruit", a final version of the video was uploaded to the CFE YouTube channel (Ferreira, 2021) and on the webpage of Plants journal. We also promoted the video on social networks (Instagram, Facebook, Twitter) and personal and institutional profiles.

6.3.2 Interviews with Biology and Geology teachers

Our main goal was to talk with current students and alums students from the *Master in Biology and Geology Teaching in the 3rd Cycle of Basic and Secondary Education* from the University of Coimbra, where our research centre is hosted. Also, several researchers from our R&D unit coordinated and taught the course. The physical and scientific proximity to these professionals makes them the perfect subjects for our purposive sample (Palys, 2008). We obtained a list of thirty names and invited them via email to participate in the study. We made three different rounds of contact. Six ex-students expressed their interest and availability for the interview (Table 6). To fulfil all the ethical requirements, we produced a Consent Form approved by the host institution. This document provides all the participation information, the research details, the implications of being part of the study, the guarantees of confidentiality and anonymity, and all the specifics about posterior procedures with the collected data. Before the interviews, all six respondents received the document, accepted the terms and signed the Consent Form.

Table 6. Interviewee profile and occupation.

	Age	**Year of graduation**	**Occupation**	**Education**
Interviewee 1	28	2019	Teacher in a private school	Basic and Secondary
Interviewee 2	31	2014	Teacher in a private school	Secondary
Interviewee 3	39	2014	Research fellow	-
Interviewee 4	26	2019	Teacher in a public school	Basic
Interviewee 5	27	2017	Research fellow	-
Interviewee 6	27	2019	Teacher in a private school	Basic

We conducted the interviews by Zoom between September and October of 2021. During the interview, we asked twenty-five questions (Appendix G). After the ten initial questions, a pause was made to show the video abstract. Concluded the screening, we returned to the dialogue focusing the questions on the video and its possibilities as an educational tool.

We recorded and transcribed the interviews and subsequently completed a content analysis (Coutinho, 2018) using MAXQDA software. The responses were organized into different categories according to the theoretical referential, the interview structure, and other relevant information: (i) interviewee's motivations and current roles; (ii) course evaluation; (iii) behaviour with science videos; (iv) science videos in the classroom; (v) video abstract evaluation and (vi) video abstract as an education tool.

6.4 Results

We have organized the responses and categories into two dimensions of analysis. First, we presented science videos, their applicability, their potential in the classroom, and the student perspective and receptivity. Secondly, we deconstruct the feedback about the film, discussing the video abstract as a potential pedagogical tool for the future.

6.4.1 Science videos inside and outside the classroom

Some initial questions allowed us to understand our interviewees' backgrounds and motivations. All described the choice to attend the Master in Biology and Geology Teacher Training as a transformative process over the high school and University years. Some of the main reasons for their choice went back to their youth: it was a child's dream, or in other cases, the passion grew by the influence of other teachers in their adolescence. They highlighted the importance of having role models that inspired them to embark on the educational journey and have a part in the world as educators. Also, the ability to communicate and interact with others and the joy from partaking in the communication processes were crucial factors. In this big communication circle, some teachers highlighted the passion for educating the younger generations and the welfare provided by contact with the younger ones.

The course challenged them to do several presentations, debate with the class, and discover different pedagogical strategies and questions. The training also allowed them to think and explore several resources, such as texts, pedagogical activities, PowerPoint presentations, interactive games, and videos. The need to be scientifically sound in all the pedagogical contents was another achieved skill. An educational professional must be aware of the whole domain and be up to date about the school's subjects. They also said that it is crucial to constantly explore oneself and self-reflect on the right and wrong actions.

All the respondents usually search and watch science videos. What differs is the motivation. Half of them watch science videos on a personal level. Full-length documentaries or popular science videos from channels like *Veritasium* or *Smarter Every Day* allow them to think differently and deepen their knowledge about a scientific topic. Although the interviewed teachers separate personal and professional viewing of science videos, they admit that the two worlds overlap. Sometimes, they come in touch with helpful videos for a current topic or a future approach. The other half acknowledge that they only watch science videos for professional purposes. They search on video channels with the only goal of finding audio-visual content to use in the classroom. Among the examples shown to the students, they pointed *TedEducation* and *TedTalks* videos and animations to explain a concept or a complex process (e.g., enzymatic protein Rubisco photosynthesis or convection currents in the Earth). Videos about the History of Science (e.g., cellular theory), medium-length documentaries, videos from Virtual School (a resources platform created by a Portuguese publisher), and news videos to establish a connection between the educational contents and the current times (e.g., the volcano in La Palma Island to teach volcanism), were also mentioned. Regardless of the strategies and categories, all the teachers agreed on two points. The first one is not to show only videos in a lesson; being essential to merge them with other tools; as a spark to discuss or recap the topics presented, the video is always complemented with additional resources.

> So, I usually use videos to introduce a particular topic because videos give us the freedom to generate a discussion period. They are stimulating at the auditory and visual levels. It ends up catching attention right at the beginning of the topics. It is the starting point for a discussion in the classroom and, from there, a beginning to include more theoretical content. (Interviewee 5)

> If I only showed them videos, they would at some point say, "oh no, another video!". There is always a balance. Sometimes it is drawings; sometimes, it is videos; sometimes, it is schematics. And sometimes it is news. (Interviewee 4)

The second common point is that the video has to be short. Usually, the interviewees avoided showing full-length documentaries because it takes up the class's total time and does not allow for later discussion and comprehension. Also, if the video is too long, the students may lose the motivation to see it. Teachers pointed out that an ideal length is between 3 and 7 minutes, always depending on how the content is presented.

> I never like to post very long videos, i.e. a ten-minute video in a class is overkill in terms of length. Five is a bit. Even though it is a video, that surprise/novelty effect is lost. Three minutes is the ideal time, but it also depends. It can be a five minutes video or even a little longer. Still, maybe I will explore it in another way. I will go ahead, ask questions, go a bit further, and ask questions, so there are not eight minutes at a time of video-only exposure. (Interviewee 2)

These two factors impact students' interests. The student's receptivity is good when the teacher keeps the diversity, showing short videos between other class materials.

> But in general, they like it. It is a break, and if they have not understood some things I have said, they will understand it with the video. Or if they are students with special needs, I think the videos have more impact on them.
> (Interviewee 6)

Furthermore, we were interested in understanding if the students consumed science videos outside the school environment, i.e., in their homes, with their family and friends. There was no clear feedback on this. Some teachers said that it depended on the family's education and environment. Others pointed to the explanation videos to study a specific topic. Nevertheless, there was a consensus that they only saw the YouTube videos suggested by the teacher. Some students followed the teacher's recommendations of sites and channels and gave feedback in class. To the teachers, this is a positive response because most of the students cannot distinguish a rigorous science video from a non-rigorous one. So, the teacher also took an active role in choosing and showing accurate science videos.

> It depends on the student. Some students are motivated toward Science; they end up looking for these videos and even signalling these errors. Others do not have this motivation. Therefore, by seeing the videos, they will take everything for granted. (Interviewee 5)

> I would say that some videos are not very accurate. I do not know if there are many or few. […] sometimes, it also depends on what we want because something without rigour can be helpful. I have already picked up countless news items to discuss the scientific error within that information. Now it is dangerous if you are going to explore alone. And then I do not know. It depends on the age. Maybe students at the end of secondary school already have a little bit of this ability. Those in the second and third cycles will not have it. Most will not be able to perceive or critically analyze if that video seems scientifically correct. (Interviewee 6)

> They see the videos in front of them; they do not look much more. I am more concerned that they are able to identify the Science in the daily information that shows up to them. (Interviewee 4)

In summary, there is a global acceptance of short videos integrated into different formats. The variety of strategies seems to be the key.

6.4.2 From academia to the classroom

After watching the video, we confronted each teacher with a group of specific questions. Our goal was to have their feedback on some video features to understand how they would improve the video and use it in the classroom. One of the critical factors explored in the previous questions was the length of the science video. There is a consensus that this specific running time (of five minutes and twenty seconds) is within the upper limit. However, the difficulty of summarising so many aspects of the research in such a short time is recognized. Some teachers mentioned the need to have gap moments and replay the video several times to explore it with their students. It was pointed out its complexity and the need to analyze some of the presented topics. The eighth-grade curricula, specifically "Sustainability" and "Ecosystems" (*Aprendizagens Essenciais - 2. º e 3. º Ciclos Do Ensino Básico | Ciências Naturais*, 2018), seemed to be the perfect fit for this presentation.

> We could use this video in a classroom because it has an ideal length for attracting students' attention. There is the topic of dioecious species; they have difficulty understanding what is

> monoecious and dioecious, so it was spectacular to introduce this topic in this exciting way. […] Therefore, I would use it over several academic years and in different ways. (Interviewee 5)

> If this were a video I presented in the classroom, I would pause it. But it would not be a video to introduce to younger ages either […] it is a video for a slightly more advanced target audience. It would make sense to follow up with a worksheet and ask questions. This specific video could also include the question of science on the making and what is an expected job in the laboratory […]. The application of this video would be very versatile. (Interviewee 2)

The versatility pointed out in the previous testimony led us to another characteristic of our video: the presence onscreen of the leading researchers. According to our interviewees, the students need to see the researchers explaining their work to give them the idea that they are all normal people. To have a sense of proximity and look at the researcher as ordinary persons who think about Science the same way they are stimulated to think. The idea that they could be the ones in that laboratory creates a bond, complemented by face-to-face visits of the researcher to the classroom. Sometimes, these researchers are friends of the teacher from their University days.

> I think it is good. I think the video with real people working, people who work on the project, is good. If only to remind you that someone does this work […] real people with faces and hair, beautiful, ugly, fat and thin, ordinary people like everyone else. Science is done by people. (Interviewee 4)

> A researcher is an ordinary person who thinks about Science in the same way that students are encouraged to think. It makes perfect sense. (Interviewee 2)

The onscreen presence of researchers leads us to discuss the students' misconceptions about scientists. Most respondents state that students still have that disconnected image of a scientist associated with popular culture references (e.g. science fiction movies, CSI series). Students still associate the idea of someone older, with a white coat and funny hair, in the laboratory. Their world is still far from day-to-day life in science research centres and institutions. Students do not know how and by whom Science is produced. So, the teacher has the essential role of deconstructing these concepts to show them that researchers are ordinary people like them and that a science career is a possibility for their future. That Science is accessible and universal.

> There is the idea that Science is not for everyone. And the goal is to be for everyone […], so we are not all going to work for the same, nor do the same thing, but there is room for everyone. That is my opinion, and the students still think it is not for everyone. (Interviewee 5)

One of the paper's authors was also the narrator of the film. We discussed this choice, asking how it works as an alternative to the professional narration. There is an agreement that this choice offers a sense of proximity besides spotting the difference between an amateur and a professional narration (e.g., accent). The language chosen by the narrator was also a point of debate. As one of our goals is to disseminate the scientific paper among peers, we use English as our primary language. So it was essential to understand if this is suitable in a scholarly context or if, on the contrary, we should have chosen to speak in Portuguese with English subtitles. On the one hand, it can be important to show these contents in English to older students (Secondary level) because it is a way to improve their skills in this language and understand that this is the most worldwide spoken language in Science. On the other hand, if our target is a younger group or students with special needs, a video in Portuguese is always a better choice.

Looking at the chosen formats, we can say that this video is a grand mixture: it has a documentary style intercalated with animations and interviews. Most of the teachers agreed that combining these elements is the best choice. However, they see animation as the most appealing format, especially for the younger generations. Also, animations and graphics are a better way to explain the concepts.

To wrap up the video features, we asked what they would change in the film. The main suggestion was to add some animations, titles, numbers, or schematics to some moments, specifically those with complex ideas. Adding more visual elements to represent what was said could help students assimilate the video's message better.

To close the circle, we asked if a video abstract could be a way to create communication paths between Secondary Schools and Universities.

> It is a missing link. […] I remember from my student years something that was missing. The professors at the University complain a lot about this. The kids are poorly prepared in manipulation, practice, scientific reasoning, etc. […] However, I think videos like this can bridge the gap very smoothly, and I think they are suitable for kids. (Interviewee 2)

> Yes, I think so. I guess it turns out to be an informal way of bringing people into what they believe is very formal. Therefore, I think it simplifies the question of Science and reaches the younger public who do not yet have the necessary maturity to read, for example, a scientific article. (Interviewee 5)

> Suppose I was teaching in the 11th grade. In that case, I could discuss the nature of scientific knowledge and the scientific method […] in the different steps needed to develop new scientific knowledge. And that, in this video, is also very well explained. (Interviewee 4)

As shown in the last testimonies, the general feedback is that the video abstract can be a new and more effective way of connecting high school students to academia. It can be a gateway to scientific research and scientific careers. However, how can we create these bonds between the different intervenients? The first suggestion from the interviewees would be to promote regular workshops and training sessions to equip the teachers with digital tools and digital literacy and deepen their knowledge of specific topics. In this case, our communication office could schedule annual workshops about pollination, ecological networks, and other topics presented in the school guides. As science communicators, we would act as an intermediate between the school and the University. These videos can be shown during that training sessions and promoted as a helpful tool.

The other idea is to work closely with scholar publishers. If a video abstract could be present in a digital school manual, it would easily be known by the scholar community. Sharing these videos and establishing a partnership with the publishers enable us to reach a more significant number of teachers. Also, governmental platforms like Virtual School are excellent places to present video abstracts. In conclusion, the first step would be to develop agreements with existing organizations instead of creating a new site for these contents.

> We do not have time, however much we want, to do things from scratch. Therefore […] the publishers save our lives many times in many circumstances when they provide us with ready-to-use material. I am sure that if they give these materials through training, these resources as teaching resources, the teachers will use them.
> (Interviewee 6)

6.5 Discussion

With this set of dialogues, it was unanimous that this pandemic impacted most of the work in the classroom, especially in a curricular unit such as Biology and Geology, with an enormous practical component. The teachers found it more challenging to scientifically present the topics if they were not interacting directly with the students, seeing their faces and perceiving their feedback. The computer screen appeared as a communication barrier to the classroom reality and other processes with other education actors (e.g., meetings with peers and parents). Despite being widely recognized that one cannot replace face-to-face learning, such an agitated period also resulted in new opportunities and partnerships. Looking at that positive perspective and focusing on the future of video abstracts, four key ideas emerged:

(i) Science videos should be part of a broader educational strategy in the classroom. The use of different approaches and other resources in the classroom, like images or texts, should be encouraged. When the teacher presents a variety of content throughout the class, the student's receptivity increases; therefore, as a pedagogical resource, the video should always be aligned with educational goals and curricula and integrated into a plan (Moreira & Nejmeddine, 2015). Also, the journey to produce a video abstract can be explored as a learning process. With the six-question formula (Table 2), the students could deconstruct and rethink scientific topics, putting themselves in the shoes of filmmakers and researchers.

Table 7. Six-questions formula (adapted from Chan,2019)

Question	Time (seconds)	Text	Key Concepts	Shots
What is the problem?				
Why is it a problem?				
What are you doing to solve the problem?				
What have you found out?				
What is the impact of the research?				
What is the next step in the research?				

(i) A video abstract should be short, with different styles and languages. The length of the video is significant in a class context. Shorter videos are preferred when compared to longer ones. Previous work settled that online science videos should be brief (García-Avilés & de Lara, 2018; Slemmons et al., 2018). However, all of our respondents agreed that a five-minute video presentation has the potential to explore different approaches. One idea from this study was adding title segments to the video to ease its didactic application. Adding titles with the six questions or main topics can help to structure the lesson and improve students' attention. The use of a format with various styles is a winning choice for this kind of content, but animation and schemes were also referred to as preferable formats and should be used the most possible. Visual representation is always an advantage (Brennan, 2021) if the video comprises several different and complex concepts. For the last and broader use of the video (between all years and ages), two versions should be prepared: one in English with Portuguese subtitles (for the older students at Secondary levels) and a Portuguese version with English subtitles (for the younger students). This ambivalence ensures video comprehension, independent of the student's age and language skills.

(ii) Like other science videos with the presence of researchers (Chen & Cowie, 2014; Krebs et al., 2020; Wyss, 2013), video abstracts align with science education goals as it inspires children and teenagers to pursue scientific careers (Hazelkorn et al., 2015). Although the student's age and background may influence it, the teachers from our sample agree that most students have a conceptualization of what a researcher does and looks like that is still far from reality. This kind of video allows the teacher to deconstruct these preconceptions, showing their students that researchers are ordinary people and that Science is reachable. So, it is essential to give a pivotal role to the researcher in the video, either through narration or interviews.

(iii) Video abstracts can work as a link between academia and high school. Projects and collaborations between primary/secondary schools and universities are decisive in approaching students to sciences (Fiolhais, 2016). The teachers presented two different calls to action to disseminate this content better. Firstly, they pointed out the publishers as essential vehicles to achieve this goal. Future strategies can englobe partnerships between the science centres or universities and the school publishers to include this content in their books and online platforms. It is a win-win situation as the teacher has a set of rigorous scientific videos available for use in class, and the researchers/institutions see their work disseminated among the youngsters. The second piece of advice was to create training sessions about these scientific areas and these scientific tools. As science communicators and researchers, we suggest that these training sessions should be planned as part of a global plan. The research centres, the universities, the science journals and other actors should work in unison with a concerted strategy to promote this type of content.

6.5 Conclusions

This paper presents the first known interaction between video abstract production and primary and secondary teaching. One of the things we felt when conducting the interviews was that this kind of dialogue was critical. These works should always be accessible to teachers since they are the source of new ideas and educational inputs. As frontline agents, they can be valuable partners in producing scientific content. From their point of view, a video abstract like this one has the potential to be used alongside other resources. A short video using different formats, showing the actual researchers and offering different language options seems to be the best formula for connecting students to academic research.

This work is another step towards a more comprehensive and collaborative science communication. For the future, it is necessary to take advantage of these new channels, moving forward with training, dissemination strategies, and evaluation moments, transforming video abstracts into an increasingly transversal resource.

6.6 Implications

Our paper introduces video abstracts to a new audience: the teachers. As an educational and national publication, readers from around the country will be presented with this new scientific tool and its potential. Teachers will be able to spread the word among their colleagues and explore video abstracts already published online, not only in Ecology and Environmental Sciences and Portuguese institutions but in other fields of science and worldwide. With this positive feedback from our sample, teachers could use this resource in their classes and reach the students and their families. Children, parents and educators could explore scientific and media literacies using video abstracts as a new guided route.

Furthermore, it represents an opportunity for the universities and institutes to tighten their bonds with schools, promoting their research and interest in Science. Beyond talks, science fairs and school visits, this paper has shown that video abstracts are an accessible and practical way to communicate and explore science. As a hybrid tool, it can be explored in different contexts, exploring the dynamics of media participation and collaboration among students. This line of work could also unlock investment in communication offices and other institutions devoted to science communication.

Lastly, with a concrete example of the production and reception of a video abstract, we contribute to those interested in creating this kind of content. Journalists, science communicators, researchers and teachers have here some valuable lessons and tips on best practices for producing a science video with educational goals.

7. General Conclusions

The history of scientific cinema is full of transformations with different purposes and stakeholders. The definition itself changed over the decades. Films initially made from one researcher to another embraced educational and science communication paradigms. Over the decades, movies produced in the laboratories have gained visibility among students and new audiences, finding new purposes. The roles of media and TV producers slowly replaced the cine scientists responsible for producing their own movies. Video abstracts shape themselves on these roots: a video about the science being produced in the laboratories and the field, with the primary goal of dissemination among peers but with the potential to explore new audiences and be used as an educational asset in the classroom.

This Thesis explores the universe of video abstracts in Ecology and Environmental Sciences for the first time, having as outputs not only five scientific publications but also two video abstracts available to researchers, educators, teachers and other stakeholders to use. The international panorama of this kind of video was explored through different stages and methodologies. Also, science communicators, researchers, audiovisual professionals, teachers and students had an active voice in the reception and evaluation of these videos. The analysis implemented allowed the creation of a best practice guide for producing an effective video abstract in these scientific areas. Based on the results and field experience, two tools to support the video abstract production were presented. The first is the chapter and article "Video Abstract Production Guide" (Ferreira, Lopes, et al., 2023), which presents a step-by-step testimony on video abstract production. Taking as an example one of the video abstracts produced (Ferreira, 2021), this field guide goes through all the stages of video abstract production – selecting the paper, writing the script, filming, editing and promoting the movie – and it can be used as a compass to all the people starting to explore this field.

Secondly, the diagram presented in Figure 16, which results from the main steps of our work – categorization, reception and interviews – represents the key ideas about what a video abstract in Ecology and Environmental Sciences should take into consideration:

1. Have authentic images that can tell the story by themselves, animations to explain more complex or abstract ideas, a narration, the presence of the researchers and good audio;
2. Be short, clear, objective, creative, dynamic and informative;
3. Produce an output for research centres and institutes and also an asset for the classroom;
4. Work as a collaborative process between different stakeholders.

This resume can be used as a checklist when preparing and producing a video abstract.

Complementing these two assets and reflecting on the previous conclusions, further guidelines and approaches for future research can be given. With these results, despite video abstracts having a word to say in science dissemination and science education, there is a long way to effectively take advantage of their full potential. Video abstracts are a complement to the written abstract and not a replacement. Recognizing this could lower some barriers and help create the needed harmony between old and new paradigms. From this work perspective, it will be crucial to:

- Create funding programs for video abstract production, implementation and recognition. Specific budgets in the universities and research centres for video abstract production will increase the volume of audiovisual content and introduce these tools to the researchers. It is vital that scientists are aware of the existence of video abstracts and that they can think of them as part of their daily scientific strategy. This institutional legitimization and conscience of the advantages of video abstracts can lead to new opportunities in research. Video abstracts could start to be considered alongside the articles in projects and grant applications as an output or asset. Also, media projects dedicated exclusively to the dynamics of video abstracts are needed.
- Explore new topics and new formats. On the verge of these new research opportunities, new fields and formats are available to explore. On the one hand, producing video abstracts in areas where this kind of content is not so common (e.g. social sciences) will be fruitful. Going beyond natural sciences could show us new and inventive ways of telling our stories. Understanding the needs, the specificities, and the potential of each field of study could be necessary to know where we should use these kinds of resources. These new topics could lead us to new formats and new narratives. Also, it is important to adjust our content to the viewers' devices of use. The creators of video abstracts must consider that much of the video content is consumed on mobile devices in the movement of day to day. It will be essential to adapt the image ratio, the language, and the duration, among other factors, to these viewing habits and devices. It is essential to study who sees the video, where, how and with what purpose.
- Create strategic measures of dissemination for the target audience. One of the realities that became clear with this work is that, usually, the producers have no preliminary strategy. Videos are often produced without defined goals and are left abandoned in the digital world. This lack of focus, on the one hand, disperses the audiences and, on the other, makes any impact assessment work difficult, as the metrics will be scattered across different platforms or channels. Defining the target group and setting goals and indicators are essential to

improve the impact of our asset. One idea is not to produce single videos but, instead, to create series and anthologies of videos and narratives with a continuum of storytelling and content. This periodicity and content volume could ease the creation of communities and audience engagement. On the other hand, as mentioned before, it will give more objects of study for research. Creating a well-defined science communication strategy for the video, from the script to the impact assessment, is fundamental to reaching the desired goals.

- Bring new stakeholders to the equation. Besides all the networks of researchers, science communicators, journalists, designers, and multimedia producers described earlier, exploring new partnerships in video abstract production will be fruitful. For example, science YouTubers with an established public and audience can be powerful allies in disseminating this content. Without neglecting the accuracy of information, understanding how these actors could maximize and communicate information entertainingly can provide essential clues to reach new audiences. Also, it can improve the exploration of new formats, like lists and tops (e.g., top 5 groundbreaking papers of the year).

- Create a collaborative educational strategy and consider participatory workshops with the students. The proposed collaborative process will naturally create moments of training and capacitating between all the intervenients. Researchers will learn new filming techniques, and media producers will learn more about how a scientist does his/her science. In addition, by working closely with the teachers, we can promote video abstracts in school through participatory workshops. Instead of just presenting the videos in the classroom, we can transform the students into directors (giving them the necessary tools) and explore their points of view in a video abstract universe. This will allow us to gain new perspectives and ideas about these younger audiences.

- Create new metrics for impact evaluation. In the future, other popularity and reach metrics must be worked on and available to everyone. Focusing only on numbers to measure the effectiveness of our communication can be reductive. In the specific case of science videos and video abstracts, it would be important to have resources to explore in-depth metrics such as retention time that not only tell us the average time watched but also allow us to explore throughout the video which moments have more and fewer views. A bookmarked view in the video log does not mean that person saw the entire movie. When we set up a reception study like ours and ask a panel to watch the videos, we know in advance with a high degree of certainty that these people have seen the entire video, but the same does not happen with the audience that we cannot control and that we want to reach. Compared with the retained audience, content studies for the various moments of the videos are essential to try to understand and discover attention-grabbing elements. We can also think of strategies and formats that build viewer loyalty and encourage them to watch the entire video, such as creating lists (as mentioned above).

- Create new algorithm factors. YouTube's algorithm determines which videos are or are not suggested based on viewing time, number of views, and other metrics. Based on the important principle that a video is useless if nobody sees it, it is also crucial that new metrics are considered. It is not enough for videos to seek the rules of the algorithm. The opposite can and should be promised in order to deal with the sea of misinformation and excessive content. Videos with the institutional stamp of universities could be highlighted if priority is given to rigour, quality, theme relevance, and presence of researchers and if the same criteria are present when evaluation surveys are carried out after each video.

Despite being aimed explicitly at video abstracts, these efforts could be important keys to establishing and reinforcing Science Communication in academia (Entradas, 2022). The above recommendations could be read on a broader scale and as a global strategy for the field. As these assets should be present in every scientific endeavour, from the beginning to the end, Science Communication should also be included in the researchers' academic duties and career profiles (Kuppers et al., 2022). Also, it could have a word to say on the issues of the professionalisation of Science Communication. Universities should support specialists in the field in order to promote training sessions for researchers, encourage them to reach out to the public, and communicate side by side with them (Trench, 2017). Video abstracts could promote collaborative actions embracing science communication as a network field of adaptative practitioners and researchers operating in the space between science, technology and society (Wehrmann & van de Sanden, 2017).

References

2017 Journal Impact Factor. (2018). In *Journal Citation Reports*. Clarivate Analytics.

Adobe. (2022a). *Adobe After Effects* (22.5). [Computer Software]. https://www.adobe.com/pt/products/aftereffects.html

Adobe. (2022b). *Adobe Illustrator* (26.4.1). [Computer Software]. https://www.adobe.com/pt/products/illustrator.html

Adobe. (2022c). *Adobe Premiere Pro* (22.5). [Computer Software]. https://www.adobe.com/pt/products/premiere.html

Allgaier, J. (2019). Science and Environmental Communication on YouTube: Strategically Distorted Communications in Online Videos on Climate Change and Climate Engineering. *Frontiers in Communication*, *4*(July), 1–15. https://doi.org/10.3389/fcomm.2019.00036

Allgaier, J., & Landrum, A. R. (Eds.). (2022). *New Directions in Science and Environmental Communication: Understanding the Role of Online Video-Sharing and Online Video-Sharing Platforms for Science and Research Communication*. Frontiers Media SA. https://doi.org/doi.org/10.3389/978-2-88974-364-3

Almeida, C., & Almeida, P. (2021). From the Living Room to the Classroom and Back – Production Guidelines for Science Videos. *Applications and Usability of Interactive TV: 9th Iberoamerican Conference*, 77–88.

Altmetric Limited. (2012). *Altmetric: Discover the attention surrounding your research*. https://www.altmetric.com/

Amado, J. (2000). A Técnica da Análise de Conteúdo. *Revista Referência*, *5*, 53–63.

Angelone, S. (2019). A New Generation of Scientists-as-Filmmakers: Experiences Gained in Switzerland. *Science Communication*, *41*(3), 369–377. https://doi.org/10.1177/1075547019837620

Angelone, S., Soriguer, R. C., & Melendo, A. (2019). Filmmaking courses for scientists help promote richer alternatives to chronological narratives. *Studies in Higher Education*, *45*(9), 2001–2010. https://doi.org/10.1080/03075079.2019.1604651

Apple. (2022). *iMovie*. [Computer Software].

Aprendizagens Essenciais - 2.º e 3.º Ciclos do Ensino Básico | Ciências Naturais (Issue 3).

(2018).

Audacity Team. (2021). *Audacity* (2.4.2). [Computer Software]. https://www.audacityteam.org/

Baram-Tsabari, A., & Osborne, J. (2015). Bridging science education and science communication research. *Journal of Research in Science Teaching*, *52*(2), 135–144. https://doi.org/10.1002/tea.21202

Bates, D., Mächler, M., Bolker, B. M., & Walker, S. C. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, *67*(1). https://doi.org/10.18637/jss.v067.i01

Bauer, M. W., & Howard, S. (2014). *Modern Portugal and its Science Culture – Regional and Generational Comparisons* (Issue June).

Beautemps, J., & Bresges, A. (2021). What Comprises a Successful Educational Science YouTube Video? A Five-Thousand User Survey on Viewing Behaviors and Self-Perceived Importance of Various Variables Controlled by Content Creators. *Frontiers in Communication*, *5*(April), 1–14. https://doi.org/10.3389/fcomm.2020.600595

Bell, S. (2020). Social Media for Ecologists: YouTube. In *Social Media for Ecologists - Improving your impact and engagement across platforms*. British Ecological Society.

Bellows, A. M., Mcdougall, M., & Berg, B. (Eds.). (2000). *Science is Fiction*. Brico Press.

Bentley, P., & Kyvik, S. (2011). Academic staff and public communication: A survey of popular science publishing across 13 countries. *Public Understanding of Science*, *20*(1), 48–63. https://doi.org/10.1177/0963662510384461

Berkowitz, J. (2013). *Video abstracts, the latest trend in scientific publishing*. https://www.universityaffairs.ca/features/feature-article/video-abstracts-the-latest-trend-in-scientific-publishing/

Blackmagic Design. (2022). *DaVinci Resolve*. [Computer Software]. https://www.blackmagicdesign.com/pt/products/davinciresolve

Boehnert, J. (2015). Ecological Literacy in Design Education - A Theoretical Introduction. *FormAkademisk - Forskningstidsskrift for Design Og Designdidaktikk*, *8*(1), 1–11. https://doi.org/10.7577/formakademisk.1405

Bolker, B. M., Brooks, M. E., Clark, C. J., Geange, S. W., Poulsen, J. R., Stevens, M. H. H., & White, J. S. S. (2009). Generalized linear mixed models: a practical guide for ecology and evolution. *Trends in Ecology and Evolution*, *24*(3), 127–135. https://doi.org/10.1016/j.tree.2008.10.008

Bonifácio, V., Malaquias, I., & Fernandes, J. (2013). Francisco Miranda da Costa Lobo na vanguarda do cinema astronómico internacional. In C. Fiolhais, C. Simões, & D. Martins (Eds.), *História da ciência luso-brasileira: Coimbra entre Portugal e o Brasil* (pp. 267–277). Imprensa da Universidade de Coimbra/Coimbra University Press.

Bonnevie, T., Repel, A., Edouard, F., & Ladner, J. (2023). Video abstracts are associated with an increase in research reports citations , views and social attention : a cross - sectional study. *Scientometrics*, *0123456789*. https://doi.org/10.1007/s11192-023-04675-9

Boon, T., & Gouyon, J. B. (2014). The origins and practice of science on British television. In M. Conboy & J. Steel (Eds.), *The Routledge Companion to British Media History*. Taylor & Francis.

Bordwell, D., & Thompson, K. (2013). *Film Art: An Introduction* (10th ed.). McGraw-Hill Education.

Borghol, Y., Ardon, S., Carlsson, N., Eager, D., & Mahanti, A. (2012). The untold story of the clones: Content-agnostic factors that impact YouTube video popularity. *Proceedings of the ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*, *January 2014*, 1186–1194. https://doi.org/10.1145/2339530.2339717

Bower, M., & Torrington, J. (2020). Typology of free Web-based learning technologies. *Educause*, *April*, 15. https://doi.org/10.13140/RG.2.2.11064.16647

Boy, B., Bucher, H.-J., & Christ, K. (2020). Audiovisual Science Communication on TV and YouTube. How Recipients Understand and Evaluate Science Videos. *Frontiers in Communication*, *5*(December), 1–18. https://doi.org/10.3389/fcomm.2020.608620

Bredbenner, K., & Simon, S. M. (2019). Video abstracts and plain language summaries are more effective than graphical abstracts and published abstracts. *PLoS ONE*, *14*(11), 1–19. https://doi.org/10.1371/journal.pone.0224697

Brennan, E. B. (2021). Why Should Scientists be on YouTube? It’s all about Bamboo, Oil and Ice Cream. *Frontiers in Communication*, *6*(April), 1–13. https://doi.org/10.3389/fcomm.2021.586297

Brossard, D. (2013). New media landscapes and the science information consumer. *Proceedings of the National Academy of Sciences of the United States of America*, *110*(SUPPL. 3), 14096–14101. https://doi.org/10.1073/pnas.1212744110

Bruns, A., & Schmidt, J. H. (2011). Produsage: A closer look at continuing developments. *New Review of Hypermedia and Multimedia*, *17*(1), 3–7. https://doi.org/10.1080/13614568.2011.563626

Bucchi, M. (2017). Credibility, expertise and the challenges of science communication 2.0. *Public Understanding of Science*, *26*(8), 890–893. https://doi.org/10.1177/0963662517733368

Bucchi, M., & Saracino, B. (2016). “Visual Science Literacy”: Images and Public Understanding of Science in the Digital Age. *Science Communication*, *38*(6), 812–819. https://doi.org/10.1177/1075547016677833

Bucchi, M., & Trench, B. (2021). Introduction: Science communication as the social conversation around science. In *Routledge Handbook of Public Communication of Science and Technology* (pp. 1–13). Routledge.

Burns, T. W., O’Connor, D. J., & Stocklmayer, S. M. (2003). Science communication: A contemporary definition. *Public Understanding of Science*, *12*(2), 183–202. https://doi.org/10.1177/09636625030122004

Burrows, S., Olive, R., O’Brien, S., & Galloway, T. (2022). Connection is key when there’s no planet B: The need to innovate environmental science communication with transdisciplinary approaches. *Science of the Total Environment*, *853*(June), 158435. https://doi.org/10.1016/j.scitotenv.2022.158435

Canva. (2022). *Pexels*. https://www.pexels.com/

Cardoso, G., & Baldi, V. (2020). *Anuário de Comunicação 2019*.

Carvalho, A. A. A. (2020). *Aplicações para dispositivos móveis e estratégias inovadoras na educação* (D.-G. da Educação (Ed.)).

Cast&Crew. (2022). *Final Draft*. [Computer Software]. https://www.finaldraft.com/

Castillo, S., Calvitti, K., Shoup, J., Rice, M., Lubbock, H., & Oliver, K. H. (2021). Production processes for creating educational videos. *CBE Life Sciences Education*, *20*(2), 1–12. https://doi.org/10.1187/cbe.20-06-0120

Castro, H., Siopa, C., Casais, V., Castro, M., Loureiro, J., Gaspar, H., Dias, M. C., & Castro, S. (2021). Spatiotemporal Variation in Pollination Deficits in an Insect-Pollinated Dioecious Crop. *Plants*, *10*(7). https://doi.org/10.3390/plants10071273

Celtx Inc. (2022). *Celtx*. [Computer Software]. https://www.celtx.com/index.html

Chan, G. (2019). *Low Cost Film Making*. Film Course presented at Science Retreats.

Chen, J., & Cowie, B. (2014). Scientists Talking To Students Through Videos. *International Journal of Science and Mathematics Education*, *12*(2), 445–465.

https://doi.org/10.1007/s10763-013-9415-y

Cisco. (2017). *Cisco Annual Internet Report (2017–2022) White Paper*.

Coutinho, C. P. (2018). *Metodologia de Investigação em Ciências Sociais e Humanas: teoria e prática* (2ª Edição). Almedina.

Cresswell, T., & Ott, J. (2022). Muybridge and Mobility. In *Muybridge and Mobility* (Vol. 6). University of California Press.

Cunha, P. M. F. (2003). *Ao Serviço da Ciência: Estudo sobre o Filme Científico Português*. Universidade de Coimbra.

Davis, Lloyd S., León, B., Bourk, M. J., & Finkler, W. (2020). Transformation of the media landscape: Infotainment versus expository narrations for communicating science in online videos. *Public Understanding of Science*, *29*(7), 688–701. https://doi.org/10.1177/0963662520945136

Davis, Lloyd Spencer, & Léon, B. (2018). New and Old Narratives: Changing Narratives of Science Documentary in the Digital Environment. In *Communicating Science and Technology Through Online Video: Researching a New Media Phenomenon* (pp. 55–62).

de Almeida, J. (2022). Notes on Scientific Cinema: Arlindo Machado. *Revista de Estudos Brasileiros*, *49*(57), 1–19. https://doi.org/https://doi.org/10.11606/issn.2316-7114.sig.2022.189813

de Almeida, J., da Silva, C. I., Suppia, A., & Stalbaum, B. (2017). Passages on Brazilian scientific cinema. *Public Understanding of Science*, *26*(5), 579–595. https://doi.org/10.1177/0963662516683638

de Ceglia, F. P. (2012). From the laboratory to the factory, by way of the countryside: Fifty years of Italian scientific cinema (1908-1958). *Public Understanding of Science*, *21*(8), 949–967. https://doi.org/10.1177/0963662511412142

Debove, S., Füchslin, T., Louis, T., & Masselot, P. (2021). French Science Communication on YouTube: A Survey of Individual and Institutional Communicators and Their Channel Characteristics. *Frontiers in Communication*, *6*(April), 1–15. https://doi.org/10.3389/fcomm.2021.612667

Díaz, S., Settele, J., Brondízio, E., Ngo, H. T., Guèze, M., Agard, J., Arneth, A., Balvanera, P., Brauman, K., Butchart, S., Chan, K., Garibaldi, L. A., Ichii, K., Liu, J., Subramanian, S. M., Midgley, G. F., Miloslavich, P., Molnár, Z., Obura, D., … Zayas, C. (2019). *IPBES (2019): Summary for policymakers of the global assessment report on biodiversity and* *ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. https://doi.org/10.1111/padr.12283

Dierks, P. O., Höffler, T. N., Blankenburg, J. S., Peters, H., & Parchmann, I. (2016). Interest in science: a RIASEC-based analysis of students' interests. *International Journal of Science Education*, *38*(2), 238–258. https://doi.org/10.1080/09500693.2016.1138337

Dirzo, R., Ceballos, G., & Ehrlich, P. R. (2022). Circling the drain: the extinction crisis and the future of humanity. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *377*(1857). https://doi.org/10.1098/rstb.2021.0378

Donhauser, D., & Beck, C. (2020). Pushing the Max Planck YouTube Channel with the Help of Influencers. *Frontiers in Communication*, *5*(January), 1–8. https://doi.org/10.3389/fcomm.2020.601168

Dubovi, I., & Tabak, I. (2021). Interactions between emotional and cognitive engagement with science on YouTube. *Public Understanding of Science*. https://doi.org/10.1177/0963662521990848

Eezy Inc. (2022). *Videezy*. https://pt.videezy.com/

Elena, A. (1996). Pela Arte e Ciência - O Nascimento do Cinema Cientifico. *Revista de Comunicação e Linguagem*, *23*, 159–162.

Entradas, M. (2022). Public communication at research universities: Moving towards (de)centralised communication of science? *Public Understanding of Science*, *31*(5), 634–647. https://doi.org/10.1177/09636625211058309

Erviti, M. C. (2018). Producing Science Online Video. In B. Léon & M. Bourk (Eds.), *Communicating Science and Technology Through Online Video: Researching a New Media Phenomenon* (pp. 28–40). Routledge.

Erviti, M. C., & Stengler, E. (2016). Online science videos: An exploratory study with major professional content providers in the United Kingdom. *JCOM*, *15*(6), 1–29. https://doi.org/https://doi.org/10.22323/2.15060206

Espanha, R., & Lapa, T. (2019). *Literacia dos Novos Media*. Mundos Sociais.

European Comission. (2020). *EU Biodiversity Strategy for 2030*. https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en#documents

Eurostat. (2021). *Key figures on Europe 2021 edition* (L. Corselli-Nordblad & H. Strandell (Eds.)).

Ferguson, S. L., & Lezotte, S. M. (2020). Exploring the state of science stereotypes: Systematic review and meta-analysis of the Draw-A-Scientist Checklist. *School Science and Mathematics*, *120*(1), 55–65. https://doi.org/10.1111/ssm.12382

Ferreira, M. (2021). *Pollination deficit in kiwifruit.* https://youtu.be/6LcGI_Eu7Ro

Ferreira, M., Granado, A., Lopes, B., & Loureiro, J. (2023). New strategies in Science Education? The use of video abstracts in Ecology and Environmental Sciences in the classroom. *Revista APEduC-Investigação e Práticas Em Educação Em Ciências, Matemática e Tecnologia*, *4*(1), 13–26. https://doi.org/https://doi.org/10.58152/APEduCJournal.316

Ferreira, M., Lopes, B., Granado, A., Freitas, H., & Loureiro, J. (2021). Audio-Visual Tools in Science Communication: The Video Abstract in Ecology and Environmental Sciences. *Frontiers in Communication*, *6*. https://doi.org/10.3389/fcomm.2021.596248

Ferreira, M., Lopes, B., Granado, A., Siopa, C., Gaspar, H., Castro, H., Castro, S., & Loureiro, J. (2023). Video Abstract Production Guide. *Frontiers in Communication*. https://doi.org/10.3389/fcomm.2023.1060567

Figueiredo, F., Almeida, J. M., Benevenuto, F., & Gummadi, K. P. (2014). Does Content Determine Information Popularity in Social Media? A Case Study of YouTube Videos' Content and their Popularity. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 979–982. https://doi.org/10.1145/2556288.2557285

Finkler, W., Higham, J. E. S., León, B., Aitken, R. E., Finkler, W., Higham, J. E. S., León, B., & Aitken, R. E. (2019). Bridging the void : science communication videos for sustainable whale watching. *International Journal of Science Education, Part B*, *0*(0), 1–15. https://doi.org/10.1080/21548455.2019.1671636

Finkler, W., & León, B. (2019). The power of storytelling and video: a visual rhetoric for science communication. *JCOM*, *18*(05), 1–23. https://doi.org/10.22323/2.18050202

Fiolhais, C. (2016). *A ciência em Portugal*. Fundação Francisco Manuel dos Santos.

Fontes, D. T. M. (2021). Uma comparação das visualizações e inscrições em canais brasileiros de divulgação científica e de pseudociência no YouTube. *JCOM América Latina*, *04*(01), 1–22. https://doi.org/10.22323/3.04010201

Fox, J., Weisberg, S., Adler, D., Bates, D., Baud-Bovy, G., & Ellison, S. (2012). *Package "car."* R Foundation for Statistical Computing.

Frances, M., & Peris, À. (2018). Rigour in Online Science Videos. In B. Léon & M. Bourk

(Eds.), *Communicating Science and Technology Through Online Video: Researching a New Media Phenomenon* (pp. 64–75).

FXhome. (2022). *HitFilm Express*. [Computer Software]. https://fxhome.com/product/hitfilm

Galliers, R. D., & Huang, J. C. (2012). The teaching of qualitative research methods in information systems: An explorative study utilizing learning theory. *European Journal of Information Systems*, *21*(2), 119–134. https://doi.org/10.1057/ejis.2011.44

García-Avilés, J. A., & de Lara, A. (2018). An Overview of Science Online Video. In B. Léon & M. Bourk (Eds.), *Communicating Science and Technology Through Online Video: Researching a New Media Phenomenon* (pp. 15–26).

Gaycken, O. (2011). "The swarming of life": Moving images, education, and views through the microscope. *Science in Context*, *24*(3), 361–380. https://doi.org/10.1017/S0269889711000159

Gaycken, O. (2012). The secret life of plants: Visualizing vegetative movement, 1880-1903. *Early Popular Visual Culture*, *10*(1), 51–69. https://doi.org/10.1080/17460654.2012.637392

Gouyon, J. B. (2016). Science and film-making. *Public Understanding of Science*, *25*(1), 17–30. https://doi.org/10.1177/0963662515593841

Granado, A., & Malheiros, J. V. (2015). *Cultura científica em Portugal: Ferramentas para perceber o mundo e aprender a mudá-lo*. Fundação Francisco Manuel dos Santos.

Gulecha, A. (2022). *Trelby*. [Computer Software]. https://www.trelby.org/

Hart, H. (2022). Best of 2022: "Nope" Cinematographer Hoyte van Hoytema on Capturing the Epic Scope of Jordan Peele's Latest. *Motion Picture Association*. https://www.motionpictures.org/2022/12/nope-cinematographer-hoyte-van-hoytema-on-capturing-the-epic-scope-of-jordan-peeles-latest-2/

Hazelkorn, E., Ryan, C., Beernaert, Y., Constantinou, C., Deca, L., Grangeat, M., Karikorpi, M., Lazoudis, A., Casulleras, R., & Welzel-Breuer, M. (2015). *Science Education for Responsible Citizenship: Report to the European Commission of the expert group on science education*. https://doi.org/10.2777/12626

Hensler, V., & Gardner, K. (2020). *New video research shows what viewers value during the pandemic, and beyond*. Google. https://www.thinkwithgoogle.com/consumer-insights/consumer-trends/pandemic-video-behavior-research-trends/

Hentschel, K. (2014). *Visual Cultures in Science and Technology: A Comparative History*.

Oxford University Press.

Higgins, J., Moeed, A., & Eden, R. (2018). Video as a mediating artefact of science learning: cogenerated views of what helps students learn from watching video. *Asia-Pacific Science Education*, *4*(1). https://doi.org/10.1186/s41029-018-0022-7

Hoang, L. N. (2020). Science Communication Desperately Needs More Aligned Recommendation Algorithms. *Frontiers in Communication*, *5*(December), 1–6. https://doi.org/10.3389/fcomm.2020.598454

Hothorn, T., Bretz, F., Westfall, P., Heiberger, R. M., Schuetzenmeister, A., & Scheibe, S. (2016). *Package "multcomp". Simultaneous inference in general parametric models.* Project for Statistical Computing.

IPCC. (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. https://doi.org/10.1017/9781009325844

Jamali, H. R., Nabavi, M., & Asadi, S. (2018). How video articles are cited, the case of JoVE: Journal of Visualized Experiments. *Scientometrics*, *117*(3), 1821–1839. https://doi.org/10.1007/s11192-018-2957-6

Jaspal, R., Turner, A., & Nerlich, B. (2014). Fracking on youtube: Exploring risks, Benefits and human values. *Environmental Values*, *23*(5), 501–527. https://doi.org/10.3197/096327114X13947900181473

JoVE | Peer Reviewed Scientific Video Journal - Methods and Protocols. (2018). https://www.jove.com/

Kalmár, É., & Stenfert, H. H. (2020). Science Communication as a design challenge in transdisciplinary collaborations. *JCOM*, *19*(4). https://doi.org/10.22323/2.19040301

Kaul, L., Schrögel, P., & Humm, C. (2020). Environmental Science Communication for a Young Audience: A Case Study on the #EarthOvershootDay Campaign on YouTube. *Frontiers in Communication*, *5*(December), 1–17. https://doi.org/10.3389/fcomm.2020.601177

Kippes, R. (2021). El videoartículo como recurso narrativo clave para la comunicación de la ciencia en los nuevos entornos digitales. *JCOM América Latina*, *04*(01), 6. https://doi.org/doi.org/10.22323/3.04010206

Kirby, D. A., & Ockert, I. (2021). Science and technology in film: Themes and representations. In *Routledge Handbook of Public Communication of Science and Technology* (pp. 77–96).

Routledge.

Kodak. (2022). How Hoyte van Hoytema FSF NSC ASC pioneered with Kodak large format film for the supernatural sensation "Nope." *Kodak*. https://www.kodak.com/en/motion/blog-post/nope

Kohler, S., & Dietrich, T. C. (2021). Potentials and Limitations of Educational Videos on YouTube for Science Communication. *Frontiers in Communication*, *6*(May), 1–10. https://doi.org/10.3389/fcomm.2021.581302

Krause, K. (2017). A framework for visual communication at Nature. *Public Understanding of Science*, *26*(1), 15–24. https://doi.org/10.1177/0963662516640966

Krebs, C. L., Loizzo, J. L., Stone, W. A., & Telg, R. W. (2020). Scientist Online: Entomologists' Experiences Engaging With School Audiences Through Skype in the Classroom. *Frontiers in Communication*, *5*(September), 1–10. https://doi.org/10.3389/fcomm.2020.576593

Krom. (2021). *Kimu Pro*. [Equipment]. https://www.kromgaming.com/en/microphones/kimu-pro

Kuppers, F., Willems, W., Barendse, S., & Aris, A. (2022). *Bruggenbouwers in spagaat Wetenschapscommunicatie door wetenschappers aan Nederlandse universiteiten*. 1–39.

Kwok, R. (2018). Science on the screen. *Nature*, *553*(7686), 117–119.

Landecker, H. (2006). Microcinematography and the history of science and film. *Isis*, *97*(1), 121–132. https://doi.org/10.1086/501105

León, B. (2010). La ciencia en imágenes. Construcción visual y documental científico. *ArtefaCRos*, *3*(1), 131–149.

León, B., & Bourk, M. (Eds.). (2018a). *Communicating Science and Technology Through Online Video: Researching a New Media Phenomenon*. Routledge.

León, B., & Bourk, M. (2018b). Investigating Science-Related Online Video. In B. Léon & M. Bourk (Eds.), *Communicating Science and Technology Through Online Video: Researching a New Media Phenomenon* (pp. 1–14). Routledge.

Leonard, M., & Kurniawan, M. (2022). *A beginner's guide to video resolution*. https://www.adobe.com/creativecloud/video/discover/video-resolution.html

Lourenço, V. (Coordenação), Duarte, A., Nunes, A., Amaral, A., Gonçalves, C., Mota, M., & Mendes, R. (2019). *PISA 2018 – Portugal. Relatório Nacional*. 156.

http://www.pnl2027.gov.pt/np4/file/1205/RELATORIO_NACIONAL_PISA2018_IAVE.pdf

Machado, A. (2014). O cinema científico. *Significação: Revista de Cultura Audiovisual*, *41*(42), 15–29.

Marçal, D., & Fiolhais, C. (2019). A divulgação da Ciência em Portugal (1900-2017). In F. Correia & A. Soares (Eds.), *Comunicação de Ciência - das universidades ao grande público*. Edições Afrontamento.

Maynard, A. (2021). How to Succeed as an Academic on Youtube. *Frontiers in Communication*, *February*, 1–9. https://doi.org/10.1055/s-0038-1644974

McBride, B. B., Brewer, C. A., Berkowitz, A. R., & Borrie, W. T. (2013). Environmental literacy, ecological literacy, ecoliteracy: What do we mean and how did we get here? *Ecosphere*, *4*(5). https://doi.org/10.1890/ES13-00075.1

Michaelis, A. R. (1955). *Research Films in Biology, Anthropology, Psychology, and Medicine*. Academic Press Inc.

Morcillo, J. M., Czurda, K., & Trotha, C. Y. R. Von. (2016). Typologies of the popular science web video. *Journal of Science Communication*, *15*(4), 32. https://doi.org/https://doi.org/10.22323/2.15040202

Moreira, J. A., & Nejmeddine, F. (2015). *O vídeo como dispositivo pedagógico e possibilidades de utilização didática em ambientes de aprendizagem flexíveis*. Whitebooks.

National Education Council. (2021). *EDUCAÇÃO EM TEMPO DE PANDEMIA |Problemas, respostas e desafios das escolas*. https://www.cnedu.pt/content/iniciativas/estudos/Educacao_em_tempo_de_Pandemia.pdf

Newman, E. J., & Schwarz, N. (2018). Good Sound, Good Research: How Audio Quality Influences Perceptions of the Research and Researcher. *Science Communication*, *40*(2), 246–257. https://doi.org/10.1177/1075547018759345

O'Neil-Hart, C., & Blumenstein, H. (2016). The Latest Video Trends: Where Your Audience Is Watching. *Think with Google*. https://www.thinkwithgoogle.com/marketing-strategies/video/video-trends-where-audience-watching/

OECD. (2020). *School education during covid -19: were teachers and students ready? – Portugal - Country Note*.

Oliveira, B. J. de. (2006). Cinema e imaginário científico. *História, Ciências, Saúde-Manguinhos*, *13*(suppl), 133–150. https://doi.org/10.1590/s0104-59702006000500009

Olson, R. (2018). *Don't be such a scientist: Talking substance in an age of style* (Second Edi). Island Press.

Palma, M., Tavares, L. C., Rito, J., Henriques, L. F., Silva, J. G., Ozório, R., Pardal, M. A., Magnoni, L. J., & Viegas, I. (2019). Metabolic Effects of Dietary Glycerol Supplementation inMuscle and Liver of European Seabass and Rainbow Trout by 1H NMR Metabolomics. *Metabolites*, *9*(10). https://doi.org/10.3390/metabo9100202

Palys, T. (2008). Purposive sampling. In L. M. Given (Ed.), *The Sage Encyclopedia of Qualitative Research Methods* (Vol. 2).

Pauwels, E. (2015). Resetting the camera's clock: Sarony, Muybridge & the aesthetics of wet-plate photography. *History and Technology*, *31*(4), 482–491. https://doi.org/10.1080/07341512.2015.1090674

Pavelle, S., Wilkinson, C., & Wilkinson, C. (2020). Into the Digital Wild : Utilizing Twitter , Instagram , YouTube , and Facebook for Effective Science and Environmental Communication. *Frontiers in Communication*, *5*(October), 1–8. https://doi.org/10.3389/fcomm.2020.575122

Pecay, R. K. D. (2017). Youtube integration in science classes: Understanding its roots, ways, and selection criteria. *Qualitative Report*, *22*(4), 1015–1030. https://nsuworks.nova.edu/tqr/vol22/iss4/6

Pedro, A., Piedade, J., & Dorotea, N. (2021). Confiança dos docentes na utilização do digital na transição para o Ensino a Distância. *Psychological Review*, *84*(2), 191–215.

Peele, J. (2022). *Nope*. Universal Pictures.

Pereira, S., Pinto, M., & Moura, P. (2015). *Níveis de Literacia Mediática: Estudo Exploratório com Jovens do 12º ano* (U. do M. CECS - Centro de Estudos de Comunicação e Sociedade (Ed.)).

Plank, M., Molnár, A. D., & Marín-Arraiza, P. (2017). Extending Media Literacy Education: The Popular Science Video Workshop. *IFLA WLIC 2017 – Wrocław, Poland – Libraries. Solidarity. Society*. https://doi.org/10.34657/625

Ponte, C., & Batista, S. (2019). *EU Kids Online Portugal*. 1–61.

PORDATA. (2020). *Indivíduos com 16 e mais anos que utilizam computador e Internet em % do total de indivíduos: por grupo etário*. https://www.pordata.pt/portugal/individuos+com+16+e+mais+anos+que+utilizam+computador+e+internet+em+percentagem+do+total+de+individuos+por+grupo+etario-1139

Putortì, E. S., Sciara, S., Larocca, N. U., Crippa, M. P., & Pantaleo, G. (2020). Communicating Science Effectively: When an Optimised Video Communication Enhances Comprehension, Pleasantness, and People's Interest in Knowing More About Scientific Findings. *Applied Psychology*, *69*(3), 1072–1091. https://doi.org/10.1111/apps.12193

Research Square. (2019). https://www.researchsquare.com/

Reutemann, J. (2016). Differences and Commonalities – A comparative report of video styles and course descriptions on edX, Coursera, Futurelearn and Iversity. *Proceedings of the European MOOC Stakeholder Summit 2016*, 383–392.

Ribeiro, J. da S. (2002). Passagem dos rituais de festival do filme científico ao desenvolvimento da cultura científica, cinematográfica e tecnológica na escola. *Caleidoscópio*.

Rigutto, C. (2017). The landscape of online visual communication of science. *Journal of Science Communication*, *16*(2).

Rodrigues, C., & Godoy-Viera, A. F. (2016). Utilização do recurso hipermediático vídeo em periódicos científicos: estudo do Journal of Visualized Experiments (JOVE). *Revista Interamericana de Bibliotecnologia*, *40*(2), 153–164.

Rosenthal, S. (2020). Media Literacy, Scientific Literacy, and Science Videos on the Internet. *Frontiers in Communication*, *5*(September), 1–7. https://doi.org/10.3389/fcomm.2020.581585

Ruiz-Mallén, I., Gallois, S., & Heras, M. (2018). From White Lab Coats and Crazy Hair to Actual Scientists: Exploring the Impact of Researcher Interaction and Performing Arts on Students' Perceptions and Motivation for Science. *Science Communication*, *40*(6), 749–777. https://doi.org/10.1177/1075547018808025

Ruzi, S. A., Lee, N. M., & Smith, A. A. (2021). Testing how different narrative perspectives achieve communication objectives and goals in online natural science videos. *PLoS ONE*, *16*(10 October), 1–23. https://doi.org/10.1371/journal.pone.0257866

Santos, S. C., & Santos, C. A. (2014). Da educação à comunicação: Um mapeamento da utilização do vídeo online em universidades portuguesas. *Observatorio*, *8*(3), 17–37.

Shah, C., & Marchionini, G. (2010). Awareness in collaborative information seeking. *Journal of the American Society for Information Science and Technology*, *61*(10), 1970–1986. https://doi.org/10.1002/asi.21379

Shaikh, A. R., Alhoori, H., & Sun, M. (2022). YouTube and science: models for research impact. *Scientometrics*, *128*(2), 933–955. https://doi.org/10.1007/s11192-022-04574-5

Shutterstock. (2021). *Premium Beat*. https://www.premiumbeat.com/

Singer, A. (1966). Television: Window on Culture or Reflection in the Glass? *The American Scholar*, *35*(2), 303–309.

Slawter, L. D. (2008). TreeHuggerTV: Re-Visualizing Environmental Activism in the Post-Network Era. *Environmental Communication*, *2*(2), 212–228. https://doi.org/10.1080/17524030802141760

Slemmons, K., Anyanwu, K., Hames, J., Grabski, D., Mlsna, J., Simkins, E., & Cook, P. (2018). The Impact of Video Length on Learning in a Middle-Level Flipped Science Setting: Implications for Diversity Inclusion. *Journal of Science Education and Technology*, *27*(5), 469–479. https://doi.org/10.1007/s10956-018-9736-2

Smith, A. A. (2020). Broadcasting Ourselves: Opportunities for Researchers to Share Their Work Through Online Video. *Frontiers in Environmental Science*, *8*(August). https://doi.org/10.3389/fenvs.2020.00150

Spicer, Scott. (2014). Exploring Video Abstracts in Science Journals: An Overview and Case Study. *Journal of Librarianship and Scholarly Communication*. https://doi.org/10.7710/2162-3309.1110

Spicer, Suzanne. (2017). The nuts and bolts of evaluating science communication activities. *Seminars in Cell and Developmental Biology*, *70*, 17–25. https://doi.org/10.1016/j.semcdb.2017.08.026

Statista. (2020a). *Average YouTube video length as of December 2018, by category*. https://www.statista.com/statistics/1026923/youtube-video-category-average-length/

Statista. (2020b). *Distribution of total YouTube video views worldwide as of December 2018*. https://www.statista.com/statistics/1026885/global-distribution-youtube-video-views-by-category/

Statista. (2023a). *Global social networks ranked by number of users 2023*. https://www.statista.com/statistics/272014/global-social-networks-ranked-by-number-of-users/mber-of-users/

Statista. (2023b). *Hours of video uploaded to YouTube every minute as of February 2022*. https://www.statista.com/statistics/259477/hours-of-video-uploaded-to-youtube-every-minute/

Statista. (2023c). *Worldwide digital population 2023*. https://www.statista.com/statistics/617136/digital-population-worldwide/

Sugimoto, C., & Thelwall, M. (2013). Scholar on Soap Boxes: Science Communication and Dissemination in TED Videos. *Journal of the American Society for Information Science and Technology*, *64*(4), 663–674. https://doi.org/10.1002/asi.22764

Thelwall, M., Kousha, K., Weller, K., & Puschmann, C. (2012). Assessing the Impact of Online Academic Videos. In *Social Information Research* (Vol. 5, pp. 195–213). https://doi.org/10.1108/S1876-0562(2012)0000005011

Tosi, V. (2005). *Cinema before cinema: the origins of scientific cinematography*. British Universities Film & Video Council.

Trench, B. (2017). Universities, science communication and professionalism. *Journal of Science Communication*, *16*(5), 1–8.

Trumbo, J. (1999). Visual literacy and science communication. *Science Communication*, *20*(4), 409–425.

Tsou, A., Thelwall, M., Mongeon, P., & Sugimoto, C. R. (2014). A community of curious souls: An analysis of commenting behavior on TED Talks videos. *PLoS ONE*, *9*(4). https://doi.org/10.1371/journal.pone.0093609

Uldam, J., & Askanius, T. (2013). Online Civic Cultures: Debating Climate Change Activism on YouTube. *International Journal of Communication*, *7*, 1185–1204.

United Nations. (2015). *The 2030 Agenda for Sustainable Development*. https://doi.org/10.1201/b20466-7

Vachon, R. (2018). *Science Videos: A User's Manual for Scientific Communication*. Springer.

Vasquez-Muriel, D., & Escobar-Ortiz, J. M. (2022). Does democratizing access to science imply democratizing science? A case study of non-corporate Spanish-speaking science YouTubers. *JCOM*, *21*(03), 1–20. https://doi.org/10.22323/2.21030202

Vázquez-Cano, E. (2013). The videoarticle: New reporting format in scientific journals and its integration in MOOCs. *Comunicar*, *XXI*(41), 83–90. https://doi.org/10.3916/C41-2013-08

Velho, Raphaela M., & Barata, G. (2020). Profiles, Challenges, and Motivations of Science YouTubers. *Frontiers in Communication*, *5*(November), 1–15. https://doi.org/10.3389/fcomm.2020.542936

Velho, Raphaela Martins, Mendes, A. M. F., & Azevedo, C. L. N. (2020). Communicating Science With YouTube Videos: How Nine Factors Relate to and Affect Video Views. *Frontiers in Communication*, *5*(September), 1–14. https://doi.org/10.3389/fcomm.2020.567606

Videvo. (2022). *Videvo*. https://www.videvo.net/

Wehrmann, C., & van de Sanden, M. C. (2017). Universities as living labs for science communication. *JCOM*, *16*(5), 1–7. https://doi.org/10.22323/2.16050303

Weingart, P. (2022). Trust or attention ? Medialization of science revisited. *Public Understanding of Science*, *31*(3), 288–296. https://doi.org/10.1177/09636625211070888

Welbourne, D. J., & Grant, W. J. (2016). Science communication on YouTube: Factors that affect channel and video popularity. *Public Understanding of Science*, *25*(6), 706–718. https://doi.org/10.1177/0963662515572068

WFMU. (2022). *Free Music Archive*. https://freemusicarchive.org/

Wolf, G. (1974). *Encyclopaedia Cinematographica*. Institut für den Wissenschaftlichen Film.

Wright, T. (2011). Press Photography and Visual Rhetoric. In E. Margolis & L. Pauwels (Eds.), *The SAGE Handbook of Visual Research Methods* (pp. 317–336). SAGE Publications Ltd.

Wyss, V. L. (2013). Developing Videos to Better Inform Middle School Students About STEM Career Options. *TechTrends*, *57*(2), 54–62. https://doi.org/10.1007/s11528-013-0646-0

Xu, S., Yu, H., Hemminger, B. M., & Dong, X. (2018). Who, what, why? An exploration of JoVE scientific video publications in tweets. *Scientometrics*, *117*(2), 845–856. https://doi.org/10.1007/s11192-018-2880-x

Yang, S., Brossard, D., Scheufele, D. A., & Xenos, M. A. (2022). The science of YouTube: What factors influence user engagement with online science videos? *PLoS ONE*, *17*(5 May), 1–20. https://doi.org/10.1371/journal.pone.0267697

Yang, W. (2017). Audioslide presentations as an appendant genre - key words, personal pronouns, stance and engagement. *ESP Today*, *5*(1), 24–45. https://doi.org/10.18485/esptoday.2017.5.1.2

YouTube. (2020). *YouTube Press*.

Zong, Q., Xie, Y., Tuo, R., Huang, J., & Yang, Y. (2019). The impact of video abstract on citation counts: evidence from a retrospective cohort study of New Journal of Physics. *Scientometrics*, *119*(3), 1715–1727. https://doi.org/10.1007/s11192-019-03108-w

Appendix A: List of surveyed journals and videos

Table A1. List of the top 40 journals in the subject area of Ecology from the 2018 Journal Citation Reports.

* Journals with scientific papers with video abstracts.

	Editor	Journal	Impact Factor (2017)	Video Abstract
1	Cell Press	Trends in Ecology & Evolution	15.938	No
2	Springer	Fungal Diversity	14.078	No
3	Annual Reviews	Annual Review of Ecology Evolution and Systematics	10.160	No
4	Springer Nature	ISME Journal	9.520	No
5	Wiley	Ecology Letters	9.137	No
6	Wiley	Global Change Biology*	8.997	Yes
7	Wiley	Frontiers in Ecology and the Environment	8.302	No
8	Wiley	Ecological Monographs	7.828	No
9	Wiley	Conservation Letters	7.279	No
10	Wiley	Molecular Ecology Resources	7.059	No
11	Elsevier	Global Environmental Change	6.371	No
12	Wiley	Methods in Ecology and Evolution	6.360	No
13	Wiley	Molecular Ecology	6.131	No
14	Wiley	Global Ecology and Biogeography	5.958	No
15	Wiley	Conservation Biology	5.890	No
16	Wiley	Journal of Applied Ecology	5.742	No
17	Wiley	Functional Ecology*	5.491	Yes
18	Wiley	Journal of Ecology*	5.172	Yes
19	Elsevier	Landscape and Urban Planning	4.994	No
20	The Royal Society	Proceedings of the Royal Society B	4.847	No
21	Wiley	Wildlife Monographs	4.800	No
22	Elsevier	Biological Conservation	4.660	No
23	Wiley	Ecology	4.617	No
24	Wiley	Diversity and Distributions	4.614	No
25	Wiley	Ecography*	4.520	Yes
26	Wiley	Journal of Animal Ecology*	4.459	Yes
27	Elsevier	Ecosystem Services	4.395	No
28	Wiley	Ecological Applications	4.393	No
29	The American Society of Naturalists	American Naturalist	4.265	No
30	Wiley	Journal of Biogeography	4.154	No
31	Springer	Ecosystems	4.030	No
32	Springer Nature	Heredity	3.872	No
33	Springer	Landscape Ecology	3.833	No
34	Wiley	Evolution	3.818	No
35	Wiley	Oikos	3.710	No
36	Elsevier	Current Opinion in Insect Science	4.171	No
37	Springer	Microbial Ecology	3.614	No
38	Elsevier	Agriculture, Ecosystems & Environment	3.541	No
39	Copernicus Publications	Biogeosciences	3.441	No
40	Oxford Academics	Behavioral Ecology	3.347	No

Table A2. List of the 24 journals that have Ecology has a subcategory and have scientific papers with video abstracts.

	Editor	**Journal**	**Impact Factor (2017)**
1	Nature	Nature	41.577
2	AAAS	Science	41.058
3	Nature	Nature Genetics	27.125
4	Nature	Nature Physics	22.727
5	Nature	Nature Climate Change	19.181
6	Nature	Nature Communications	12.353
7	AAAS	Science Advances	11.511
8	Nature	Nature Plants	11.471
9	Cell Press	Current Biology	9.251
10	Wiley	Land Degradation & Development	7.270
11	Springer Nature	BMC Biology	5.770
12	Scientific Reports	Scientific Reports	4.122
13	Springer	Sustainability Science	3.855
14	Wiley	Ambio	3.616
15	Wiley	Environmental Toxicology and Chemistry	3.179
16	Springer Nature	Parasites & Vectors	3.163
17	Springer Nature	BMC Evolutionary Biology	3.027
18	Wiley	Ecohydrology	2.755
19	Wiley	Ecology and Evolution	2.340
20	Nature	Nature Ecology & Evolution	Not Available
21	New Phytologist Trust	Plants, People, Planet	Not Available
22	Wiley	WIREs Water	Not Available
23	Wiley	Fisheries Magazine	Not Available
24	Springer Nature	BMC Zoology	Not Available

Table A3. List of the 171 analyzed video abstracts (with video title and link) and respective scientific papers.

	Scientific paper	Video title
1	Hawlena, D., Kress, H., Dufresne, E. R., & Schmitz, O. J. (2011). Grasshoppers alter jumping biomechanics to enhance escape performance under chronic risk of spider predation. Functional Ecology, 25(1), 279-288.	Grasshopper jumping https://youtu.be/cevL1RWcmqQ
2	Santana, S. E., Dumont, E. R., & Davis, J. L. (2010). Mechanics of bite force production and its relationship to diet in bats. Functional Ecology, 24(4), 776-784.	Modeling bat feeding https://youtu.be/WRahGKo6P_8
3	Gleiss, A. C., Norman, B., & Wilson, R. P. (2011). Moved by that sinking feeling: variable diving geometry underlies movement strategies in whale sharks. Functional Ecology, 25(3), 595-607.	Whale shark diving https://youtu.be/W9TazVodFXs
4	Huusko, A., Mäki-Petäys, A., Stickler, M., & Mykrä, H. (2011). Fish can shrink under harsh living conditions. Functional Ecology, 25(3), 628-633.	Fish shrink in Winter https://youtu.be/MzO9Cj48AKw
5	Cotter, S. C., Ward, R. J., & Kilner, R. M. (2011). Age-specific reproductive investment in female burying beetles: independent effects of state and risk of death. Functional Ecology, 25(3), 652-660.	Reproduction and death in beetles https://youtu.be/N2lvcSoNkjI
6	Massot, M., Clobert, J., Montes-Poloni, L., Haussy, C., Cubo, J., & Meylan, S. (2011). An integrative study of ageing in a wild population of common lizards. Functional Ecology, 25(4), 848-858.	Ageing in lizards https://youtu.be/wmXUJzW7E5E
7	Chapperon, C., & Seuront, L. (2011). Space–time variability in environmental thermal properties and snail thermoregulatory behaviour. Functional Ecology, 25(5), 1040-1050.	A micro-view of thermal stress in snails https://youtu.be/AtzobFKTnzE
8	Ujvari, B., & Madsen, T. (2011). Do natural antibodies compensate for humoral immunosenescence in tropical pythons?. Functional Ecology, 813-817.	Age & Immune response https://youtu.be/q4Vh7IKkXVI
9	Scott, R., Marsh, R., & Hays, G. C. (2012). Life in the really slow lane: loggerhead sea turtles mature late relative to other reptiles. Functional Ecology, 26(1), 227-235.	Life in the really slow lane https://youtu.be/6fyxPdus4Uw
10	McArthur, C., Orlando, P., Banks, P. B., & Brown, J. S. (2012). The foraging tightrope between predation risk and plant toxins: a matter of concentration. Functional Ecology, 26(1), 74-83.	The foraging tight-rope https://youtu.be/GFCRphhPWro
11	Hammerschlag, N., Gallagher, A. J., Wester, J., Luo, J., & Ault, J. S. (2012). Don't bite the hand that feeds: assessing ecological impacts of provisioning ecotourism on an apex marine predator. Functional Ecology, 26(3), 567-576.	Does Ecotourism in the Bahamas affect Tiger Shark Movement and Behavior? https://youtu.be/9iFl7BxbnXQ
12	Archard, G. A., Earley, R. L., Hanninen, A. F., & Braithwaite, V. A. (2012). Correlated behaviour and stress physiology in fish exposed to different levels of predation pressure. Functional Ecology, 26(3), 637-645.	Behaviour & stress physiology in fish https://youtu.be/ix2c8ueowP8

	Scientific paper	Video title
13	Gunderson, A. R., & Leal, M. (2012). Geographic variation in vulnerability to climate warming in a tropical Caribbean lizard. Functional Ecology, 26(4), 783-793.	Running lizards provide climate clues https://youtu.be/Jh3UtsvZmLI
14	Schmieder, D. A., Kingston, T., Hashim, R., & Siemers, B. M. (2012). Sensory constraints on prey detection performance in an ensemble of vespertilionid understorey rain forest bats. Functional Ecology, 26(5), 1043-1053.	Hide and seek in the rainforest: how do bats tell food from foliage? https://youtu.be/dQbgC5n7mAI
15	Garbuzov, M., & Ratnieks, F. L. (2014). Quantifying variation among garden plants in attractiveness to bees and other flower-visiting insects. Functional Ecology, 28(2), 364-374.	Garden plants for flower-visiting insects--quantifying variation in attractiveness https://youtu.be/GgEf8LLSlsc
16	Price-Rees, S. J., Lindström, T., Brown, G. P., & Shine, R. (2014). The effects of weather conditions on dispersal behaviour of free-ranging lizards (T iliqua, S cincidae) in tropical A ustralia. Functional ecology, 28(2), 440-449.	The effects of weather on dispersal behaviour of free-ranging lizards in tropical Australia https://youtu.be/TDC_wG_sR1Q
17	Chen, C. C. W., & Welch Jr, K. C. (2014). Hummingbirds can fuel expensive hovering flight completely with either exogenous glucose or fructose. Functional ecology, 28(3), 589-600.	Hovering on a high fructose diet: hummingbirds can fuel expensive flight with glucose or fructose https://youtu.be/TGczsWrCre4
18	Goyens, J., Dirckx, J., & Aerts, P. (2015). Costly sexual dimorphism in Cyclommatus metallifer stag beetles. Functional Ecology, 29(1), 35-43.	Massive armature trumps running for stag beetles https://youtu.be/R5TxMP71Ynw
19	Galván, I., Bonisoli-Alquati, A., Jenkinson, S., Ghanem, G., Wakamatsu, K., Mousseau, T. A., & Møller, A. P. (2014). Chronic exposure to low-dose radiation at Chernobyl favours adaptation to oxidative stress in birds. Functional Ecology, 28(6), 1387-1403.	Science Bulletins: Chernobyl's Birds Adapt to Radiation https://youtu.be/Etbse7Vyb1g
20	Velez, A., Gall, M. D., Fu, J., & Lucas, J. R. (2015). Song structure, not high-frequency song content, determines high-frequency auditory sensitivity in nine species of N ew W orld sparrows (P asseriformes: E mberizidae). Functional Ecology, 29(4), 487-497.	Bird song properties and auditory sensitivity https://youtu.be/one3h9j98qg
21	Fleishman, L. J., Ogas, B., Steinberg, D., & Leal, M. (2016). Why do Anolis dewlaps glow? An analysis of a translucent visual signal. Functional Ecology, 30(3), 345-355.	Why do Anolis lizard dewlaps glow? An analysis of a translucent visual signal https://youtu.be/errevFcr01k
22	Donihue, C. M., Brock, K. M., Foufopoulos, J., & Herrel, A. (2016). Feed or fight: testing the impact of food availability and intraspecific aggression on the functional ecology of an island lizard. Functional Ecology, 30(4), 566-575.	Feed or fight: Food availability and intraspecific aggression for an island lizard https://youtu.be/vWJNCX0-p60
23	Coelho, P., Kaliontzopoulou, A., Rasko, M., & van der Meijden, A. (2017). A 'striking'relationship: scorpion defensive behaviour and its relation to morphology and performance. Functional Ecology, 31(7), 1390-1404.	To know a scorpion by its tail: the tail strike of scorpions differs between species https://youtu.be/7dHsNmqs8Bs
24	Henze, M. J., Lind, O., Mappes, J., Rojas, B., & Kelber, A. (2018). An aposematic colour-polymorphic moth seen through the eyes of	The coloured wings of wood tiger moths, seen with moth and bird eyes https://youtu.be/aqn0SarlHW4

	Scientific paper	Video title
	conspecifics and predators–Sensitivity and colour discrimination in a tiger moth. Functional Ecology, 32(7), 1797-1809.	
25	Martin, L. J., Agrawal, A. A., & Kraft, C. E. (2015). Historically browsed jewelweed populations exhibit greater tolerance to deer herbivory than historically protected populations. Journal of Ecology, 103(1), 243-249.	Laura Martin - Harper Prize Highly Commended Paper 2015 https://youtu.be/QSCm0pA_vcA
26	Stepien, C. C. (2015). Impacts of geography, taxonomy and functional group on inorganic carbon use patterns in marine macrophytes. Journal of Ecology, 103(6), 1372-1383.	Courtney Stepien - Harper Prize Highly Commended Paper 2015 https://youtu.be/5PULuVG0694
27	Fuchslueger, L., Bahn, M., Hasibeder, R., Kienzl, S., Fritz, K., Schmitt, M., ... & Richter, A. (2016). Drought history affects grassland plant and microbial carbon turnover during and after a subsequent drought event. Journal of Ecology, 104(5), 1453-1465.	Lucia Fuchslueger - Drought history effects on plant and microbial C turnover https://youtu.be/WuqB58CAS74
28	Blume-Werry, G., Kreyling, J., Laudon, H., & Milbau, A. (2016). Short-term climate change manipulation effects do not scale up to long-term legacies: Effects of an absent snow cover on boreal forest plants. Journal of Ecology, 104(6), 1638-1648.	Gesche Blume-Werry - Short-term snow cover reduction effects do not scale up to long-term legacies https://youtu.be/T6DcbMC9BSc
29	Albornoz, F. E., Burgess, T. I., Lambers, H., Etchells, H., & Laliberté, E. (2017). Native soilborne pathogens equalize differences in competitive ability between plants of contrasting nutrient-acquisition strategies. Journal of Ecology, 105(2), 549-557.	Felipe Albornoz - Native soilborne pathogens equalize differences in competitive abilities https://youtu.be/mjOvyShsX4s
30	Chacón-Labella, J., de la Cruz, M., & Escudero, A. (2017). Evidence for a stochastic geometry of biodiversity: the effects of species abundance, richness and intraspecific clustering. Journal of Ecology, 105(2), 382-390.	Julia Chacón-Labella - Evidence for a stochastic geometry of biodiversity https://youtu.be/xxQ2_RVggH0
31	Giljohann, K. M., McCarthy, M. A., Keith, D. A., Kelly, L. T., Tozer, M. G., & Regan, T. J. (2017). Interactions between rainfall, fire and herbivory drive resprouter vital rates in a semi-arid ecosystem. Journal of Ecology, 105(6), 1562-1570.	Katherine Giljohann - Interactions between rainfall, fire and herbivory drive resprouter vital rates https://youtu.be/ChCsFg045Yk
32	Daskin, J. H., Stalmans, M., & Pringle, R. M. (2016). Ecological legacies of civil war: 35-year increase in savanna tree cover following wholesale large-mammal declines. Journal of Ecology, 104(1), 79-89.	Joshua Daskin - Harper Prize Highly Commended Paper 2016 https://youtu.be/CSg-L9E1Ouo
33	Messier, J., Lechowicz, M. J., McGill, B. J., Violle, C., & Enquist, B. J. (2017). Interspecific integration of trait dimensions at local scales: the plant phenotype as an integrated network. Journal of Ecology, 105(6), 1775-1790.	Julie Messier - Interspecific integration of trait dimensions at local scales https://youtu.be/xAHLsLUd_XM
34	Visser, M. D., Schnitzer, S. A., Muller-Landau, H. C., Jongejans, E., de Kroon, H., Comita, L. S., ... & Wright, S. J. (2018). Tree species vary widely in their tolerance for liana infestation: A case study of differential host	Marco Visser - Influences of Lianas on Tropical Tree Populations https://youtu.be/8AEQ9WoiraI

	Scientific paper	Video title
	response to generalist parasites. Journal of Ecology, 106(2), 781-794.	
35	Krab, E. J., Roennefarth, J., Becher, M., Blume-Werry, G., Keuper, F., Klaminder, J., ... & Dorrepaal, E. (2018). Winter warming effects on tundra shrub performance are species-specific and dependent on spring conditions. Journal of Ecology, 106(2), 599-612.	Eveline Krab - Winter warming effects on tundra shrub performance https://youtu.be/fGf28Ijh1zw
36	Thrippleton, T., Bugmann, H., & Snell, R. S. (2018). Herbaceous competition and browsing may induce arrested succession in central European forests. Journal of Ecology, 106(3), 1120-1132.	Timothy Thrippleton - Arrested succession in central European forests https://youtu.be/KwAn79FQcHA
37	Fong, C. R., Bittick, S. J., & Fong, P. (2018). Simultaneous synergist, antagonistic and additive interactions between multiple local stressors all degrade algal turf communities on coral reefs. Journal of Ecology, 106(4), 1390-1400.	Caitlin Fong - Multiple Local Stressors of Algal Turf Communities https://youtu.be/WB2HoLnEiv0
38	Conti, L., Block, S., Parepa, M., Münkemüller, T., Thuiller, W., Acosta, A. T., ... & Moser, D. (2018). Functional trait differences and trait plasticity mediate biotic resistance to potential plant invaders. Journal of Ecology, 106(4), 1607-1620.	Luisa Conti - Biotic resistance to potential invaders mediated by plant functional trait differences https://youtu.be/14jC40x6WT0
39	Fitzpatrick, C. R., Gehant, L., Kotanen, P. M., & Johnson, M. T. (2017). Phylogenetic relatedness, phenotypic similarity and plant–soil feedbacks. Journal of Ecology, 105(3), 786-800.	Connor Fitzpatrick - Harper Prize Highly Commended Paper 2017 https://youtu.be/hrt8Tcf9t8c
40	Mariotte, P., Canarini, A., & Dijkstra, F. A. (2017). Stoichiometric N: P flexibility and mycorrhizal symbiosis favour plant resistance against drought. Journal of Ecology, 105(4), 958-967.	Pierre Mariotte - Harper Prize Highly Commended Paper 2017 https://youtu.be/lwat4ll_bNo
41	Bruns, E. L., Antonovics, J., & Hood, M. (2019). Is there a disease-free halo at species range limits? The codistribution of anther-smut disease and its host species. Journal of Ecology, 107(1), 1-11.	Emily Bruns - Frequency-dependent disease transmission can affect host distribution! https://youtu.be/b0hr08BNGjs
42	Pessarrodona, A., Foggo, A., & Smale, D. A. (2019). Can ecosystem functioning be maintained despite climate-driven shifts in species composition? Insights from novel marine forests. Journal of Ecology, 107(1), 91-104.	Albert Pessarrodona - Can marine ecosystem functioning be maintained under climate change? https://youtu.be/0-CRPLita3Q
43	Irl, S. D., Anthelme, F., Harter, D. E., Jentsch, A., Lotter, E., Steinbauer, M. J., & Beierkuhnlein, C. (2016). Patterns of island treeline elevation–a global perspective. Ecography, 39(5), 427-436.	Irl et al Ecography Video island treeline https://youtu.be/EkPkeAQHibQ
44	Algar, A. C., & López-Darias, M. (2016). Sex-specific responses of phenotypic diversity to environmental variation. Ecography, 39(8), 715-725.	Algar LopezDarias EcographyAug2016 https://youtu.be/fyCQolv76uo
45	Kane, A., Healy, K., Guillerme, T., Ruxton, G. D., & Jackson, A. L. (2017). A recipe for	ECOGRAPHY KH Jan 27 vid2 https://youtu.be/uc7_JgApusY

	Scientific paper	Video title
	scavenging in vertebrates–the natural history of a behaviour. Ecography, 40(2), 324-334.	
46	Lundgren, E. J., Ramp, D., Ripple, W. J., & Wallach, A. D. (2018). Introduced megafauna are rewilding the Anthropocene. Ecography, 41(6), 857-866.	Introduced megafauna are rewilding the Anthropocene https://youtu.be/Manatr_Exgc
47	Múrria, C., Dolédec, S., Papadopoulou, A., Vogler, A. P., & Bonada, N. (2018). Ecological constraints from incumbent clades drive trait evolution across the tree-of-life of freshwater macroinvertebrates. Ecography, 41(7), 1049-1063.	Trait evolution across the tree-of-life of freshwater macroinvertebrates https://youtu.be/_1tEETP9G84
48	D'Amen, M., Mod, H. K., Gotelli, N. J., & Guisan, A. (2018). Disentangling biotic interactions, environmental filters, and dispersal limitation as drivers of species co-occurrence. Ecography, 41(8), 1233-1244.	Biotic interactions, environmental filters & dispersal limitation drives species co-occurrence https://youtu.be/pKCtzptuGAE
49	Murray, K. A., Olivero, J., Roche, B., Tiedt, S., & Guégan, J. F. (2018). Pathogeography: leveraging the biogeography of human infectious diseases for global health management. Ecography, 41(9), 1411-1427.	Pathogeography - biogeography of human infectious diseases for global health management https://youtu.be/q_RJ9zvI4UI
50	Senner, N. R., Stager, M., & Cheviron, Z. A. (2018). Spatial and temporal heterogeneity in climate change limits species' dispersal capabilities and adaptive potential. Ecography, 41(9), 1428-1440.	Spatial and temporal variation in climate change limits species dispersal https://youtu.be/99euSZjSFb8
51	Kohli, B. A., Terry, R. C., & Rowe, R. J. (2018). A trait-based framework for discerning drivers of species co-occurrence across heterogeneous landscapes. Ecography, 41(12), 1921-1933.	What drives species co-occurrence across heterogeneous landscapes? https://youtu.be/jubVM9Ok0qA
52	Davis, K. T., Dobrowski, S. Z., Holden, Z. A., Higuera, P. E., & Abatzoglou, J. T. (2019). Microclimatic buffering in forests of the future: the role of local water balance. Ecography, 42(1), 1-11.	Microclimatic buffering in forests of the future: the role of local water balance https://youtu.be/jubVM9Ok0qA
53	Dittel, J. W., Moore, C. M., & Vander Wall, S. B. (2019). The mismatch in distributions of vertebrates and the plants that they disperse. Ecography, 42(4), 621-631.	The mismatch in distributions of vertebrates and the plants that they disperse https://youtu.be/NGkLXD5Uvms
54	Baudier, K. M., D'Amelio, C. L., Sulger, E., O'Connor, M. P., & O'Donnell, S. (2019). Plastic collective endothermy in a complex animal society (army ant bivouacs: Eciton burchellii parvispinum). Ecography, 42(4), 730-739.	How does group thermoregulation of army ant bivouacs change at high elevations? https://youtu.be/9ce4mg8MyqI
55	Shamoun-Baranes, J., Nilsson, C., Bauer, S., & Chapman, J. (2019). Taking radar aeroecology into the 21st century.	Taking Radar Aeroecology into the 21st Century https://youtu.be/uwvXKmOViws
56	Straw, A. D., Lee, S., & Dickinson, M. H. (2010). Visual control of altitude in flying Drosophila. Current Biology, 20(17), 1550-1556.	Altitude control in Drosophila https://youtu.be/P4FDRqz3f0k
57	Goheen, J. R., & Palmer, T. M. (2010). Defensive plant-ants stabilize megaherbivore-driven landscape change in an African savanna. Current Biology, 20(19), 1768-1772.	Symbiotic ants defend acacia hosts from elephants https://youtu.be/s3blzcbll7Q

	Scientific paper	Video title
58	Slot, J. C., & Rokas, A. (2011). Horizontal transfer of a large and highly toxic secondary metabolic gene cluster between fungi. Current biology, 21(2), 134-139.	Fungi share genes https://youtu.be/ydBIpUn_Mlk
59	Gutnick, T., Byrne, R. A., Hochner, B., & Kuba, M. (2011). Octopus vulgaris uses visual information to determine the location of its arm. Current biology, 21(6), 460-462.	Visual control of octopus arm movements https://youtu.be/ZlVFqlNWo9E
60	Klahre, U., Gurba, A., Hermann, K., Saxenhofer, M., Bossolini, E., Guerin, P., & Kuhlemeier, C. (2011). Pollinator choice in Petunia depends on two major genetic loci for floral scent production. Current Biology, 21(9), 730-739.	Mixing and matching floral traits https://youtu.be/o1BcisZPBqg
61	Bateson, M., Desire, S., Gartside, S. E., & Wright, G. A. (2011). Agitated honeybees exhibit pessimistic cognitive biases. Current biology, 21(12), 1070-1073.	Pessimism in honeybees https://youtu.be/_o5mqJmNIuY
62	Maguire, S. M., Clark, C. M., Nunnari, J., Pirri, J. K., & Alkema, M. J. (2011). The C. elegans touch response facilitates escape from predacious fungi. Current Biology, 21(15), 1326-1330.	Nematode escape from fungal traps https://youtu.be/-jfex7AnO1U
63	Marek, P., Papaj, D., Yeager, J., Molina, S., & Moore, W. (2011). Bioluminescent aposematism in millipedes. Current Biology, 21(18), R680-R681.	Bioluminescent millipedes https://youtu.be/ivU0YdlE7E4
64	Rodríguez-Muñoz, R., Bretman, A., & Tregenza, T. (2011). Guarding males protect females from predation in a wild insect. Current Biology, 21(20), 1716-1719.	Chivalrous insects https://youtu.be/Bzxs6pqTrII
65	Samuni-Blank, M., Izhaki, I., Dearing, M. D., Gerchman, Y., Trabelcy, B., Lotan, A., ... & Arad, Z. (2012). Intraspecific directed deterrence by the mustard oil bomb in a desert plant. Current biology, 22(13), 1218-1220.	Fruit chemistry alters animal behavior https://youtu.be/BaTFV0Jo26Y
66	Handegard, N. O., Boswell, K. M., Ioannou, C. C., Leblanc, S. P., Tjøstheim, D. B., & Couzin, I. D. (2012). The dynamics of coordinated group hunting and collective information transfer among schooling prey. Current biology, 22(13), 1213-1217.	Dynamics of group hunting and collective evasion https://youtu.be/e_NVDz7XzIo
67	Brandenburg, A., Kuhlemeier, C., & Bshary, R. (2012). Hawkmoth pollinators decrease seed set of a low-nectar Petunia axillaris line through reduced probing time. Current Biology, 22(17), 1635-1639.	Pollinator probing time determines plant fitness https://youtu.be/7RiHAX0an3w
68	Gobbato, E., Marsh, J. F., Vernié, T., Wang, E., Maillet, F., Kim, J., ... & Mysore, K. S. (2012). A GRAS-type transcription factor with a specific function in mycorrhizal signaling. Current Biology, 22(23), 2236-2241.	Establishing beneficial plant-fungal symbiosis https://youtu.be/DrsNuwOnoEM
69	Herrera, A. M., Shuster, S. G., Perriton, C. L., & Cohn, M. J. (2013). Developmental basis of phallus reduction during bird evolution. Current Biology, 23(12), 1065-1074.	Loss of external genitalia in bird evolution https://youtu.be/K9sHWHYdjPo
70	Dalziell, A. H., Peters, R. A., Cockburn, A., Dorland, A. D., Maisey, A. C., & Magrath, R. D. (2013). Dance choreography is coordinated	Coordinated song and dance in lyrebirds https://youtu.be/zdvt-oTHs0o

	Scientific paper	Video title
	with song repertoire in a complex avian display. Current Biology, 23(12), 1132-1135.	
71	Mazzini, F., Townsend, S. W., Virányi, Z., & Range, F. (2013). Wolf howling is mediated by relationship quality rather than underlying emotional stress. Current Biology, 23(17), 1677-1680.	Wolf Howling Is Mediated by Relationship Quality Rather Than Emotional Stress https://youtu.be/mLpubeRc8NU
72	Ghisalberti, M., Gold, D. A., Laflamme, M., Clapham, M. E., Narbonne, G. M., Summons, R. E., ... & Jacobs, D. K. (2014). Canopy flow analysis reveals the advantage of size in the oldest communities of multicellular eukaryotes. Current Biology, 24(3), 305-309.	Canopy Flow Analysis Helps Explain the Evolution of the World's Oldest Fossil Communities https://youtu.be/MwM1bMmPn7g
73	Hartikainen, H., Stentiford, G. D., Bateman, K. S., Berney, C., Feist, S. W., Longshaw, M., ... & Bass, D. (2014). Mikrocytids are a broadly distributed and divergent radiation of parasites in aquatic invertebrates. Current Biology, 24(7), 807-812.	The Mikrocytida -- Divergent Pathogens of Aquatic Invertebrates https://youtu.be/O91iXkMmTWY
74	Kazemi, B., Gamberale-Stille, G., Tullberg, B. S., & Leimar, O. (2014). Stimulus salience as an explanation for imperfect mimicry. Current Biology, 24(9), 965-969.	Imperfect Mimics Can Succeed as Long as They Mimic the Most Salient Trait https://youtu.be/BRolG24YkJQ
75	Rogers, A., Blanchard, J. L., & Mumby, P. J. (2014). Vulnerability of coral reef fisheries to a loss of structural complexity. Current Biology, 24(9), 1000-1005.	Coral Reef Fisheries and Habitat Degradation https://youtu.be/U8TQoCykaKU
76	Garbuzov, M., Couvillon, M. J., Schürch, R., & Ratnieks, F. L. (2015). Honey bee dance decoding and pollen-load analysis show limited foraging on spring-flowering oilseed rape, a potential source of neonicotinoid contamination. Agriculture, Ecosystems & Environment, 203, 62-68.	Dancing Bees Cast Their Votes on Best Land Types and Areas https://youtu.be/DTFqI3pFUc8
77	Dellinger, A. S., Penneys, D. S., Staedler, Y. M., Fragner, L., Weckwerth, W., & Schönenberger, J. (2014). A specialized bird pollination system with a bellows mechanism for pollen transfer and staminal food body rewards. Current Biology, 24(14), 1615-1619.	Plants Blast Pollinating Passerine Birds with Pollen Clouds https://youtu.be/nqQbK0Ypk5M
78	Cortesi, F., Feeney, W. E., Ferrari, M. C., Waldie, P. A., Phillips, G. A., McClure, E. C., ... & Cheney, K. L. (2015). Phenotypic plasticity confers multiple fitness benefits to a mimic. Current Biology, 25(7), 949-954.	A Wolf in Sheep's Clothes: Deceptions through Flexible Color Changes in a Coral Reef Fish Mimic https://youtu.be/UFUQYFdZwlw
79	Dutel, H., Herbin, M., Clément, G., & Herrel, A. (2015). Bite force in the extant coelacanth Latimeria: the role of the intracranial joint and the basicranial muscle. Current Biology, 25(9), 1228-1233.	Bite Force of the Living Coelacanth https://youtu.be/P6eYlZ_EfHU
80	Couvillon, M. J., Al Toufailia, H., Butterfield, T. M., Schrell, F., Ratnieks, F. L., & Schürch, R. (2015). Caffeinated forage tricks honeybees into increasing foraging and recruitment behaviors. Current Biology, 25(21), 2815-2818.	Caffeinated Forage Tricks Foraging Honeybees/ Curr. Biol., Oct. 15, 2015 (Vol. 25, Issue 21) https://youtu.be/SNirW8IK87k
81	Laurance, W. F., Sloan, S., Weng, L., & Sayer, J. A. (2015). Estimating the environmental costs of Africa's massive "development	Impacts of Africa's Development Corridors/ Curr. Biol., Nov. 25, 2015 (Vol. 25, Issue 24) https://youtu.be/lWX8ec5zbFQ

	Scientific paper	Video title
	corridors”. Current Biology, 25(24), 3202-3208.	
82	Last, K. S., Hobbs, L., Berge, J., Brierley, A. S., & Cottier, F. (2016). Moonlight drives ocean-scale mass vertical migration of zooplankton during the Arctic winter. Current Biology, 26(2), 244-251.	Moonlight Mass Migration of Zooplankton/ Curr. Biol., Jan. 7, 2016 (Vol. 26, Issue 2) https://youtu.be/ITI7PjpvfTg
83	Friedlaender, A. S., Goldbogen, J. A., Nowacek, D. P., Read, A. J., Johnston, D., & Gales, N. (2014). Feeding rates and under-ice foraging strategies of the smallest lunge filter feeder, the Antarctic minke whale (Balaenoptera bonaerensis). Journal of Experimental Biology, 217(16), 2851-2854.	Kinematic Diversity in Rorqual Feeding Mechanisms/ Curr. Biol., Sep. 22, 2016 (Vol. 26, Issue 19) https://youtu.be/dw3oL6vCVnM
84	Nagelkerken, I., Goldenberg, S. U., Ferreira, C. M., Russell, B. D., & Connell, S. D. (2017). Species interactions drive fish biodiversity loss in a high-CO2 world. Current Biology, 27(14), 2177-2184.	Fish Biodiversity Loss in a High-CO2 World/ Curr. Biol., Jul. 6, 2017 (Vol. 27, Issue 14) https://youtu.be/fUMPQ4ODQJ8
85	Shine, R. R., Bustamante, P., & Goiran, C. (2017). Industrial Melanism in the Seasnake Emydocephalus annulatus.	Industrial Melanism in a Seasnake/ Curr. Biol., Aug. 10, 2017 (Vol. 27, Issue 16) https://youtu.be/Neg6GldQlMg
86	Huber, R., & Knaden, M. (2017). Homing ants get confused when nest cues are also route cues. Current Biology, 27(23), 3706-3710.	How Ants Deal with Confusing Cues/ Curr. Biol., Nov. 22, 2017 (Vol. 27, Issue 23) https://youtu.be/UrYosN1TETM
87	Mays Jr, H. L., Hung, C. M., Shaner, P. J., Denvir, J., Justice, M., Yang, S. F., ... & Primerano, D. A. (2018). Genomic analysis of demographic history and ecological niche modeling in the endangered Sumatran rhinoceros Dicerorhinus sumatrensis. Current Biology, 28(1), 70-76.	Sumatran Rhinoceros Population History/ Curr. Biol., Dec. 14, 2017 (Vol. 28, Issue 1) https://youtu.be/3s4ARLCalks
88	Voigt, M., Wich, S. A., Ancrenaz, M., Meijaard, E., Abram, N., Banes, G. L., ... & Gaveau, D. (2018). Global demand for natural resources eliminated more than 100,000 Bornean orangutans. Current Biology, 28(5), 761-769.	Dramatic Decline of Bornean Orangutans/ Curr. Biol., Feb. 15, 2018 (Vol. 28, Issue 5) https://youtu.be/yWzTL79D81U
89	Jones, K. R., Klein, C. J., Halpern, B. S., Venter, O., Grantham, H., Kuempel, C. D., ... & Watson, J. E. (2018). The location and protection status of Earth’s diminishing marine wilderness. Current Biology, 28(15), 2506-2512.	Mapping Earth's Diminishing Marine Wilderness/ Curr. Biol., Jul. 26, 2018 (Vol. 28, Issue 15) https://youtu.be/yUYPSAhpqBA
90	Corl, A., Bi, K., Luke, C., Challa, A. S., Stern, A. J., Sinervo, B., & Nielsen, R. (2018). The genetic basis of adaptation following plastic changes in coloration in a novel environment. Current Biology, 28(18), 2970-2977.	Plasticity and Adaptation in a Novel Environment/ Curr. Biol., Sep. 6, 2018 (Vol. 28, Issue 18) https://youtu.be/JnbebwU_bsI
91	Mennill, D. J., Doucet, S. M., Newman, A. E., Williams, H., Moran, I. G., Thomas, I. P., ... & Norris, D. R. (2018). Wild birds learn songs from experimental vocal tutors. Current Biology, 28(20), 3273-3278.	Wild Birds Learn Songs from Experimental Vocal Tutors/Curr. Biol., Oct. 22, 2018 (Vol. 28, Issue 20) https://youtu.be/uASnwll8Nfo
92	Martin, S. J., Funch, R. R., Hanson, P. R., & Yoo, E. H. (2018). A vast 4,000-year-old spatial pattern of termite mounds. Current Biology, 28(22), R1292-R1293.	Vast 4,000-Year-Old Spatial Pattern of Termite Mounds/Curr. Biol., Nov. 19, 2018 (Vol. 28, Issue 22) https://youtu.be/uXlS48mptbM

	Scientific paper	Video title
93	Demartsev, V., Strandburg-Peshkin, A., Ruffner, M., & Manser, M. (2018). Vocal turn-taking in meerkat group calling sessions. Current Biology, 28(22), 3661-3666.	Vocal Turn-Taking in Meerkat Group Calling Sessions/ Curr. Biol., Nov. 8, 2018 (Vol. 28, Issue 22) https://youtu.be/nF3JUzdmG2Y
94	Samplonius, J. M., & Both, C. (2019). Climate change may affect fatal competition between two bird species. Current Biology, 29(2), 327-331.	Fatal Competition between Two Bird Species/ Curr. Biol., Jan. 10, 2019 (Vol. 29, Issue 2) https://youtu.be/CECWUe3lWFw
95	Sonnenberg, B. R., Branch, C. L., Pitera, A. M., Bridge, E., & Pravosudov, V. V. (2019). Natural selection and spatial cognition in wild food-caching mountain chickadees. Current Biology, 29(4), 670-676.	Natural Selection and Spatial Cognition/ Curr. Biol., Feb. 7, 2019 (Vol. 29, Issue 4) https://youtu.be/a69lKv65mZk
96	Kalan, A. K., Hohmann, G., Arandjelovic, M., Boesch, C., McCarthy, M. S., Agbor, A., ... & Bocksberger, G. (2019). Novelty response of wild African apes to camera traps. Current Biology, 29(7), 1211-1217.	Reactions to Camera Traps by Wild Great Apes/ Curr. Biol., Mar. 14, 2019 (Vol. 29, Issue 7) https://youtu.be/otyssW1P968
97	Wild, S., Krützen, M., Rankin, R. W., Hoppitt, W. J., Gerber, L., & Allen, S. J. (2019). Long-term decline in survival and reproduction of dolphins following a marine heatwave. Current Biology, 29(7), R239-R240.	Cascading Impacts of Heatwave Hit Dolphins Hard/ Curr. Biol., Apr. 1, 2019 (Vol. 29, Issue 7) https://youtu.be/CcAJNcAnBDg
98	Roth, S., Balvín, O., Siva-Jothy, M. T., Di Iorio, O., Benda, P., Calva, O., ... & Naylor, R. (2019). Bedbugs evolved before their bat hosts and did not co-speciate with ancient humans. Current Biology, 29(11), 1847-1853.	New Bedbug Phylogeny/ Curr. Biol., May 16, 2019 (Vol. 29, Issue 11) https://youtu.be/zjfwBlH2pzY
99	Baldock, K. C., Goddard, M. A., Hicks, D. M., Kunin, W. E., Mitschunas, N., Morse, H., ... & Staniczenko, P. P. (2019). A systems approach reveals urban pollinator hotspots and conservation opportunities. Nature ecology & evolution, 3(3), 363-373.	How to help pollinators in cities https://youtu.be/JsypVU8VkS4
100	Peleg, O., Peters, J. M., Salcedo, M. K., & Mahadevan, L. (2018). Collective mechanical adaptation of honeybee swarms. Nature Physics, 14(12), 1193-1198.	Shake those bees back and forth: Smart swarm intelligence https://youtu.be/jswSJznyvDI
101	Graham, N. A., Wilson, S. K., Carr, P., Hoey, A. S., Jennings, S., & MacNeil, M. A. (2018). Seabirds enhance coral reef productivity and functioning in the absence of invasive rats. Nature, 559(7713), 250-253.	Of Rats and Reefs: How rodents are harming tropical coral https://youtu.be/fLlr-4IU7d4
102	Chong, A. Y. Y., Johnson, R. N., O'Meally, D., Chen, Z., Etherington, G. J., Ho, S. Y. W., ... & Dennison, S. (2018). Adaptation and conservation insights from the koala genome. Nature Genetics, 50.	The koala code: Secrets of the koala genome https://youtu.be/tcMCni28nNo
103	Moran, D., & Kanemoto, K. (2017). Identifying species threat hotspots from global supply chains. Nature Ecology & Evolution, 1(1), 1-5.	The trade routes that threaten biodiversity https://youtu.be/Jk2nccG701s
104	Mullen, A. D., Treibitz, T., Roberts, P. L., Kelly, E. L., Horwitz, R., Smith, J. E., & Jaffe, J. S. (2016). Underwater microscopy for in situ studies of benthic ecosystems. Nature communications, 7(1), 1-9.	Coral close-ups https://youtu.be/kXgEKLC63mw
105	Midgley, J. J., White, J. D., Johnson, S. D., & Bronner, G. N. (2015). Faecal mimicry by	Smelly seeds fool dung beetles https://youtu.be/CSuskDPoWNU

	Scientific paper	Video title
	seeds ensures dispersal by dung beetles. Nature Plants, 1(10), 1-3.	
106	Hauser, O. P., Rand, D. G., Peysakhovich, A., & Nowak, M. A. (2014). Cooperating with the future. Nature, 511(7508), 220-223.	Handing on a sustainable future https://youtu.be/xrXyRJV96mk
107	Greenblatt, J. B., & Saxena, S. (2015). Autonomous taxis could greatly reduce greenhouse-gas emissions of US light-duty vehicles. Nature Climate Change, 5(9), 860-863.	Go green, go driverless! https://youtu.be/iezUmvPUDGw
108	Merckx, V. S. F. T., Hendriks, K. P., Beentjes, K. K., Mennes, C. B., Becking, L. E., Peijnenburg, K. T. C. A., ... & Buang, M. M. (2015). YC, Dow R, Feijen FAA, Feijen H, Soest CF, Geml J, Geurts R, Gravendeel B, Hovenkamp P, Imbun P, Ipor I, Janssens SB, Jocqué M, Kappes H, Khoo E, Koomen P, Lens F, Majapun RJ, Morgado LN, Neupane S, Nieser N, Pereira JT, Rahman H, Sabran S, Sawang A, Schwallier RM, Shim PS, Smit H, Sol N, Spait M, Stech M, Stokvis F, Sugau JB, Suleiman M, Sumail S, Thomas DC, van Tol J, Tuh FYY, Yahya BE, Nais J, Repin R, Lakim M, Schilthuizen M. 2015. Evolution of endemism on a young tropical mountain. Nature, 524, 347-350.	Jungle Genetics https://youtu.be/thTadunA8eQ
109	van Kleunen, M., Dawson, W., Essl, F. et al. Global exchange and accumulation of non-native plants. Nature 525, 100–103 (2015).	Plant Invaders https://youtu.be/bRpdPLkzl1E
110	Crowther, T. W., Glick, H. B., Covey, K. R., Bettigole, C., Maynard, D. S., Thomas, S. M., ... & Tuanmu, M. N. (2015). Mapping tree density at a global scale. Nature, 525(7568), 201-205.	How many trees are there in the world? https://youtu.be/jqdOkXQngw8
111	Bruce, T. J., Aradottir, G. I., Smart, L. E., Martin, J. L., Caulfield, J. C., Doherty, A., ... & Jones, H. D. (2015). The first crop plant genetically engineered to release an insect pheromone for defence. Scientific reports, 5, 11183.	Genetically engineered wheat releases insect pheromones to ward off pests https://youtu.be/PccO6sCLADM
112	Depczynski, M., Gagliano, M., Vyazovskiy, V. V., Borbely, A. A., & Grimonprez, M. (2016). Learning by Association in Plants. Null.	Pondering pea plants - Can plants learn? https://youtu.be/LCvwyScn9jU
113	Rasmussen, C. M., Ullmann, C. V., Jakobsen, K. G., Lindskog, A., Hansen, J., Hansen, T., ... & Nielsen, A. T. (2016). Onset of main Phanerozoic marine radiation sparked by emerging Mid Ordovician icehouse. Scientific Reports, 6(1), 1-9.	Climatic cooling during the Ordovician caused explosion of marine diversity https://youtu.be/iBc9SK2_X3U
114	Junqueira, A. C. M., Ratan, A., Acerbi, E., Drautz-Moses, D. I., Premkrishnan, B. N., Costea, P. I., ... & Subramanian, P. (2017). The microbiomes of blowflies and houseflies as bacterial transmission reservoirs. Scientific reports, 7(1), 1-15.	Houseflies and blowflies efficiently deliver pathogens from decaying matter right to your door https://youtu.be/lXG7XOx8mJI
115	Haustein, K., Allen, M. R., Forster, P. M., Otto, F. E. L., Mitchell, D. M., Matthews, H. D., & Frame, D. J. (2017). A real-time Global Warming Index, Sci. Rep., 7, 15417.	A real-time Global Warming Index https://youtu.be/2pfEPgPpARc

	Scientific paper	Video title
116	Eng, M. L., Stutchbury, B. J., & Morrissey, C. A. (2017). Imidacloprid and chlorpyrifos insecticides impair migratory ability in a seed-eating songbird. Scientific Reports, 7(1), 1-9.	Common pesticides pose threat to seed-eating songbirds https://youtu.be/i5rkN154PO8
117	Crane, P. R. (2019). An evolutionary and cultural biography of ginkgo. Plants, People, Planet, 1(1), 32-37.	Peter Crane: An evolutionary and cultural biography of ginkgo https://youtu.be/OJq7XWxYnJQ
118	Thorogood, C. J. (2019). Oxygyne: An extraordinarily elusive flower. Plants, People, Planet, 1(2).	Chris Thorogood: Oxygyne – an extraordinarily elusive flower https://youtu.be/nkCGICXhFHE
119	Lovejoy, T. E. (2019). Look back lest you fail to mark the path ahead. Plants, People, Planet, 1(2), 71-76.	Thomas Lovejoy: Look back lest you fail to mark the path ahead https://youtu.be/c4a-liM9eLo
120	Kountche, B. A., Jamil, M., Yonli, D., Nikiema, M. P., Blanco-Ania, D., Asami, T., ... & Al-Babili, S. (2019). Suicidal germination as a control strategy for Striga hermonthica (Benth.) in smallholder farms of sub-Saharan Africa. Plants, People, Planet, 1(2), 107-118.	Harnessing plant hormones for food security https://youtu.be/HConb99yhcI
121	Thorogood, C. (2019). Hydnora: The strangest plant in the world?. Plants, People, Planet, 1(1), 5-7.	Chris Thorogood – Hydnora: the strangest plant in the world? Flora Obscura https://youtu.be/4l3pftfCy_w
122	Coker, T. L., Rozsypálek, J., Edwards, A., Harwood, T. P., Butfoy, L., & Buggs, R. J. (2019). Estimating mortality rates of European ash (Fraxinus excelsior) under the ash dieback (Hymenoscyphus fraxineus) epidemic. Plants, People, Planet, 1(1), 48-58.	Tim Coker: Estimating mortality of European ash under the ash dieback epidemic https://youtu.be/9u9ZXAvLHGo
123	Smith, P. (2019). The challenge for botanic garden science. Plants, People, Planet, 1(1), 38-43.	Paul Smith: The challenge for botanic garden science https://youtu.be/wMNGGeLeQeg
124	Yang, H., Wang, X., & Tian, J. (2019). Beautiful genes, beautiful plants. Plants, People, Planet, 1(1), 27-31.	Huanming Yang: Beautiful genes, beautiful plants https://youtu.be/3zzcswEWx7c
125	Knapp, S. (2019). People and plants: The unbreakable bond. Plants, People, Planet, 1(1), 20-26.	Sandra Knapp – People and plants: the unbreakable bond https://youtu.be/sAD_TQhSEoQ
126	Reed, T. E., Jenouvrier, S., & Visser, M. E. (2013). Phenological mismatch strongly affects individual fitness but not population demography in a woodland passerine. Journal of Animal Ecology, 82(1), 131-144.	Climate change and phenological mismatch https://vimeo.com/61793002
127	Steyaert, S. M., Kindberg, J., Swenson, J. E., & Zedrosser, A. (2013). Male reproductive strategy explains spatiotemporal segregation in brown bears. Journal of Animal Ecology, 82(4), 836-845.	Infanticide and segregation in brown bears https://vimeo.com/61726431
128	Stahler, D. R., MacNulty, D. R., Wayne, R. K., VonHoldt, B., & Smith, D. W. (2013). The adaptive value of morphological, behavioural and life-history traits in reproductive female wolves. Journal of Animal Ecology, 82(1), 222-234.	Behaviour, morphology and life histories of reproductive female wolves https://vimeo.com/61790660
129	Cassirer, E. F., Plowright, R. K., Manlove, K. R., Cross, P. C., Dobson, A. P., Potter, K. A., & Hudson, P. J. (2013). Spatio-temporal dynamics of pneumonia in bighorn sheep. Journal of Animal Ecology, 82(3), 518-528.	The dynamics of bighorn sheep pneumonia https://vimeo.com/61796112

	Scientific paper	Video title
130	Burkholder, D. A., Heithaus, M. R., Fourqurean, J. W., Wirsing, A., & Dill, L. M. (2013). Patterns of top-down control in a seagrass ecosystem: could a roving apex predator induce a behaviour-mediated trophic cascade?. Journal of animal ecology, 82(6), 1192-1202.	A behaviour-mediated trophic cascade https://vimeo.com/67285828
131	Matich, P., & Heithaus, M. R. (2014). Multi-tissue stable isotope analysis and acoustic telemetry reveal seasonal variability in the trophic interactions of juvenile bull sharks in a coastal estuary. Journal of Animal Ecology, 199-213.	Seasonal variability in trophic interactions of juvenile bulls sharks https://vimeo.com/69532148
132	Szostek, K. L., Schaub, M., & Becker, P. H. (2014). Immigrants are attracted by local pre-breeders and recruits in a seabird colony. Journal of Animal Ecology, 83(5), 1015-1024.	Immigration and demography in a seabird colony https://vimeo.com/87672398
133	Martín-Vivaldi, M., Soler, J. J., Peralta-Sánchez, J. M., Arco, L., Martín-Platero, A. M., Martínez-Bueno, M., ... & Valdivia, E. (2014). Special structures of hoopoe eggshells enhance the adhesion of symbiont-carrying uropygial secretion that increase hatching success. Journal of animal ecology, 83(6), 1289-1301.	Mutualism between hoopoes and bacteria https://vimeo.com/99734614
134	Marsh, L., Copley, J. T., Tyler, P. A., & Thatje, S. (2015). In hot and cold water: differential life-history traits are key to success in contrasting thermal deep-sea environments. Journal of Animal Ecology, 84(4), 898-913.	In hot and cold water: differential life-history traits are key to success in contrasting thermal deep-sea environments https://vimeo.com/121119680
135	DeMars, C. A., & Boutin, S. (2018). Nowhere to hide: effects of linear features on predator–prey dynamics in a large mammal system. Journal of Animal Ecology, 87(1), 274-284.	Nowhere to hide… https://vimeo.com/274488509
136	Araújo, M. B., Anderson, R. P., Barbosa, A. M., Beale, C. M., Dormann, C. F., Early, R., ... & O'Hara, R. B. (2019). Standards for distribution models in biodiversity assessments. Science Advances, 5(1), eaat4858.	Araújo et al. 2019. Standards for distribution models in biodiversity assessments. Science Advances https://youtu.be/iS31WaKMW_Y
137	Jesmer, B. R., Merkle, J. A., Goheen, J. R., Aikens, E. O., Beck, J. L., Courtemanch, A. B., ... & Kauffman, M. J. (2018). Is ungulate migration culturally transmitted? Evidence of social learning from translocated animals. Science, 361(6406), 1023-1025.	How bighorn sheep use crowdsourcing to find food on the hoof https://youtu.be/u3s7gY8Sy7Q
138	Houghton, I.A., Koseff, J.R., Monismith, S.G. et al. Vertically migrating swimmers generate aggregation-scale eddies in a stratified column. Nature 556, 497–500 (2018).	Tiny shrimp may be mixing ocean water as much as the wind and waves https://youtu.be/dJKrPuohvYA
139	Crall, J. D., Switzer, C. M., Oppenheimer, R. L., Versypt, A. N. F., Dey, B., Brown, A., ... & de Bivort, B. L. (2018). Neonicotinoid exposure disrupts bumblebee nest behavior, social networks, and thermoregulation. Science, 362(6415), 683-686.	New tracking system could show how pesticides are harming bee colonies https://youtu.be/U2GBYG5RwEI
140	Milliner, C., Materna, K., Bürgmann, R., Fu, Y., Moore, A. W., Bekaert, D., ... & Argus, D. F. (2018). Tracking the weight of Hurricane	Watch a hurricane put a dent in Earth's crust https://youtu.be/1sVrc-9nMGU

	Scientific paper	Video title
	Harvey's stormwater using GPS data. Science advances, 4(9), eaau2477.	
141	Johnson, M. T., & Munshi-South, J. (2017). Evolution of life in urban environments. Science, 358(6363).	Cities are putting pressure on animals' genes, from bobcats to gulls to bedbugs https://youtu.be/wBc-Oa-snm4
142	Connolly, C. N. (2017). Nerve agents in honey. Science, 358(6359), 38-39.	Pesticides found in honey around the world https://youtu.be/0j7C_KQp8qM
143	Chown, S. L. (2017). Tsunami debris spells trouble. Science, 357(6358), 1356-1356.	Megarafting animals rode from Japan to US and Canada after the 2011 tsunami https://youtu.be/L3QGiPpXaC0
144	Von Euw, S., Zhang, Q., Manichev, V., Murali, N., Gross, J., Feldman, L. C., ... & Falkowski, P. G. (2017). Biological control of aragonite formation in stony corals. Science, 356(6341), 933-938.	Corals can still grow their 'bones' in acid waters https://youtu.be/Z4OCZWWoWls
145	Obradovich, N., Migliorini, R., Mednick, S. C., & Fowler, J. H. (2017). Nighttime temperature and human sleep loss in a changing climate. Science advances, 3(5), e1601555.	Scientists warn of sleepless nights in a warming world https://youtu.be/IydJa1LuCwI
146	Smith, T. M., Austin, C., Hinde, K., Vogel, E. R., & Arora, M. (2017). Cyclical nursing patterns in wild orangutans. Science advances, 3(5), e1601517.	Orangutans nurse the longest of all mammals https://youtu.be/lOCHsipaBKg
147	Lamb, J. B., Van De Water, J. A., Bourne, D. G., Altier, C., Hein, M. Y., Fiorenza, E. A., ... & Harvell, C. D. (2017). Seagrass ecosystems reduce exposure to bacterial pathogens of humans, fishes, and invertebrates. Science, 355(6326), 731-733.	Seagrass can half concentrations of harmful bacteria https://youtu.be/0KYp6nbzBiA
148	Wilf, P., Carvalho, M. R., Gandolfo, M. A., & Cúneo, N. R. (2017). Eocene lantern fruits from Gondwanan Patagonia and the early origins of Solanaceae. Science, 355(6320), 71-75.	Tomato ancestor evolved 50 million years ago near Antarctica https://youtu.be/r3X__rx2NwY
149	Hu, G., Lim, K. S., Horvitz, N., Clark, S. J., Reynolds, D. R., Sapir, N., & Chapman, J. W. (2016). Mass seasonal bioflows of high-flying insect migrants. Science, 354(6319), 1584-1587.	Masses of insects on the move https://youtu.be/DVOkWRo87DM
150	Kromdijk, J., Głowacka, K., Leonelli, L., Gabilly, S. T., Iwai, M., Niyogi, K. K., & Long, S. P. (2016). Improving photosynthesis and crop productivity by accelerating recovery from photoprotection. Science, 354(6314), 857-861.	Turning up plant efficiency https://youtu.be/Av0dTk9KzlY
151	Birks, H. J. B., Birks, H. H., & Ammann, B. (2016). The fourth dimension of vegetation. Science, 354(6311), 412-413.	Pollen, practically indestructible https://youtu.be/NM-N76qWMtQ
152	Solomon, S., Ivy, D. J., Kinnison, D., Mills, M. J., Neely, R. R., & Schmidt, A. (2016). Emergence of healing in the Antarctic ozone layer. Science, 353(6296), 269-274.	Ozone layer on the mend, thanks to chemical ban https://youtu.be/sFTfkuae8lM
153	Anandhi, A., Sharma, A., & Sylvester, S. (2018). Can meta-analysis be used as a decision-making tool for developing scenarios and causal chains in eco-hydrological systems? Case study in Florida. Ecohydrology, 11(7), e1997.	A 3-in-1 tool for climate change and resiliency assessments https://youtu.be/ddcuq5tgHHQ

	Scientific paper	Video title
154	Dittrich, R., Giessing, B., Benito, M. M., Russ, A., Wolf, C., Foudoulakis, M., & Norman, S. (2019). Multiyear monitoring of bird communities in chlorpyrifos-treated orchards in Spain and the United Kingdom: Spatial and temporal trends in species composition, abundance, and site fidelity. Environmental toxicology and chemistry, 38(3), 616-629.	The use of a pesticide poses low risk to bird communities https://youtu.be/EC6pjhloZpg
155	Colvin, S. A., Sullivan, S. M. P., Shirey, P. D., Colvin, R. W., Winemiller, K. O., Hughes, R. M., ... & Danehy, R. J. (2019). Headwater streams and wetlands are critical for sustaining fish, fisheries, and ecosystem services. Fisheries, 44(2), 73-91.	Rule change threatens ecological lifelines in US https://youtu.be/cLlDhqzM21Q
156	Carlson, A. K., Taylor, W. W., Kinnison, M. T., Sullivan, S. M. P., Weber, M. J., Melstrom, R. T., ... & Zydlewski, G. B. (2019). Threats to freshwater fisheries in the United States: perspectives and investments of state fisheries administrators and agricultural experiment station directors. Fisheries, 44(6), 276-287.	Putting threats to freshwater fisheries into perspective https://youtu.be/pivGz_uMylI
157	Raatz, M., van Velzen, E., & Gaedke, U. (2019). Co-adaptation impacts the robustness of predator–prey dynamics against perturbations. Ecology and evolution, 9(7), 3823-3836.	Co-adaptation affects how predator and prey ride out environmental changes https://youtu.be/070FBj6Lfe4
158	Wutich, A., Budds, J., Jepson, W., Harris, L. M., Adams, E., Brewis, A., ... & Miller, J. (2018). Household water sharing: A review of water gifts, exchanges, and transfers across cultures. Wiley Interdisciplinary Reviews: Water, 5(6), e1309.	The cultural, economic, and health implications of water sharing https://youtu.be/qF1QIYTtsSs
159	Staal, A., van Nes, E. H., Hantson, S., Holmgren, M., Dekker, S. C., Pueyo, S., ... & Scheffer, M. (2018). Resilience of tropical tree cover: the roles of climate, fire, and herbivory. Global Change Biology, 24(11), 5096-5109.	A look at tropical ecosystem structure in the face of fires, herbivory, and climate change https://youtu.be/_3ShxMfjQYc
160	Chazdon, R. L., Brancalion, P. H., Laestadius, L., Bennett-Curry, A., Buckingham, K., Kumar, C., ... & Wilson, S. J. (2016). When is a forest a forest? Forest concepts and definitions in the era of forest and landscape restoration. Ambio, 45(5), 538-550.	Seeing the definition through the trees: a framework for re-defining forests https://youtu.be/mLmhGltGcGQ
161	Siam, M. S., & Eltahir, E. A. (2017). Climate change enhances interannual variability of the Nile river flow. Nature Climate Change, 7(5), 350-354.	Highs and lows of climate change: Nile river likely to see more extreme floods and droughts https://youtu.be/KoSP4Fm62Iw
162	Sosef, M. S., Dauby, G., Blach-Overgaard, A., Van Der Burgt, X., Catarino, L., Damen, T., ... & Duarte, M. C. (2017). Exploring the floristic diversity of tropical Africa. BMC biology, 15(1), 1-23.	Exploring plant diversity of tropical Africa https://youtu.be/fNCSIvjxRq8
163	Samaš, P., Rutila, J., & Grim, T. (2016). The common redstart as a suitable model to study cuckoo-host coevolution in a unique ecological context. BMC Evolutionary Biology, 16(1), 255.	Taking over the nest: when parasite chicks are brought up by cavity nesting hosts https://youtu.be/Pl63cvnvkgk

	Scientific paper	Video title
164	Holding, J. M., Duarte, C. M., Sanz-Martín, M., Mesa, E., Arrieta, J. M., Chierici, M., ... & Reigstad, M. (2015). Temperature dependence of CO 2-enhanced primary production in the European Arctic Ocean. Nature Climate Change, 5(12), 1079-1082.	Temperature dependence of CO2-enhanced primary production in the European Arctic Ocean https://youtu.be/kwoyVMxk290
165	Molinos, J. G., Halpern, B. S., Schoeman, D. S., Brown, C. J., Kiessling, W., Moore, P. J., ... & Burrows, M. T. (2016). Climate velocity and the future global redistribution of marine biodiversity. Nature Climate Change, 6(1), 83-88.	Climate velocity and the future global redistribution of marine biodiversity https://youtu.be/JZptVz5IxOw
166	Viranta, S., Atickem, A., Werdelin, L., & Stenseth, N. C. (2017). Rediscovering a forgotten canid species. BMC Zoology, 2(1), 6.	A wolf in jackal's clothing Re discovering an African wolf species https://youtu.be/UuSb1IxdPAU
167	Feng, C., Wang, Z., Zhu, Q., Fu, S., & Chen, H. Y. (2018). Rapid increases in fine root biomass and production following cessation of anthropogenic disturbances in degraded forests. Land Degradation & Development, 29(3), 461-470.	A look at fine roots supports China's efforts at forest conservation https://vimeo.com/252402191
168	Franke, F., Armitage, S. A., Kutzer, M. A., Kurtz, J., & Scharsack, J. P. (2017). Environmental temperature variation influences fitness trade-offs and tolerance in a fish-tapeworm association. Parasites & vectors, 10(1), 252.	How temperature influences the fitness of fish and their tapeworm parasites https://youtu.be/ZBmXcYjgwcg
169	Kleindorfer, S., & Dudaniec, R. Y. (2016). Host-parasite ecology, behavior and genetics: a review of the introduced fly parasite Philornis downsi and its Darwin's finch hosts. BMC Zoology, 1(1), 1.	Modern evolutionary lessons from the Galapagos parasitic flies and Darwin's finches https://youtu.be/YfkMFxBZSns
170	Von Beeren, C., & Tishechkin, A. K. (2017). Nymphister kronaueri von Beeren & Tishechkin sp. nov., an army ant-associated beetle species (Coleoptera: Histeridae: Haeteriinae) with an exceptional mechanism of phoresy. BMC Zoology, 2(1), 3.	New species of beetle discovered hitchhiking on ants https://youtu.be/6R1LtmL47UE
171	Stafford-Smith, M., Griggs, D., Gaffney, O., Ullah, F., Reyers, B., Kanie, N., ... & O'Connell, D. (2017). Integration: the key to implementing the Sustainable Development Goals. Sustainability Science, 12(6), 911-919.	Promoting sustainability through connection https://vimeo.com/248151806

Appendix B: Grid analysis for video abstract categorization

Number from dataset: #		
Date:		
Video general description		
Channel:		
Title:		
Length:	Date of publication:	
Nº of subscribers:	Nº of views:	
Nº of likes:	Nº of dislikes:	
Nº of comments:	Presence in the official page of the journal (Y/N):	
Paper general description		
Journal:		
Editor:		
Title:		
Nº of citations:	Date of publication:	
Altmetric:	Scientific area:	
Country of origin of the first author:		
Video design description		
Thumbnail description:		
Narrator´s gender	Female	
	Male	
	No gender	
Number of narrators:		
Type of narration	First-person	
	Third-person	
	First + Third persons	
Style of the production	Still images	
	Moving images	
	Still + moving images	
Type of production	Amateur	
	Semi-professional	
	Professional	
Location(s)	Indoor	
	Outdoor	
	Indoor + Outdoor	
Number of takes	1	
	2	
	>3	
Shots used	Extreme long shot	
	Long shot	
	Medium long shot	
	Medium shot	
	Medium close-up	
	Close-up	
	Extreme close-up	
	Other	
Format	Animation	
	Documentary	
	Dynamic Presentation	
	Monologue	
	Simple Presentation	

Intro description:		
Outro description:		
Additional elements	Pictures	
	Graphics	
	Maps	
	Titles	
	Others	
Sound design	Music in intro	
	Music in outro	
	Music in body	
	Ambient sound	
	Additional sound effects	
	Other	
Audio quality	Good	
	Bad	
	No sound	
Narrator´s voice quality	Good	
	Bad	
	No narration	
Observations:		

Appendix C: Experts profile and occupation

	Age	Education	Area	Occupation
Expert 1	40	PhD	Biology	Researcher
Expert 2	40	PhD	Biology	Researcher
Expert 3	35	MSc	Biology	Researcher
Expert 4	39	MSc	Biology	Science Manager
Expert 5	41	MSc	Philosophy	Researcher
Expert 6	39	MSc	Environmental Sciences	Researcher
Expert 7	32	MSc	Education	Kindergarten teacher
Expert 8	41	MSc	Biology/Education	Researcher
Expert 9	40	PhD	Biology	Researcher
Expert 10	38	PhD	Sociology	Researcher
Expert 11	40	PhD	Biology	Researcher
Expert 12	33	MSc	Data Science	Data scientist
Expert 13	36	MSc	Biology	Researcher
Expert 14	31	MSc	Design	Graphic designer
Expert 15	29	MSc	Marketing	Marketing technician
Expert 16	31	MSc	Education	Kindergarten teacher
Expert 17	41	PhD	Geology	Researcher
Expert 18	42	PhD	Sociology	Researcher
Expert 19	32	MSc	Communication	Show technician
Expert 20	45	MSc	Chemistry	Teacher
Expert 21	37	MSc	Journalism	Videographer
Expert 22	39	PhD	Biology	Researcher
Expert 23	35	MSc	Multimedia	Freelancer
Expert 24	35	MSc	Chemistry	Science communicator
Expert 25	39	MSc	Biology	Science communicator
Expert 26	30	MSc	Medical anthropology	Researcher
Expert 27	40	PhD	Biology	Videographer

Expert 28	31	MSc	Biology	Researcher
Expert 29	29	MSc	Multimedia	Videographer
Expert 30	43	PhD	Mathematics	Rsearcher

Appendix D: Questionnaire on viewing habits and video abstract importance

1. How often do you watch science videos (a science video is a short audio-visual format with scientific content, which aims to reach a wider audience, using resources that adapt scientific aspects to the general public, keeping its rigour and precision)?

- Very often
- Often
- Sometimes
- Rarely
- Never
- Do not know/Do not answer

2. Do you consider that the existence of a video abstract benefits the dissemination of your research?

- Yes
- No
- Do not know/Do not answer

3. If you answer "yes" to the previous question, tell us why

Appendix E: Categories created from content analysis on the most and least liked features

1. Audio

a. Sound: references to sound or music;

b. Sound Features: description of the sound attributes;

2. Presentation

a. Narration and Presentation: involves the process of presentation and narration and its actors (e.g., narrative, narrator, presenter, explanation, exposition, presentation, speech and language);

b. Narration and Presentation Features: evaluation of presentation and narration process;

c. Narration and Presentation Dynamics: contains some details of the process of presentation and narration;

3. Topic

a. Theme and Content: comprises all references associated with the topic (e.g., theme, premise, content, idea and information);

b. Theme and Content Features: involves the attributes of the theme and content;

c. Video Moments: comprises the references to a specific act of the video (e.g., conclusions, results, introduction, beginning, methodology, fact sheet and credits);

d. Video Sections Features: includes the characteristics of the previous subcategory;

4. Visual Resources

a. Images: comprises all the references to the used footage (e.g. videos, photos and images, in a general or specific way);

b. Images Features: includes the characteristics of images and videos;

c. Animations: this subcategory includes all references to animations (e.g. infographics, drawings, graphics and stop-motion);

d. Animations Features: comprises all adjectives that classify animations and their use;

e. Graphic Elements: includes all the secondary resources that support the video (e.g., maps, diagrams, subtitles, titles and text);

f. Graphic Elements Features: comprises the features of the previous subcategory;

5. Production

a. Format: indicates the chosen format (e.g., documentary, interview, PowerPoint presentation)

b. Duration: comprises all the references to the length of the video and its features;

c. Production Stages: this subcategory includes every concept related to production, editing, resources, filming areas, structure, organization, script, editing and sets;

d. Video Features: comprises general or specific video traits.

6. Don’t know/Don’t answer

7. Nothing

Appendix F: Questionnaire "Video-abstract in Biology learning”

This survey is part of a doctoral project in science communication, in which three "video abstracts" of three scientific articles written by researchers from the Center for Functional Ecology at the University of Coimbra will be produced.

All scientific articles include a summary. This summary helps other researchers better understand the study discussed in the scientific article before fully reading it. As a general rule, the summaries of a scientific article communicate the framework of the study, the methods used, the results and the future implications of the study. More recently, "video abstract" has also started to be used, better known in English as "video abstract".

The questionnaire is structured in three parts, each consisting of short answer or selection questions. You must answer all the questions and be honest. Your participation in this survey and its data will be completely confidential. Thanks for the collaboration!

PART I

Age: ______ Gender: _____

Parent's Profession:

____

Favourite subject in the current academic year:

____

1. How much do you like each of the following subjects?
2.

	I don't like it at all						I like it a lot	I do not know/I do not want to answer
Biology/Geology	1	2	3	4	5	6	7	
English	1	2	3	4	5	6	7	

3. How often do you use the following study methods for Biology and Geology?

	I never use						I use it very frequently	I do not know/I do not want to answer
School Manual	1	2	3	4	5	6	7	
Other books	1	2	3	4	5	6	7	
Web pages	1	2	3	4	5	6	7	
Online videos	1	2	3	4	5	6	7	
School notes	1	2	3	4	5	6	7	
Others	1	2	3	4	5	6	7	

3. Do you usually watch videos online? YES______ NO_______ (If you answered "no" go to the next question)

If yes, what type of videos?

____

____

____

____

____

4. Let us now talk specifically about science videos.

4.1 How often do you watch science videos?

Very often
Often
Sometimes
Rarely
Never (go to question 4.3)
DK/DA

What are the reasons that lead you to watch science videos?

____

____

____

____

____

In what language?

Portuguese
English
French
German
Other

5. Professionally, what do you see yourself doing in the future?
____
____
____
____
____

PART II

(To be completed after reading the summary/reading the summary and watching the video)

	I totally disagreee	Disagree	Indifferent	Agree	I totally agree	DK/DA
Aquaculture is an important source of human food	1	2	3	4	5	
Aquaculture is a solution to the problem of feeding the world's population	1	2	3	4	5	
Aquaculture is environmentally sustainable	1	2	3	4	5	
Aquaculture is economically sustainable	1	2	3	4	5	
The scientific method is based on the replicability of its procedures	1	2	3	4	5	
To reach a scientific discovery, we have to make mistakes many times	1	2	3	4	5	
Researchers need to work with colleagues from different scientific areas	1	2	3	4	5	

Scientific knowledge is important for the well-being of citizens	1	2	3	4	5	
Science allows us to solve global problems	1	2	3	4	5	
I benefit from science and scientific discoveries in my daily life	1	2	3	4	5	
Science communication is important for the development of society	1	2	3	4	5	
Science communication is important for the development of science itself	1	2	3	4	5	

1. What is aquaculture for you?

____
____
____
____
____

2. Imagine that you are challenged to devise a research plan to study the diet of a species of fish. What would be your first steps?

____
____
____
____
____

3. Describes the work of a researcher in Life Sciences.

____
____
____
____
____

4. Should researchers disseminate and communicate their work? Why?

____
____

PART III

(To be completed only after watching the video and reading the summary)

1. What questions do the study authors aim to answer?

2. What are the study's conclusions presented in the video abstract?

3. What did you learn from the study presented in the video abstract?

4. Say in one sentence what you liked most about this video.

5. Say what you liked the least about this video in one sentence.

6. From 1 to 10, with 1 being "very bad" and 10 being "very good", how would you classify this "video abstract"?

7. Do you have any suggestions for this investigation?

Appendix G: Interview script "Video abstract as an educational tool"

Socio-demographic description

Name:

Gender:

Age:

Education:

Year of completion of the Master's Degree in Teaching Biology and Geology:

Actual occupation:

Motivations, current role and expectations

1. What is your academic background, and what motivated you to enrol in the Masters in Biology and Geology Teaching?

2. What tools did you obtain from the course, and what tools would you like to have obtained?

3. How do you think the teaching of Biology and Geology differs from the teaching of other subjects?

4. How did the pandemic affect your work, and what challenges did it bring? Did you use any new tools for you?

Behaviour with science videos

5. On a personal note, do you usually watch videos online? If so, what type of videos (categories) are viewed, and how often are they viewed?

6. Speaking more specifically about the target category of this study, do you usually watch science videos? If so, what type of videos (typologies) and how often?

7. If you answered yes to the previous question, what makes you watch science videos?

Science videos in the classroom

8. Have you ever used a science video in an educational/classroom context? If so, what type of video?

9. If you answered yes to the previous question, how receptive are students to this type of content? Do they see this kind of video outside of school?

10. How has the pandemic affected your relationship with video on a personal and professional level?

Video abstract evaluation

11. About the object of study of this work, were you familiar with video abstracts? Have you ever seen one? If so, which one?

12. Do you think video abstracts can be of added value in disseminating the research produced by researchers? Why?

13. Specifically, about the video you watched, "Pollination deficit in kiwifruit", what did you think of the length? Is it suitable?

14. What did you think of the topic? Do you think the theme influences our evaluation of a video, or if a video is well made, can any theme be used?

15. What did you think of the sound quality?

16. What did you think of the narration? It was made by one of the researchers who participated in the investigation. What do you think of this choice? Do you think it is better in English to have Portuguese subtitles or vice versa?

17. What did you think of the presence and performance of the two researchers in the video? Is being present an added value? Why?

18. The video mixes several formats: documentary, interview and animation. What do you think of this type of crossover? What formats do you find most exciting in a video of this type?

19. What did you think of the video's production values? Would you have the means to produce a video of this type?

20. What would it be if you could change something in the video?

Video abstract as an educational tool

21. Would you use this video as an educational tool in the classroom context? If so, how? If not, why?

22. Could this type of content be an asset in a pandemic context?

23. Do you think this type of content can replace the written format in some cases or should it always function as complements?

24. Do you consider the connection of secondary students to academia and researchers to be important? Why? Do you think video abstracts can strengthen this relationship?

25. If you wanted to use a CFE video, how would you go about accessing this resource? What would be the most efficient way for you to monetize this information and get the content to schools?