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Recontextualizing specialized knowledge outside Academia: multiple routes to science communication

Coordinatore:
Chiar.mo Prof. Italo TESTA

Tutore:
Chiar.ma Prof.ssa Michela CANEPARI

Dottoranda:
Ilaria GIORDANO

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Table of contents

List of tables

List of figures

Abstract

At present, science and technology-related issues have become integral to the fabric of our contemporary society. However, despite their pivotal role in shaping people's everyday lives, non-experts still encounter a multitude of challenges in acquainting themselves with these topics, mainly because of the overabundance of science-related information and the language barriers posed by the domain-specific discourses. As a result, in the attempt to accurately educate the general public, as well as to prompt meaningful communication between them and the world of Academia, scientists, scholars and institutions alike are now compelled to "redraft and remodel" (Zou & Hyland 2019) the way in which scientific concepts are presented, and to "recontextualise" (Calsamiglia 2003, Gotti 2013) the specialised information into new contexts or formats. In this light, this research sets out to investigate how domain-specific knowledge in the fields of biology, chemistry and Earth sciences is transmitted across three different media, e.g., blogs, YouTube channels and comic books. Grounded in the perspectives of corpus linguistics and discourse analysis, this study endeavours to investigate the rhetorical *dispositio* of the contents and their *elocutio*, namely the specific linguistic and discursive strategies employed for information tailoring purposes. Under scrutiny is a 504,762-word corpus, purposely-built for this research, assembled from authentic blog, video and comic book data (e.g. *CrashCourse Biology*, *SciTechDaily*, *The Cartoon Guides to the Environment*). The insights and reflections derived from the two parallel investigations into the 'moves' and 'steps' that constitute the discourse, and into the items that lexicalise the *docere* and *delectare* rhetorical goals shed light, above all, on the potentialities these media have on the dissemination of specialized information. Furthermore, these results not only provide information on the linguistic, discursive and rhetorical means employed to accommodate science in blogs, videos and comic books, but highlight also a number of similarities and differences that can be observed between these three media.

Keywords: scientific knowledge communication, discourse analysis, information tailoring strategies, science blogs, YouTube educational videos, science comics

Chapter 1

Introduction

1.1 Background to the study

In a 2021 interview with environmental data scientist William Kerney, sociologist Alondra Nelson, elected Deputy Director for Science and Society at the White House Office of Science and Technology Policy (OSTP), asserted that, in the current context, scientific and technological matters “sit in the centre of every policy and social issues”, since “every dimension of national and international policy, from health to education, to security, social welfare, and everything in between, has something to do with science and technology” (Nelson & Kearney 2021: 27).

Yet, this idea is not entirely new to us. As early as 2006, Broks (2006: 1) affirmed that his contemporary culture was “saturated with science”, implying that scientific ideas, methodologies and technological advancements had become deeply intertwined with his contemporary world. Then, a few years later, Daum (2009: 332) also talked about the ‘scientificisation of the everyday life’, highlighting how science and technology had become a major force in shaping the day-to-day existence, the decision-making processes and in providing people with a framework for addressing societal challenges. According to UNESCO, in today’s society, science represents ‘the greatest collective endeavour’, because it is responsible for contributing to ensuring us a longer and healthier quality of life, for monitoring our health, providing us with medicines to cure our diseases, and, last but not least, for generating solutions for our everyday living[1].

Under these conditions, it thus becomes evident that people are now required to become scientifically literate, thus mastering the specialized knowledge that was once solely the domain of a restricted circle of experts (Canepari 2023). Gone are the days when scientists could work within the walls of an ivory tower without sharing information about their work with the public at large: as demonstrated, every aspect of modern society is somehow touched

[1] Retrieved from the UNESCO blog page, available at https://en.unesco.org/themes/science-society.

and shaped by scientific and technological advancements, and individuals need to understand these discourses to make well-informed choices and actively take part in public debate.

Nevertheless, the general public encounters significant challenges in acquainting themselves with the realm of science (Barnfield *et al.* 2017). As US astronomer and science communicator Carl Sagan (1995: 25) aptly stated

> we've arranged a global civilization in which most crucial elements profoundly depend on science and technology. We have also arranged things so that almost no one understands science and technology. This is a prescription for disaster. We might get away with it for a while, but sooner or later this combustible mixture of ignorance and power is going to blow up in our faces.

This situation is attributable to two main reasons. On the one hand, due to the advent of new technologies that allow for an easier and quicker information retrieval, people are nowadays exposed to an overabundance of science-related information coming primarily from social media and news outlets (National Science Board 2020). As a consequence of this ‘infodemic’ (Cinelli *et al.* 2020), individuals are continuously bombarded with a plethora of scientific data, research findings and challenging theories, which make it difficult, especially for those who do not possess a solid scientific and technical background, to retrieve trustworthy information to make well-informed choices (Porat *et al.* 2020). Indeed, as demonstrated by the 2021 European survey concerning citizens’ knowledge and attitudes towards science and technology, only 21% of the respondents claimed to be sufficiently informed about environmental issues, while a mere 13% affirmed to possess adequate knowledge on new medical discoveries (European Commission, Directorate-General for Communication 2021: 13).

On the other hand, another obstacle for lay people approaching science is the language employed in the field. Domain-specific discourses in the realms of science and technology, imbued with technical jargon, complex terminology and dense syntactic structures, present several challenges and obstacles for individuals seeking to retrieve information on specialized topics, often leading them to a feeling of exclusion and a desire to completely withdraw from these topics. Indeed, as showcased by the aforementioned 2021 European survey, nearly 40% of the interviewees defined scientists and researchers as ‘bad at communicating’ and cited a lack of knowledge in the field as the primary motivation for their disengagement from these domains. Additionally, when asked about their perception on the complexity and relevance of science and technology-related issues, 46% of them stated that "science is so complicated that they do not understand much about it", while an additional 33% even concurred with the notion that their day-to-day lives remain unaffected by scientific advancements, and thus they feel no urgency to acquaint themselves with it. (European Commission, Directorate-General for Communication 2021: 15, 44).

Hence, it is not surprising that the consequences of providing the public with inaccessible and overly complex scientific texts can be severe. Above all, as stated by Brownell *et al.* (2013), one of the first drawbacks caused by inaccurate understanding of science is people's rejection of the information in its totality. When faced with complex or unfamiliar scientific concepts, individuals may feel overwhelmed and alienated from those issues, therefore finding it easier to dismiss the information rather than trying to understand it. Then, another possible consequence is the difficulty of discerning accurate and reliable knowledge from misinformation or pseudoscience, with the consequent rapid spread of fake news that can quickly go viral and reach a global-scale audience in just a few clicks (Maci 2019). Finally, another dramatic outcome of this situation is what Broks (2006: 118) calls 'crisis in trust', which presents itself as a progressively widespread weakening in confidence towards institutions, scholarly research and scientists. In this environment of mistrust, individuals do not believe in scientific advancements, in the words of scientists and in the importance of investing in research, consequently causing far-reaching repercussions that hinder societal progresses and improvements in the living conditions of individuals. Even though often underestimated, this phenomenon permeates our everyday lives in a crucial way. This is particularly evident in the findings of the abovementioned 2021 European report, where nearly half of the interviewees asserted that they believed that scientists could not be trusted anymore, as they are increasingly dependent on the money they receive from industries (European Commission, Directorate-General for Communication 2021: 47).

Against this backdrop, it becomes evident that scientists, communicators and institutions alike are now compelled to find new and effective ways to democratise specialized scientific knowledge, in the attempt to accurately educate the general public, as well as to prompt direct and meaningful communication between them and the world of Academia. In this light, popular science thus represents an essential part of the scientific endeavour (Gregory & Miller 1998) and a constituent element of the knowledge production process (Whitley 1985), as it allows non-experts to gain valid knowledge and awareness on the issues, to develop a sense of social cohesion and autonomy in decision-making processes, to grow an interest in the realm of science, and, most of all, to build trust in scientists as 'reliable sources of information' (Turney 1996; Falcone *et al.* 2020; Gay & Lo Dico 2020).

Hence, these are "both exciting and challenging times to be communicating science" (Holliman 2008: 1): practitioners, scholars and institutions are now urged to rethink the way in which they speak to the public, in order to provide them with products that do not simply 'sell' the importance of science and research (Nisbet & Scheufele 2011: 1776), but that effectively contribute to the democratisation of specialised scientific knowledge. Developments in technology now provide great opportunities for spreading information around the globe, but specific attention must also be paid to the language and discourses employed for these purposes, as they way in which messages are framed plays a crucial role in shaping perceptions, understanding and interpretations. Indeed, as asserted by Italian science journalist and writer Piero Angela (1982: 46-47), this represents a significant hurdle in the realm of modern scientific popularisation:

> the environment which we live in today is brimming with languages that elude our comprehension: languages that pertain to the worlds of economics, technology, art, politics, science, and so on. The difficulty, however, often lies not in the concepts themselves, but in the way they are expressed. [...] Popularisation must come to terms with these two problems, which require competence and imagination. On one hand, it necessitates a profound understanding of these concepts, which makes it possible to appropriately transfer them into a different language. On the other hand, it calls for a communication that is not only clear but also non-boring, while still maintaining the integrity of the message. [...] For these reasons, paradoxically, we can argue that it is more difficult... to be easy. Indeed, anyone can speak or write in an obscure and boring manner: clarity and simplicity, on the other hand, are troublesome. Not only because they require more effort and talent, but also because they leave no room for deception.[2]

[2] Unless otherwise stated all translations are mine.
"L'ambiente in cui oggi viviamo e pieno di linguaggi che non comprendiamo: linguaggi che riguardano il mondo dell'economia, della tecnologia, dell'arte, della politica, della scienza ecc. La difficoltà, molto spesso, non è nei concetti, ma nel modo in cui sono espressi. […] La divulgazione deve infatti fare i conti con questi due problemi, che richiedono competenza e immaginazione: cioè da un lato comprendere nel modo giusto le cose, interpretandole adeguatamente per trasferirle in un diverso linguaggio: dall'altro essere non solo chiari ma anche non-noiosi, pur mantenendo integro il messaggio […] Per queste ragioni, paradossalmente, si può dire che è più difficile... essere facili. Tutti, infatti, sono capaci di parlare o di scrivere in modo oscuro e noioso: la chiarezza e la semplicità, invece, sono scomode. Non solo perché richiedono più sforzo e più talento, ma perché quando si è costretti a essere chiari non si può barare.

1.2 Research objectives

The present study seeks to scrutinise the discourse of popular science across three distinct media platforms: blogs belonging to official institutions, YouTube educational videos and comic books. Points of departure of this research work are the perspectives of scholars such as, *inter alia*, Gotti (2013, 2014), Calsamiglia and Van Dijk (2014), Załęska (2016) and Xia (2023) – who view popular science as a communication activity aimed at the creation of the knowledge society – and the insights of linguists such as Hyland (2010) – who claim that, in order to make science accessible to a wide audience, authors have to *reformulate* (Gotti 2014; Mattiello 2015) – or *re-draft* and *re-model* (Zou & Hyland 2019) the internal linguistic material – and *recontextualise* (Calsamiglia 2003; Gotti 2013: 16) the information into new contexts or formats. In this light, the overarching research question that the present study seeks to address is as follows:

> How do authors transmit the domain-specific contents related to biology, chemistry and earth sciences in Institutional blogs, YouTube educational videos and comic books?

However, to conduct a thorough investigation into this research topic, two subordinate questions will be addressed:

> (1) How is the information discursively organized and arranged in order to achieve a logical, coherent and successful communication of the message?
>
> (2) Which linguistic items and discursive techniques play a role in shaping the transmission of the specialized contents and the engagement of the audience?

In addressing the first question, the present study will analyse the textual samples from a macro-textual point of view, namely by conducting an in-depth analysis on the rhetorical moves retrieved in the texts, as described by Swales (1981, 1990, 2004) and Biber *et al.*

(2007). Observing their frequencies, purposes, types and patterns will enable to obtain a comprehensive understanding of how specialized contents are discursively organized and presented, and of how each information unit contributes to the overall meaning of the text. By focusing on research question 2, the work will delve into the micro-textual aspects of the texts, namely the specific linguistic items that contribute to the transmission of the contents. The study on the frequencies of occurrence, on their lines of concordance and collocates will not only make it possible to identify each item's specific discursive and rhetorical strategies but will also elucidate how they contribute to the process of meaning-making (Baker 2006; Baker *et al.* 2008; Baker & Mc Enery 2015).

In the end, by providing an answer to the aforementioned research questions, this work will ultimately reveal a number of cross-media similarities and differences, therefore offering valuable insights into how blogs, YouTube videos and comics vary in their approaches to content transmission, laying the path for future research into the dynamics of popular science across various platforms. Additionally, the findings derived from this study will also have practical implications for both scientific communication, inspiring the adoption of evidence-based practices that enhance the accessibility of the products, and for science education, providing teachers and students with authentic materials that will foster deeper engagement and critical thinking in the domain-specific subjects.

1.3 Materials and methods overview

The present study employs a mixed-methods approach (Creswell 1999, 1998; Dörnyei 2007; Clark *et al.* 2008) to the study of the collected data, in order to conduct an investigation into the linguistic, discursive and rhetorical devices employed for the purposes of scientific popularisation in weblogs, YouTube videos and comic books about science.

Under investigation, in this specific context, is a 504,762-word corpus, composed of 364 texts extracted from 6 Institutional blogs, 9 YouTube channels and 15 comics, taken from 5 different book series, specialized in the fields of biology, chemistry and Earth sciences. After consulting online feed aggregators such as *Feedspot*, domain-specific search engines like *BlogSearchEngine*, and educational resources like *Pop Culture Classroom* and *The School Library Journal*, only resources specialized in the hard sciences, originally written in English by acknowledged experts in their fields, and that were active at the time of the analysis were selected to be included in the corpus.

The investigation is conducted in two phases: to answer the first research question, a macro-textual level analysis on the *dispositio* of the specialized contents is conducted, while, to address research question number 2, the study configures itself as a micro-textual level investigation on their *elocutio*. Specifically, this last part of the study addresses the linguistic items lexicalising the *docere* rhetorical goal, namely the strategies for the transmission of specialized contents, and the *delectare*, namely the techniques for engaging and entertaining the public (Załęska 2016). Drawing on previous scholarly literature on the discourse of popular science (see, *inter alia*, Myers 1990, 2003; Moirand 2003), these two components were purposely chosen, as they embody the two core tenets that underlie this genre.

During the first phase of the work, data are studied according to the *structural move analysis* approach (Swales 1981). The full set of 15 comics, together with a sample of 135 blog posts and 103 YouTube scripts extracted through the application of Cochran's (1977) sample size formula, are analysed using computer-assisted hand-tagging to identify the distinct 'moves' and 'steps' that allow for the internal organization of the discourse.

During the second phase of this research, on the other hand, data are studied according to the principles and tools of corpus-assisted discourse analysis (Baker 2006). Here, specific attention is paid to the linguistic features lexicalising the *docere* rhetorical goal (Załęska 2016: 34), e.g., self-mentions and definitions, and to the items rendering the *delectare* rhetorical goal (Załęska 2016: 35), namely interrogatives and 2nd person pronouns. In line with the principles of corpus linguistics, these items are extracted through CQL queries, and analysed both quantitatively and qualitatively.

Tools employed to conduct the aforementioned two-phase investigation include CATMA (https://catma.de/), which was used for the annotation of the moves, and AntConc (https://www.laurenceanthony.net/software/antconc/), which was employed for the study on the specific lexico-grammatical features.

1.4 Outline of the study

The present work is composed of six chapters, with the present section acting as an introduction to the work in its entirety. More specifically, it provides details onto the context in which this research project is situated, outlines the underlying research questions and gives information concerning the gathered data and the methodological approaches employed for the investigation: through these details, the section sets the foundation for the subsequent chapters and frames the overall scope and purpose of the present work.

Chapter 2, instead, is devoted to the survey of the existing literature on the topics of popular science, scientific communication and language studies of discourse. More specifically, particular emphasis is put on the issues of scientific outreach and the relationship with the general public, the new emerging media and the type of discourse involved in the dissemination of the specialized contents, and the importance of language studies and linguistic investigation for specialized communication purposes. The aim of this chapter is to provide background information on these topics in order to contextualise the study and, as a consequence, to provide a rationale for the research questions and hypotheses presented here. At the same time, it also intends to offer insights into the ways in which the present investigation can contribute to the existing body of knowledge.

In Chapter 3, the research methodology and design used in the present investigation are presented in detail. The focus here is on two main aspects: the corpus that was built *ad hoc* for this research, and the tools and methodological approaches used for its investigation. The first part of the chapter provides a comprehensive description of the *Science Popularisation Corpus*, including its sampling frame and the different stages involved in the compilation process. The second part, on the other hand, provides a detailed description of the tools and methodologies used for its investigation: this includes the specifications on the software employed for the processing and analysis of the data, as well as the methodological approaches that guided the investigation and interpretation of the outcomes.

Chapters 4 and 5, then, are both centered on the presentation of the results. More specifically, chapter 4 focuses on examining the discursive and rhetorical structure of the three media under analysis through a macro-textual lens, namely by looking at the *dispositio* of the contents through the *structural move analysis* approach. Chapter 5, instead, explores blogs, YouTube videos and comics at the *elocutio* level of textual organization through the application of corpus linguistic methodology to the study of discourse: this section investigates four linguistic items employed to render the *docere* and *delectare* rhetorical aims, e.g., self-mentions, definitions, interrogatives and reader pronouns.

Finally, chapter 6 presents a summary of the main findings and discusses them in light of the original aims of the research project. It ties together the various threads of the study, highlighting how the results answer (or relate to) the overarching research questions and hypotheses that guided this work.

Chapter 2

“From the lab to the public”: an exploration into the genre of scientific popularisation

This chapter provides a reflection on the key concepts that represent the core underpinnings of this research project – the genre of popular science, the practice of scientific communication, and the language studies of discourse. The opening section (paragraph 2.1) presents an overview on the genre of popular science, with specific attention to relevant aspects such as its definition, its target audience, history and its peculiar type of language and rhetoric. The second section of the chapter, on the contrary, is focused on reflecting on the practice of science communication. It extensively explores the evolving landscape of specialized knowledge dissemination, which has been profoundly shaped by the advent of web-based media and the increasing use of visual tools. Here, particular attention is given to highlighting the growing significance of blogs, YouTube videos and comics as powerful media within this domain. Lastly, the third section of this chapter (paragraph 2.3) is dedicated to the explanation of the significance of language studies in understanding popular science discourse. More specifically, particular emphasis is placed on the corpus-assisted and the structural move analysis approaches, providing information on their core principles and their contributions to the research.

2.1 Beneath the surface: navigating the multifaceted realm of popular science

2.1.1 Conceptualizing popular science

Scientific popularisation, known as *vulgarisation* in French, *divulgazione* or *popolarizzazione* in Italian, *divulgación* in Spanish, and *Wissenschaftspopularisierung* in German, is typically defined in dictionaries as “scientific ideas or discoveries presented in a way that is easy for anyone to understand” (Cambridge English Dictionary).

Despite being traditionally viewed as a mere 'translation' (Paul 2004: 32), or simplification, of the domain-specific contents into a language that is easy to understand for the public – with the audience seen as a large, homogeneous and passive group of *tabulae rasae* waiting to be infused with knowledge – popular science configures itself as a much more dynamic and multifaceted practice that extends far beyond this surface-level perception, and that encompasses a well-diversified spectrum of competencies and objectives, as evidenced by the various scholarly definitions proposed (see, *inter alia*, Calsamiglia 2003; Hyland 2010; Gotti 2013; Calsamiglia & Van Dijk 2014; Mattiello 2015; Garzone 2020; Xia 2023).

In our contemporary society, scientific popularisation wears many hats. Above all, it can be viewed as a well-defined genre of literature working to make scientific knowledge accessible. In the words of Hyland (2009: 152) "popular science refers to articles, books, journals and television programmes produced for audiences without a professional need for information about science". Expanding on this perspective, we can therefore understand that there exists no single medium or format for transmitting specialized contents. Rather, popular science takes on several forms, from traditional paper-based magazines and books, which have traditionally served as popular means of disseminating scientific information amongst the wider public, to radio and TV programs. In our contemporary digital age, it has even extended its reach to web-based platforms, taking advantage of the vast accessibility of the Internet: within this context, platforms such as YouTube videos, social networks, and blog posts have become powerful and practical tools for the dissemination of domain-specific knowledge. Through the use of varied mediums and formats, scientific popularisation thus acknowledges the significance of reaching out to audiences where they are and recognises that individuals have different levels of familiarity with scientific concepts.

Secondly, scientific popularisation can be interpreted as a process of knowledge communication beyond its usual borders. According to scholarly literature, popularisation can be defined as "a communicational activity in demand, a part of strategy aiming at the creation of the knowledge society" (Załęska 2016: 32), as "une activité de diffusion, vers l'extérieur, de connaissances scientifiques déjà produites et circulant à l'intérieur d'une communauté plus restreinte"[3] (Authier 1982: 34) and as "phénomène social de diffusion des

[3] "Popular science represents an outward process of dissemination of scientific knowledge already produced and circulating within a more restricted community".

connaissances"[4] (Mortureux 1985: 825). In light of these considerations, popular science can thus be viewed as a powerful tool and a strategic act of communication that entails the dissemination of domain-specific knowledge from the confines of specialized academic research to a wide and heterogeneous public. Its aim is to promote the creation and development of a knowledge-based society, characterized by the widespread accessibility and circulation of reliable information. In doing so, popular science thus contributes to dismantling the idea that scientific understanding is the exclusive domain of experts, and not only encourages a broader societal engagement with the domain-specific topics, but also fosters the development of an environment where specialized and technical knowledge is regarded as a significant resource for decision-making and problem-solving.

Thirdly, scientific popularisation can be seen as a medium that blends education with entertainment. As noted by Myers (2003: 273) "popularisation is a matter of interaction as well as information" and, as specificed by Jurdant (1993: 3) "popularisation of scientific texts will include formal clues which are especially designed to put you in a different mood. The reader's curiosity will be titillated by the difference between what he is supposed to know and what he is supposed not to know […] and the text will attempt to change your reading mood through an appeal to your curiosity".

Building upon these definitions, we come to realise that popular science products are not only about presenting specialized facts and knowledge, but they also focus on entertaining the audience by captivating their attention, stimulating their imagination and encouraging their intellectual curiosity. This strategy, known as 'edutainment' (Singhal & Rogers 2003), is realized through the employment of various well-defined strategies such as narrative storytelling, visual and interactive media, humorous and satirical tones, and metaphors from the everyday life: by leveraging on these techniques, edutainment helps foster a lifelong interest in learning and science, and facilitates memory retention.

Ultimately, popular science can be envisioned as the bridge that links together the realm of science-related research and the non-expert public. In the words of Bucchi and Trench (2016: 153), popularisation is a term "used to describe a wide range of practices in making scientific information accessible to general, non-expert audiences". It is a "form of mediation" (Broks 2006: 143) between the world of science and the world of everyday life, which implies more than just a 'transfer' or 'translation' of the specialised information

[4] "A social phenomenon of knowledge dissemination".

(Bucchi 2008: 66; Peters 2008: 139) and requires a more complex, multifaceted and dynamic process of 'recontextualization' (Calsamiglia & Van Dijk 2004; Gotti 2005; Hyland 2010; Luzón 2013a; Gotti 2013; Caliendo 2014). As stated by Hall (1999, cited in Caliendo 2014: 8) the term 'recontextualization' indicates "various ways of appropriating, using, and reusing talk or text drawn from one context to make formulations available in another. [...] it entails more than just the representation of speech and written text, as it presupposes another context, viz. 'contextualisation'". Hence, in the specific context of scientific popularisation, this process entails taking the various domain-specific concepts from their original academic setting and tailoring them for a broader, non-specialist audience. This adaptation is achieved through the use of new media and formats for the transmission of the contents, and involves employing narratives and discourses that are understandable by people without a scientific background.

In essence, while multiple perspectives and interpretations of popular science are possible, a number of features stand out as the defining characteristics of this genre. At present, scientific popularisation turns out to contribute to the blurring of the boundaries between experts and non-experts, by helping the scientific community to convey specialized and technical information related to scientific research to the public at large. To this aim, it spans over an extensive range of media and formats such as books, TV programmes and web-based platforms, and utilizes a language that is easily understandable, readily accessible, and that suits people of varied ages, diverse educational backgrounds and different levels of scientific literacy. Within this context, by presenting the domain-specific information in a way that is interesting, informative and relevant to people's day-to-day lives, popularisation contributes, above all, to the demystification and democratization of science, providing every individual the possibility to have access to up-to-date and reliable science-related contents. Concurrently, it also serves as a catalyst for citizen empowerment, not only promoting scientific literacy and fostering curiosity for the science-related topics, but also providing them with the necessary means for participating in scientific discussions, joining collective decision-making processes and making individual well-informed choices. All these aspects are effectively summarized in the definition of popularisation provided by Calsamiglia and Van Dijk (2014: 369-370):

> popularisation is a social process consisting of a large class of discursive-semiotic practices, involving many types of mass media, books, the Internet, exhibitions and other genres of communicative events, aiming to communicate lay versions of scientific knowledge, as well as opinions and ideologies of scholars, among the public at large. Popularisation in general […] is primarily characterized by the properties of the communicative context: participants and participant roles such as scientific sources, specialized journalists, a lay public; their respective purposes, beliefs and knowledge; as well as the relevance of such knowledge in the everyday lives of the citizens. […] Popularisation involves not only a reformulation, but in particular also a recontextualization of scientific knowledge and discourse that is originally produced in specialized contexts to which the lay public has limited access. This means that popularisation discourse must always adapt to the appropriateness conditions and other constraints of the media and communicative events, e.g., those of the daily press or specialized magazines, in which they appear. […] This means that popularisation discourse needs to be formulated in such a way that non-specialized readers are able to construct lay versions of specialized knowledge and integrate these with their existing knowledge. Thus, various strategies of explanation, such as definitions, examples, or metaphors, among many others, are the semantic means that allow language users to relate new knowledge to old knowledge.

Researches working at the Division of Behavioural and Social Sciences and Education of the U.S. National Academies of Sciences, Engineering, and Medicine (2017) have identified five broad goals of scientific popularisation, which are in line with the ones synthesized by Burns, O'Connor and Stocklmayer (2003: 190) in their proposed five-letter acronym AEIOU: here, A stands for 'awareness', E for 'enjoyment', I for 'interest', O for 'opinion', and U for 'understanding'.

First and foremost, one of the most important goals of popular science is to increase people's knowledge and understanding of science, particularly in relation to specialized decision-making contexts. Their objective is to equip people with a comprehensive understanding of the scientific underpinnings, with specific attention to the origins, features, and implications of these topics. At the same time, scientists and communicators also seek to draw attention to overlooked or neglected aspects within a specific subject or area: they do this to provide the public with different perspectives on such issues, to stimulate more comprehensive and holistic discussions, and to improve the overall quality of media coverage through an accurate and responsible reporting.

Secondly, popular science also aims at increasing people's appreciation concerning the role of science and scientific enterprise in everyday society. According to the U.S Committee on the Science of Science Communication (2017: 32), this goal assumes that people who possess greater knowledge on these matters are more likely to recognise the positive impact that scientific research and advancements have on both individuals and on the society as a whole. To achieve this goal, science communicators thus try to shed light onto the processes, methodologies and ethics involved in research and in scientific reasoning, which, in turn, will lead to a greater transparency of science and promote confidence in the scientific enterprise.

Thirdly, another important goal of scientific popularisation is to "share the findings and excitement of science" (National Science Board 2017: 31). This objective is grounded on the belief that by conveying the passion and intellectual enthusiasm that comes with scientific experiments and discoveries, scholars and practitioners will ultimately be able to enrich other people's lives, inspire their curiosity, and stimulate their interest on these topics. By providing resources, recommendations, and opportunities for further learning, such as books, documentaries, YouTube channels, blogs, comic books series and exhibitions, science communicators will, on the one hand, encourage individuals who do not possess formal scientific training or background to look for additional information, thus acting as catalysts for a process of knowledge expansion and lifelong learning. On the other hand, by showing the real-world applications and potential of science and technology to the younger generations, science communicators will ultimately be able to inspire children of different ages, backgrounds, and cultures to pursue their interests in science, thus contributing to shaping the next generation of researchers and scientists working to address the challenges of tomorrow.

Fourthly, scientific popularisation also strives to raise awareness on science and technology-related issues and on their impacts on society as a whole. As reported in the research agenda of the U.S. National Academy of Science, Engineering and Medicine (2017: 32), communicators have successfully worked to make people aware, for example, of the benefit of exercising, the dangers of heavy smoking and the importance of controlling one's blood pressure, thus contributing to improving many people's health and well-being. By cultivating science and technology-related awareness, scientists and science communicators contribute to the empowering of individuals, who are provided with the necessary reliable information to evaluate claims critically, to assess the risks and potential benefits of their choices and actions, and to avoid misconceptions, scepticism and misinformation.

Finally, one last goal of popular science is to engage and entertain the public. While this may not be its primary goal, this aspect undoubtedly plays an important role in fostering a positive attitude towards science. Above all, by including narratives and storytelling, captivating visuals, humorous tones and interactive activities, popular science contributes to the breaking down of the barriers and to the dismantling of the misconception that science is too difficult for non-experts. Additionally, this is an important aspect that creates connection with the audience, and instils a sense of wonder and curiosity, facilitates memory retention, and contributes to the development of a lasting interest in science as well.

Science, intended as “the systematic study of the structure and behavior of the natural and physical world, or the knowledge obtained about the world by watching it carefully and experimenting” (Cambridge English Dictionary), has been a part of the human culture for thousands of years. Yet, popular science, viewed as the enterprise to present scientific concepts in a way that is both approachable and captivating for the public, has a more specific historical background.

Early traces of what we now recognise as ‘scientific popularisation’ existed as far back as Greek and Roman civilizations (Muñoz Morcillo & Robertson-Von Trotha 2020). A prime example of these works is represented by Aristotle’s *De Partibus Animalium* (IV century B.C.) a treaty belonging to the field of biology, which focuses on the anatomy, reproduction, behaviour, and classification of animals, and that is articulated in a way that renders the writing accessible and understandable to the readers of his time. Similarly, Lucretius and Hipparchus’ poems *De Rerum Natura* (around I century B.C.) and *Phenomena* (around I century B.C) were written with the objective of preserving and disseminating among a wider audience science-related theories belonging to Epicurus and Eudoxus respectively (Musacchio 2017: 9). In the ensuing centuries, then, other notable writings aimed at opening scientific knowledge up to the public emerged: this is the case, for instance, of Chaucer’s work *Treatise on the Astrolabe* (1392), which was written in vernacular middle English – and not in Latin – to facilitate the understanding of the readers (Musacchio 2017: 10).

However, it was with the advent of the 17th century and the Enlightenment that the issue of making scientific knowledge accessible to the general public started to be perceived as a societal necessity. In his notable work *Conversation on the Plurality of Wolds* (1686)[5], French philosopher and scientist Bernard Le Bovier de Fontenelle clearly stressed the importance of speaking to both 'les savants', e.g., the scientists, and the 'gens du monde', namely the non-expert people living his contemporary society (Bucchi 1998: 1). For the first time, he explicitly recognised that science should not be confined within the ivory tower of the Academia but should instead be disseminated to the entire community of people. Additionally, he also promoted the idea of presenting the domain-specific concepts in a way that was engaging, accessible and appealing to both the experts and the general public by using a conversational style, an easy-to-understand terminology and imaginative scenarios to pique the curiosity of a diverse readership: these aspects, in turn, played a pivotal role in shaping the evolution of the modern genre of popular science, as they made scientific information more engaging, accessible, and appealing to a wider audience. What is more, the period comprised between 1650 and 1750 also saw the emergence of various state-sponsored professional organizations such as the Royal Society of London and the French Académie Royale des Sciences, and of several publications such as the *Journal des Savants* and the *Journal des Trévoux*, which encouraged the dissemination of specialized knowledge outside the walls of the Academia (Lynn 2018).

The date of birth of popular science as a genre is however to be found in the 19th century. On the one hand, the Industrial Revolution, which started in the late 18th century and extended into the 19th, yielded significant social transformations: new advancements in technology, mass production, and means of transportation and communication were introduced, leading to a transition from agricultural to industrialised economies. As a consequence, workers were now required to have new specialized types of expertise (Pilkington 2018: 5) and, at the same time, the general public started to develop a sense of curiosity towards these new tools: in the words of Weingart and Guenther (2016: 1) "this public, ranging from an upper-class bourgeoisie to the shopkeeper, the craftsman, and the worker, was fascinated by and truly interested in what science had to offer". On the other hand, the lifting of most of the printing restrictions in force at that time, together with the development of mass production, also contributed to the rise of popular science as a genre (Ciapuscio 2003). Previously, scientific and intellectual works were subject to stringent controls and censorship, and the printing process was itself strictly regulated, with authorities

[5] Originally published in French as *Entretiens sur la pluralité des mondes*.

exerting stringent supervision on both printing machines and materials (Bartling & Friesike 2014). The relaxation of these restrictions, instead, favoured an explosion of popular science products such as books – this is the case of Charles Darwin's *On the Origin of Species* (1859), which was written in a way to be accessible to a general audience – and magazines, such as *Scientific American* (1845) and *Popular Science Monthly* (1872). Simultaneously, another aspect that contributed to the development of popular science was the improvement in the education system and in the literacy rates, which resulted in a growing quest for knowledge and in an expanding interest in science-related topics (Yeo 1993). However, it was especially the rise of the journalist as a new populariser that shaped the face of the genre of scientific popularisation. As evidenced by Broks (2006: 59), journalists progressively started to take on the responsibility of making scientific contents accessible to the general public: through the employment of an easy-to-understand language, concrete and relatable examples, storytelling techniques and captivating descriptions they thus started to act as mediators between the academic realm and the everyday life of people.

Yet, it was in the mid-20th century that popular science witnessed its most significant growth: Gregory and Miller (1998: 379-380) have referred to this period as 'the post-war bonanza' to highlight its historical importance. This phase, which started immediately after the end of World War II, was characterised by the public's increasing desire to know more about scientific and technological progresses. Above all, the war itself had shown how the advancements in fields such as biology, physics and chemistry could shape the everyday lives of the citizens of the world, with both positive and negative consequences. Additionally, the expansion of mass media such as radio and TV[6] further contributed to the dissemination of specialized information to the public through TV series, documentaries, public lectures and radio programmes. Concurrently, a sequence of noteworthy events took place, prompting both the public and the academic sphere to recognise that science had become a matter of national importance: this was the case, for example, of the 1950 launch of the NASA's moon program (Weingart 2016: 3) – for which the U.S. government wanted to obtain public support – and of the start of the 'space race' between U.S and Russia with the launch of the Soviet satellite Sputnik. What is more, as specified by Weingart (2016: 2) the rebellious movements of 1968 also contributed to the development of popular science: these social and political

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[6] See, for example, the role the BBC had in bringing science to the public with TV series such as Bronowski's *The Ascent of Man* (1973), Attenborough's *Life on Earth* (1979) and Sagan's series *Cosmos* (1980).

turmoils led to a wave of activism that challenged established authority and asked for a greater accessibility and transparency in different aspects of society – including the world of science.

From that moment onwards, facilitated by the rise and development of the Internet and other digital media, as well as the emergence of the so-called 'Plain English' movements, popular science has undergone significant development and diversification. Web-based technologies have, on the one hand, radically transformed the access and dissemination of scientific knowledge, allowing everyone wishing to know more to read and engage with up-to-date and reliable science-related knowledge. Simultaneously, the birth and development of the 'Plain Language' movements, emphasizing the employment of clear, concise, and jargon-free language to render specialized information more accessible (Canepari 2013; Orletti & Iovino 2018) contributed to the widespread recognition of the importance of breaking down complex ideas into more accessible terms.

In this light, contemporary popular science configures itself as a vital conduit that bridges the gap existing between the realm of Academia and the general public. With its versatile and impactful role, it now serves to encourage dialogue and critical thinking, it promotes greater scientific literacy, it shapes public understanding of science and empowers the individuals to make well-informed choices.

Within this specific context, the notion of audience assumes a discerning and significant role, since a thorough understanding of this dimension is paramount for effective communication and engagement. Specifically, in the realm of 'popular' science, the audience is constituted by the *populus* (Załęska 2016), that is 'the public'. Simultaneously, as claimed by Burns, O' Connor and Stocklmayer (2003: 184), the term 'public' encompasses the entire spectrum of individuals living in the contemporary society.

According to the 'dominant view' of popularisation (see, *inter alia*, Lewenstein 1985; Hilgartner 1990) widely adopted in the 1980s and 1990s, experts and public were divided by a vast gulf, characterised by "absolute knowledge on the one hand and absolute ignorance on the other" (Garzone 2020: 154). According to this model, defined as the 'deficit' or 'canonical' model of science communication (Wynne 1991; Ziman 1991; Grundmann & Cavaillé 2000), the public was imagined as a passive and monolithic entity, composed people who were not only 'ignorant' and unable to understand the achievements of scientific research, but also 'hostile' to the expertise possessed by experts (Stilgoe & Lock 2014: 7). This perspective thus offered an oversimplified and binary outlook on knowledge and ignorance, implying that only experts possessed the expertise, while the general public did not possess the necessary abilities to participate, learn and contribute to the knowledge creation and dissemination processes.

However, this view has been meticulously examined and refuted, and new models have been proposed to depict the expert-public relationship. At present, the so-called 'contextual' model (Einsiedel 2000) enjoys widespread acceptance. According to this perspective, science communication is a 'two-way flow' between scientists and their audience, composed of individuals who do not act as mere 'empty containers' that must be imbued with information, but who are active subjects that process information according to "social and psychological schemas" (Garzone 2020: 155) shaped by various factors, contexts and experiences. What is more, the audience is not anymore as devoid of knowledge as it was suggested by the dominant view. As pointed out by Myers (2003: 268) "nor is the public entirely cut off from expertise": they possess various forms of knowledge, such as experiential and cultural knowledge, and other forms of expertise that go beyond those typically acknowledged in conventional scientific domains. Additionally, they can now access a plethora of information sources and interact with scientific content through different media outlets, which allow them to expand what they already know on their domain-specific topics of interest.

Against this backdrop, it thus becomes increasingly evident that what we normally refer to as 'the public' is a highly diversified and heterogeneous group, which is "as multifaceted and unpredictable as the individuals that compose it" (Burns, O'Connor & Stocklmayer 2003: 184). In this light, there thus exists not just one 'public', but multiple 'publics' (Hyland 2009: 157; Bucchi & Trench 2016: 158-159), each with its own unique characteristics and dynamics. These 'publics' are therefore not homogeneous entities, but multifaceted groups which can either be differentiated according to a number of demographic factors such as age, sex and level of education, or distinguished according to their needs, interests, attitudes and levels of expertise in the scientific domain. In the words of Burns *et al.* (2003: 184) these groups include other scientists, working in industries, research centres and/or academic settings, mediators – namely communicators and other practitioners playing a role in facilitating the dissemination of scientific information – decision-makers within governmental institutions, who have the power to take decisions according to scientific evidence, the general public, composed of the entire members of society, the so-called 'attentive public', which comprises the people who already possesses some degree of knowledge about science and scientific activities, and, ultimately, the group referred to as 'interested' public, which includes people who have an interest in science and technology, but who may not possess extensive knowledge in these areas.

Recognising the existence of multiple 'publics' instead of a singular 'public' carries significant implications for science communication. By understanding the unique characteristics, needs, and knowledge of different groups, science communicators can successfully tailor their approaches to engage and communicate with diverse audience segments. As a result, they can therefore amplify the impact and significance of their communication, allowing for a deeper understanding of the domain-specific contents and encouraging a more meaningful public involvement in the realms of science and technology.

2.1.2 Scientific popularisation and the language of science

According to scholarly literature, the term 'language of science' embodies "the various forms of discourse in which the activities of 'doing science' are carried out" (Halliday 2004: 49). However, as evidenced by scholars such as Myers and Hyland, science "is not a monolithic entity always understood in the same way" (Hyland 2010: 118), but, instead, is a "a terrain of competing discourses and practices" (Myers 2003: 267), which encompasses a continuum of genres and practices, acting as channels for the creation and dissemination of specialized scientific knowledge to a general and heterogeneous public.

As claimed by Halliday and Martin (1993: 59), this concept can be described as a "semiotic space within which there is a great deal of variability", which, in turn, manifests itself in multiple ways, and can be interpreted according to the parameters of field, tenor and mode.

In linguistics, the term 'field' indicates the topic or the thematic focus of the discourse, and, as far as science is concerned, it refers to the employment of language in the transmission of the knowledge in domains such as physics, biology, chemistry and environmental sciences.

The term, 'tenor', instead, refers to the hierarchical relationships and interactions between the participants – be they writers, speakers, readers, or listeners – which are influenced by elements such as power dynamics, social distance, and level of formality. As far as this specific aspect is concerned, four main stages have been identified within scientific communication (Cloître & Shinn 1985): these are the so-called ‘intraspecialistic’, ‘interspecialistic’, ‘pedagogical’ and ‘popular’ levels. The former refers to the stage that is aimed at presenting new findings, research outcomes and methodologies, using a highly specialized technical jargon. It is specifically tailored to the needs and interests of experts of the same discipline, who are assumed to possess the necessary background knowledge to interpret the technolets. What follows is the ‘interspecialistic’ level, that aims at translating the theoretical ideas into more tangible forms, in order to reach a public composed of individuals who possess some background knowledge in science, but who work in different fields. The third stage is what Fleck (1979, cited in Bucchi 1998: 9) calls ‘textbook science’ and concerns the level where science is explained to an audience made of students looking to specialise in this field. Here, no prior knowledge is assumed, and technical terms are introduced and immediately explained in order to be correctly assimilated. Fourthly, the last stage is the so-called ‘popular’ and refers to the process of producing and transmitting science-related knowledge for people “without a professional need for information about science, but who want to keep abreast of developments” (Hyland 2010: 118). The discourse at this stage tries to be linear, coherent and employs a number of rhetorical strategies that make specialized terms less cognitively demanding.

Ultimately, the ‘mode’, concerns the code used in communication, the type of channel employed, and the level of spontaneity or planning involved. In the context of popular science, this feature may encompass media such as journal articles, popular science magazines, television programs, podcasts, blog and social media posts, public lectures, and even interactive exhibitions, which can present themselves in the forms of carefully scripted and edited contents, more spontaneous live formats, static one-way communications, or more engaging two-way interactions.

Extensive academic research into the language and discourse of science (see, *inter alia*, Myers 1990; Calsamiglia 2003; Masi 2013; Calsamiglia & Van Dijk 2014; Vicentini & Grego 2018; Maglie & Abbatantuono 2020; Xia 2023) has revealed that science is not a ‘neutral’ activity (Calsamiglia 2003), but it is, instead, characterized by a well-defined rhetoric, which is influenced both by the aforementioned parameters of field, tenor and mode, as well as by the type of public and socio-pragmatic context in which this communication occurs. Such investigations converge on the idea that there exist two extremes within the continuum of scientific English: one end, is defined by Halliday and Martin (1993) as ‘Attic’ discourse, while the opposing end is referred to as 'Doric'. The former type of discourse is characterized by the presence of technical and complex expressions packed in nominal groups, structured as *epithet* + *thing* + *qualifier*, (e.g., *rapid deterioration of the item*), and by a simple construction of the clauses, composed of just three elements in it: two nominal groups at the beginning and at the end, and a verbal group indicating a process in the middle (e.g., *prolonged exposure will result in rapid deterioration of the item*, Halliday 2004: 103). The 'Doric' style, on the other hand, is the style in which the complex nominal groups are 'unpacked' and broken down into clauses: it is reworded as *medium* + *process* + *circumstance*, (e.g., *it will deteriorate rapidly*), and the clause results composed of two interconnected sentences (e.g., *if the item is exposed for long, it will deteriorate rapidly*, Halliday 2004: 103). These two types of discourse correspond to what Załęska (2016: 31-32) identifies, borrowing Aristotle's classification, as 'internal' (*esoterikós*) and 'external' (*exoterikós*) speeches, respectively. The former, characterized by a more complex and densely structured language, was aimed at teaching students with already advanced knowledge who could process the complex notions discussed during the lectures. The latter approach, on the contrary, involved the dissemination of knowledge to non-specialist people, necessitating a more straightforward and easily comprehensible presentation of the concepts.

Against this backdrop, the 'internal' and 'Attic' type of discourse can be related to the scientific discourse retrieved in academic settings, where authors address an audience of peers: this is the case, for example, of scholarly outlets such as journals, research papers, and conference abstracts. In these contexts, the language is technical, complex, and requires a high level of literacy in the specialized language and concepts of the discipline. As evidenced by Halliday (2004: 138), this type of argumentation is characterized by several well-defined features: high lexical density, the use of interlocking definition, technical taxonomies and 'special expressions', syntactic ambiguity, semantic discontinuity, grammatical metaphors, and the employment of a neutral tone.

Here, if on the one hand the syntactic structure of the clauses is, as stated above, quite simple because the number of the elements is reduced, from a lexical point of view, the clause is quite complex and dense. In Hallidayan terms (2004: 33), 'lexical density' refers to the measure of the information load in a text or in a portion of text and is established by counting the number of lexical words in a sentence. Specialized texts are highly dense, with a number of 6-10 content words per clause, compared to just 1 or 2 in casual speech. In this context, lexical words include acronyms (e.g., *MHz*), technical terms that refer to processes (e.g., *sterilisation*), qualities (e.g., *resistance*) and specialised equipment (e.g., *spectrometer*). Additionally, are part of the lexical set of specialised languages also the elements that Halliday (2004: 165) calls ‘special expressions’, which indicate those fixed word combinations that are unique to a scientific domain, and that serve as tools for concise and efficient communication among experts within a field (e.g., *high energy physics*). Furthermore, also the so-called ‘technical taxonomies’ are part of the specialized lexis: this term represents the hierarchical classification systems or categorization structures that exist within specialized languages and that are employed to define, classify, and organise the domain-specific concepts efficiently and precisely within the framework of a particular field. Within technical taxonomies, terms and concepts are categorized into hierarchical levels according to two fundamental semantic relationships, superordination and composition (Musacchio 2017: 46), which allow experts to have a shared framework of organization and classification that facilitates effective communication and knowledge sharing.

Subsequently, two other important elements in the structuring of science discourse are nominalizations – defined by Halliday (2004) as ‘grammatical metaphors’ – and interlocking definitions. The former represents the process of turning the elements of a sentence into nouns, such as in the case of the preposition *with*, transformed into *accompaniment*, or the adjective *unstable* and the verb *transform*, which are lexicalised as *instability* and *transformation*. In the Attic style, however, the metaphor does not only affect terminology, but has an impact on the structure of the entire clause: the processes become nominal groups linked by a verbal group that expresses the logical relationship between the two. The nominal group can then be expanded through the addition of other elements that, in this context, become modifiers of the head noun (e.g., in the sentence *The driver’s overrapid downhill driving of the bus caused brake failure*, taken from Halliday 2004: 57, all the elements of the sentence are modifiers of the noun *driving*). Interlocking definitions, on the other hand, describe “a series of definitions where defining one concepts requires reference to other interrelated concepts” (Musacchio 2017: 44): the process of ‘interlocking’ thus enables a comprehensive understanding of definitions by analysing how they interact with one another and how they contribute to the overall construction of scientific discourse.

From the point of view of the construction of the argumentation, then, in this specific type of scientific discourse, the main claim is usually found at the end, coming after a contextualisation of the issue through the account of previous research on the topic. The focus of the argument is the object of the study: the narrative follows the argumentation of the scientist, who explains the issue by showing the step-by-step development of the research and draws particular attention on the elements of novelty and of interest to the scientific community.

Finally, highly specialized languages are also characterized by a high degree of neutrality, syntactic ambiguity, and semantic discontinuity. The former aspect refers to the fact that, in scientific English, personal judgments or subjective comments are deliberately excluded: authors never intervene in the texts to comment on the issues under analysis, and normally use the passive to hide their voice and to redirect attention towards research processes and outcomes. At the same time, though, they employ fixed phrases and domain-specific expressions that omit specific pieces of information, resulting in a potential degree of ambiguity and discontinuity within the text. Yet, these expressions are correctly interpreted by their target expert readers because they possess the necessary background knowledge to understand the intended meaning.

As we can observe, all these linguistic and discursive elements are integrated into the specialized language to enhance clarity and to facilitate effective communication among experts. However, this poses several problems for the lay public, who may lack the required expertise in the field to decipher the conveyed message. As claimed by Calsamiglia (2003: 141) this kind of argumentation is, for the lay audience, "unknown, difficult and hermetic" and it is conditioned by "a special rhetoric which has to be learned". Similarly, students approaching the world of science often feel intimidated and perceive the world of research and discoveries as too distant or overly challenging for them. On this matter Lemke (1990: 129-30) states

> how does science teaching alienate so many students from science? How does it happen that so many students come away from their contact with science in school feeling that science is not for them, that it is too impersonal and inhuman for their tastes, or that they simply 'don't have a head for science'? One way this happens, I believe, is through the way we talk science. The language of classroom science sets up a pervasive and false opposition between a world of objective, authoritative, impersonal, humourless scientific fact and the ordinary personal world of human uncertainties, judgements, values and interests.

However, what he defines as 'the language of classroom science' is simply the 'Attic' style of scientific English adapted to the classroom context, which creates a number of comprehension issues not only because of the non-experts' unfamiliarity with the technical terms and acronyms employed in the text, but also due to the presence of complex synctactic structures that hinder the easy understanding of the clauses. Therefore, from this perspective, specialized scientific English may appear, to the layperson's ear, as an archaic and artificial language, characterized by an intricate grammar and an obscure terminology. As Friesen (2018: 1) points out

> the language of scientists and their stories, even at its best, can often be compared to Talkien's Old Entish, described by an Entish native speaker as "a lovely language, but it takes a very long time saying anything in it, because we do not say anything in it, unless it is worth taking a long time to say, and to listen to." This is because scientists must describe every meticulous detail of their controlled and repeatable experiments, how these experiments target specific processes to evaluate nuanced hypotheses and, hopefully, report new, exciting, often incremental findings that are then published in scientific journals after rigorous peer review.

This is precisely the reason why, in order to communicate with the public, popular science has not only gained prominence as a distinct genre from the standard scientific communication, but employs also a different type of argumentation: popularisation is, according to Turney (2007: 2) "a literature of reality, of *how things are*", which is not only about transmitting specialized contents, but is "a matter of interaction as well as information" and "it involves persons and identities as well as messages" (Myers 2003: 273).

As mentioned in the previous sections, academic research on popular science discourse rejects the idea that sees this practice as a mere 'simplification' or 'translation' of science for a lay audience. According to them, this is both a matter of *recontextualizing* (Calsamiglia 2003: 142; Gotti 2013: 16; Gotti 2014: 22) scientific knowledge that was originally produced for a public of experts, and of *reformulating* (Loffler-Laurian 1984: 110; Jacobi 1991: 1; Gotti 2014: 19; Mattiello 2015: 4), or *re-drafting* and *re-modelling* (Zou & Hyland 2019) the internal linguistic material, so as to suit the needs of people who do not possess a solid background in science.

Going back to the classifications proposed by Halliday (2004) and Załęska (2016), this specific type of scientific English can be linked to the 'Doric' and 'external' styles of discourse. Here, the complexity of the clause is to be found in the syntactic structure, rather than in the lexis. This is because the clause is no longer composed of two nominal groups: nominalizations are unpacked to produce a more understandable rewording, and the clauses result to be made up of smaller sentences joined together. What links the fragments is the verb, together with a series of devices such as conjunctions or prepositions that make the relationships between the sentences evident and immediate to understand. As a result, the clause happens to be longer, as we can see in the following example taken from Halliday (2004: 55): *The driver was driving the bus too fast down the hill,* ***so*** *the brakes failed*. As far as lexis is concerned, on the other hand, the density that was characteristic of the Attic style is not to be found here: this is because popular science writers and bloggers' aim is to make their message understandable by the public, which brings them to avoid sentences that are too complex or that carry too much information. The number of technical words and acronyms is also reduced, even though not completely avoided: typically, technicalities, when present, are usually accompanied by definitions, acronyms are generally followed by the explanation in parenthesis, and when authors have to give a technical definition of a specific element, they do it by paraphrasing it with words that are understandable by the largest possible audience.

However, there are other features that characterise the discourse of scientific popularisation. According to Hyland (2009, 2010), among the most important linguistic-discursive aspects of this specific type of argumentation are the type of presentation of the concepts, the argument structure, the expression of stance and credibility, as well as the establishment of a relationship with the readers.

As far as the first aspect is concerned, authors employ several strategies to convey the domain-specific contents effectively. One of the most prominent examples is the use of different types of explanatory structures. As Calsamiglia and Van Dijk (2004) point out, five main techniques can be identified – denomination or designation, definition, generalization, reformulation or paraphrase and explication proper. Here, the employment of various explanatory structures allows authors to suit the needs of different types of publics, from the more detail-oriented individual who already possesses some background knowledge on these topics, to the complete novice, who both needs to be taught the most basic concepts and necessitates to be accompanied in the process of interpretation of the issues. Within this context, experts make also extensive use of visuals and imageries – which are key tools that enable the visualization of complex processes and features, thus helping laypeople in the interpretation and understanding of the issues under analysis – and of the so-called 'thought experiments' (Freddi 2016: 203), which are mental exercises and scenarios that require the use of one's imagination to consider various possibilities and solutions without the need for practical experiments. These devices are used by scientists to help the public gain deeper insights into complex phenomena, to explore different viewpoints and to test hypothesis. Then, they also utilise real-life examples, which enable specialists to relate the complex domain-specific notions to the public's everyday life and familiar experiences, together with similes and metaphors. As stated by Garzone (2020), by evoking vivid imageries and using concrete and well-known concepts as referents, these devices further bridge the gap between the world of science and the realm of everyday experience.

Then, as the structure of the argumentation is concerned, instead of presenting the main claim towards the end of the article, as in the 'Attic' mode, popular science texts characteristically place it at the beginning. This arrangement both facilitates the public's understanding of the topic and captures their attention. As Nwogu (1991) points out, these texts normally open with a background move that contextualizes the issue and that immediately display the outcomes of the research. Then, the overall presentation of the information follows a deductive rhetorical pattern, which enables authors to put emphasis on the novelty of the issues presented. To be precise, specific attention is put on the so-called 'newsworthiness', e.g., the presentation of the issues "in terms of what is of immediate value or potential benefit to readers" (Hyland 2010: 120). This, in turn, creates a sense of proximity and engagement, fostering a stronger connection between the audience and the subject matter.

Thirdly, two other important elements in popular science discourse are the expression of stance and credibility. As concerns the first aspect, contrary to highly specialized texts, popular science usually makes the opinion of the authors clearly visible during the presentation of the concepts. In this context, experts usually critically comment on the issues under analysis, express their opinions in relation to the conducted research and its results, and thoroughly analyse their implications on social life. From a linguistic point of view, opinions are usually lexicalised through hedges, attitude markers, modals, verbs expressing opinions, and through the employment of self-mentions that make the voice of the speaker visible. This approach not only allows authors to enrich the content they provide to the public, but it also enables them to guide their non-expert audience towards the correct interpretation of the issues, removing the risk of possible misinterpretations and contributing to drawing their attention to specific points within the narration. Additionally, another important element in popular science discourse is credibility, that is the practice of emphasising the reliability of the source they are referring to. From a linguistic point of view, this is achieved by using direct quotes from scientists working in the field, or by making the official affiliation of the researchers visible in the texts. In doing so, authors thus enhance the credibility of the information they transmit, and reassure the public that the presented information is underpinned by solid scientific evidence: this emphasis on credibility is essential for cultivating trust with the readership.

Finally, a fundamental element that characterizes popular science discourse is what Hyland (2010: 125) refers to as ‘proximity’. This term refers to the notion of establishing a sense of closeness and connection with the audience. Within this context, further to presenting information in a relatable and accessible manner, incorporating familiar examples, and dealing with topics that directly impact the readers’ everyday realities, authors pay specific attention to their *engagement* (Hyland 2005, 2008, 2010). This term describes the practice of actively involving and drawing the public into the discussions by captivating their interest, maintaining their attention, and stimulating their curiosity: from a linguistic point of view, this is achieved by posing thought-provoking questions, using humorous and ironic tones, and employing direct addresses through second person pronouns. In the end, this practice thus serves to create an immersive reading or listening experience, to inspire intellectual curiosity, and to develop a more positive attitude towards the world of scientific research and discoveries.

All in all, these considerations seem to confirm Halliday’s idea that “science has no beginning”, but that is simply “the continuation of the grammar’s theorizing of ourselves and our relations with our environment” (2004: 4). In his view, language is therefore not separate from the practice of science itself, but, instead, the way in which it is employed is crucial for the creation of meaningful knowledge. In this light, the significance of linguistic inquiry in unravelling the intricacies of scientific discourse becomes evident: by studying the rhetoric and discourse of scientific language, we can acquire a deeper understanding of how concepts are conveyed, relationships are established, and information is arranged. These insights, in their turn, are crucial for comprehending the fundamentals of scientific reasoning and communication.

2.2 The science of science communication: multiple avenues for the transmission of content

As mentioned above, we are currently living in an era in which "although people can choose not to do science, they cannot choose to ignore it" (Fischoff 2013: 14033). Science and technology nowadays touch all public and private spheres, from healthcare to transportation, from entertainment to the environment, and, as a consequence, all citizens are called to develop some level of scientific awareness and literacy in order to navigate the domain-specific topics that interest their everyday lives.

Within this context, the effective communication of such knowledge becomes pivotal, and to achieve this, several factors must be taken into consideration. First and foremost is the audience, with their needs, interests, and level of scientific literacy. Second important aspect, then, are the language employed, the media, and the formats selected to transmit such contents. Thirdly, the societal environment in which such knowledge will circulate must also be considered, in order to connect such information to people's everyday life and enhance the relevance and applicability of scientific information (Bryant 2002, Davies 2008, Trench & Bucchi 2010, Liang et al. 2014). In this light, the process of scientific popularisation thus configures itself as a 'a *mise-en-culture*' of science (Lévy-Leblond 1996, cited in Bucchi & Trench 2021: 5), because rather than simply transmitting domain-specific topics, it also involves a process of nurturance and integration of science into the surrounding cultural background: echoing the words of Bucchi and Trench (2021: 6), popular science thus represents "the social conversation around science".

However, over the past few decades, the landscape of science communication has been undergoing a period of significant changes, largely driven by advancements in technology and an increased emphasis on visual communication methods which have opened up new avenues for disseminating scientific information, and, at the same time, changed the way practitioners and academics engage with the lay public. Consequently, this has significantly contributed to the blurring of the boundaries between experts and non-experts (Holliman 2008; National Science Board 2017).

Traditional media platforms such as paper-based tools (e.g., books, magazines, and newspapers) and broadcasting technologies (e.g., radio and television) have for a long time been the pioneers of science communication, playing a pivotal role in enhancing the public's scientific literacy during the so-called age of 'science communication 1.0' (Bucchi 2019: 4). During these early stages of scientific dissemination, the primary means of communication and education were the written texts, and print media such as newspapers, books and magazines represented effective platforms for the sharing of discoveries, theories, and scientific advancements. On the one hand, newspapers and magazines featuring dedicated science sections or columns, with their wide distribution and accessibility, both facilitated the dissemination to a broad readership of science-related news and helped contextualise such developments within larger societal and cultural frameworks. On the other hand, science books written for the general public, such as Hawking's *A Brief History of Time* (1988), which became global bestsellers, not only contributed, with their engaging narratives and thought-provoking explanations, to the process of knowledge dissemination and to the development of debates and discussion on these topics, but served also to stimulate curiosity and interest in the realms of science, inspiring millions of readers to actively take part in the world of discoveries, research and technologies (Daum 2005; Broks 2006).

Broadcasting technologies such as radio and TV, which started to be employed at the beginning of the 20th century and gained widespread adoption between the 1950s and 1960s, have been instrumental in bringing science to the living rooms of many (Encyclopedia Britannica). Within this context, television has been the medium with the most impactful influence on science communication. Above all, its wide accessibility made domain-specific knowledge easily accessible to people regardless of their location or socioeconomic status. Then, its multimodal nature (combining audio-visual materials such as videos, images, experts' testimonies, and practical demonstrations) provided the audience with an immersive experience which was, at the same time, comprehensible, informative and entertaining. Subsequently, its ability to give real-time updates on scientific discoveries and breakthroughs made it possible to bring the latest scientific developments directly to the audience, fostering a sense of immediacy and relevance. Ultimately, its wide variety of products – ranging from documentaries to talk shows – suited different types of audiences, including both science enthusiasts and those with a general curiosity about the world.

At present, scientists work and live in an era in which communication via the Internet is 'natural' (Trench 2008: 185) and where even non-expert information consumers have "embraced the digital revolution" (Brossard 2013: 14097) for the purposes of scientific information retrieval. This specific trend is also testified by the data provided by two premier American research centres: the Pew Research Centre and the National Science Board. According to their surveys, there has been a significant increase in the number of US residents who use the web as their main resource for scientific enculturation outside the classroom environment: specifically, the 2001 NSB report showed that only 10% of people utilized Internet for these purposes (National Science Board 2001), while by 2012 and 2016 that number had grown, respectively to 50% and even over (National Science Board 2012; 2016). The Pew Research Centre further documented this shift, finding, in their 2017 report, that 70% of individuals now depend on digital resources to support their scientific learning (Funk, Gottfried & Mitchell 2017).

This shift to a "digital age of science reporting" (Fahy & Nisbet 2011) is motivated by the potentialities that Internet offers to the process of knowledge retrieval and exchange. Since its birth in the 1960s, it has evolved from being a mere repository and conduit of information, to being a platform "for multifarious communicative practices" (Hoffmann 2012: 1): more specifically, unlike traditional media, which can materialise only in the forms of traditional news and publications, Internet-based media offer the possibility to establish both *two-way* communications – as in the case of conversations and dialogues between experts and general public – collaborations, and exchanges and, simultaneously, *many-to-many* communications, like information and news sharing (Büchi 2016: 2-3). This shift, which has established the so-called 'Web 2.0', has rewritten the rules of knowledge exchange and communication, giving rise to a new era where individuals are no longer passive consumers of information, but active participants in the creation and dissemination of knowledge. At the same time, it has also democratized the process of information exchange, blurring the hierarchies by enabling direct and immediate interactions between experts and the general public.

Leveraging the power of the web, science communicators are thus progressively discovering and utilizing new avenues – such as, *inter alia*, social networks, blogs and microblogging platforms, video channels and forums – which offer unprecedented opportunities to engage and meet the demands of an increasingly interested public. Above all, they allow for a 'global reach' (Askehave & Nielsen 2005), giving everyone with an Internet connection the possibility to access reliable and up-to-date information. Furthermore, they make the development of interactions and discussions possible thanks to their technologies that facilitate inclusive and participatory formats, such as group challenges, live-streaming Q&As sessions and bidirectional conversations.

Thirdly, they enable the combined use of different semiotic resources, therefore suiting the needs of people's different learning modes, a concept known as 'multimodality'. Ultimately, they allow for the integration of links to other resources, enabling users to access additional materials within the channel that allow them to deepen their knowledge on the topics: this is referred to as 'hypertextuality' and 'intertextuality' (Garzone 2019: 18-21).

However, in the present-day society, the widespread adoption of web-based media is accompanied by an increase in the employment of visual materials, which can either be found in combination with the written narratives, as in comic books, or serve as complementary aids for explaining domain-specific content, as in the case of infographics, diagrams, animations, and photographs. The growing reliance on visuals in science communication stems from the understanding that these elements can convey complex information in a more accessible, engaging, and memorable way, at the same time presenting data in a more tangible format and elevating the emotional engagement and stimulation associated with the process of knowledge acquisition. Additionally, Miller (1998), Schönbrun *et al.* (2006), Ainsworth (2008b) and Krum (2013) maintain that visuals also have the capability to suit people's different learning styles – thus allowing the specialized contents to reach a wider audience – and to bolster memory retention, therefore increasing the likelihood that the public will remember the concepts for a longer time. Ultimately, they can increase the accessibility of science by making the information understandable to people of different ages, cultural backgrounds, and education levels, stimulating critical thinking and creativity, working as catalysts for discussions, debates, the development of new ideas and for a deeper engagement with scientific inquiry. In this light, thanks to the combination of engaging narratives and impactful visuals, comic books turn out to be an exceptionally powerful tool for science communication.

All in all, given the increasingly vital role of web-based and visual media for science communication, and the fact – as noted by Brownell, Price and Steinman (2013) – that most scientists lack formal training in science communication and in harnessing the potentialities of these genres, there is a pressing need for an in-depth investigation into the rhetorical and linguistic-discursive configuration of these media. Such study might uncover the strategies and techniques used to distil complex scientific information into more digestible and compelling contents. As such, this investigation will, in turn, be able to yield valuable insights into the way researchers can better utilise these platforms to enhance the impact of their science communication enterprise.

2.2.1 Blogs in the popular scientific enterprise

In 1990, Tim Berners-Lee, a British computer scientist working at CERN, revolutionized the way we access and share information through the development of HTML (Hypertext Markup Language) technology, which later became the foundation of the World Wide Web. Among the earliest websites, Berners-Lee created a resource known as his 'log of websites', which served as a comprehensive record of the online pages and their associated URLs as they appeared on the web. Notably, this creation laid the groundwork for a new form of online expression and information sharing: the blog.

Until December 1997, when Jorn Barger introduced the expression to refer to his online journal *Robot Wisdom*, nobody had ever used the word 'weblog' to refer to this emerging genre of websites (Blood 2000). The shorter form that we employ nowadays – 'blog' – was then introduced in 1999, when Peter Merholz wrote in the sidebar of his online website "I've decided to pronounce the word 'weblog' as 'wee–blog', or 'blog' for short" (Merholz 1999, cited in Walker Rettberg 2008: 3).

The emergence of blogs can be traced back to the timeframe between 1994 and 1999. However, it was especially after the release of a few content management tools such as Pitas, Blogger, Java and Groksoup in July 1999, that this type of websites started to proliferate. Notably, a significant turning point occurred in 2001, when the dramatic events of 9/11 prompted the rise of what came to be known as 'warblogs': these platforms provided writers with an outlet to discuss crucial topics such as war, peace, and totalitarian regimes. The most radical change, however, took place in 2002, when blog software introduced the feature of comments. This enabled interactivity and dialogue, transforming blogs into virtual spaces where discussions and debates could take place (Domingo & Heinoen 2008). The impact was far-reaching: while in 2000, *LiveJournal*, one of the popular blogging platforms at the time, witnessed a number of less than 10 new diary weblogs being created daily, this same number was attested at approximately 200-300 at the end of that same year. This exponential growth persisted, and towards the end of 2004, the number had reached a staggering figure of around 9,000. In 2004, the significance of blogs reached new heights as the Merriam-Webster dictionary defined 'blog' their word of the year, on the basis of the fact that it was the most searched term in their dictionary. By then, the media had started writing about blogs regularly and the concept had become familiar to almost everybody (Walker-Rettberg 2008: 3).

According to rhetoricians Miller and Shepherd (2004), the birth of the blog in the 1990s was largely driven by the cultural environment of that era. This period, spanning from the end of the 20th century and the beginning of the 21st, saw a significant erosion of the boundaries between private and public spheres. As people found themselves living in a 'media-saturated world' (Miller & Shepherd 2004: 4), there was a growing impulse to seek the truth and to know more about the life of others and of the world. As a result, reality shows, talk shows and talent shows, which spotlighted real-life narratives and aimed to turn ordinary people into celebrities, gained widespread popularity on television. At the same time, this confusion between the public and private sectors also led to the individual's "willingness to overshare" (Calvert 2000, cited in Miller & Shepherd 2004: 5), e.g., the growing propensity of individuals to behave like public figures, sharing copious amounts of personal information, and broadcasting their everyday lives to the world. Within this context, the emergence of blogs can be perceived as a natural progression of this cultural landscape. To date, a blog can be defined as

> a frequently updated website consisting of dated entries arranged in reverse chronological order. It can comprise various semiotic modes (audioblogs, vlogs, textblogs, etc.), and is usually constructed by an individual (seldom by a group of collaborative writers). Blogs are accessible and readable by Internet users whose access and level of participation can be constrained by the blog author. Blogs are based on the organizational format of hypertexts which encourage selective readings of blog contents. While some properties of the blog (e.g., entry arrangement, hyperlinks, HTML/XML code) are stable, others come in great variety, such as quality, theme, content, purpose and ambition. (Hoffmann 2012: 18-19)

Expanding on this definition, the distinct genre-specific features that set blogs apart from other forms of media come to the fore. Above all, what distinguishes them from other tools is their organizational format. On the one hand, they display a reverse chronology of the frequently updated entries, which is something that, according to Blood (2000), conveys a sense of immediacy to the audience, boosting the impression that the contents are true. On the other, they present a series of hypertexts, which allows readers to navigate through entries and hyperlinks in a non-linear manner, enabling them to individually select the content according to what they find most interesting. Another important feature is the presence of diverse semiotic modes: blogs have expanded beyond text-based entries and now encompass various multimodal forms, which allow bloggers to engage their audience and create a more immersive experience. Nevertheless, one of the most important features of blogs is the presence of comment sections at the end of the entries: here, users are provided with a platform where they can engage actively with the content and in which they can share their thoughts, opinions, and feedback on what they have read. As demonstrated by previous studies on the topic, these spaces can have both beneficial and detrimental effects. Discussions in commentaries frequently take uncivil routes, where offensive replies, insults, rude critiques, flame wars and personal attacks hinder the democratic and constructive nature of discussion (Shils 1992; Papacharissi 2004; Upadhyay 2010; Bolander 2012; Luzón 2013b; Anderson *et al.* 2014). However, if properly employed, the interactive nature of these sections fosters a sense of community and encourages fruitful discussions between the authors and their readers. It allows for a dynamic exchange of ideas, perspectives, and additional information related to the posts, thus contributing to the creation of a collaborative and participatory environment.

In light of these considerations, blog can thus be compared to the ‘Speaker’s corner’ in London, as noted by Wijnia (2004). In the corner of Hyde Park, people can climb on a box and start talking about a subject. Passers-by in the surroundings can join in, initiating discussions with the speaker. Similar to this real-life setting, a blog serves as a virtual platform where individuals can share their stories or talk about topics in which they are interested, and much like how people pause to listen to speakers at Speaker's Corner, Internet users can stop and read their posts. At the same time, and just like those at Speaker's Corner, they can respond through comments or even create their own blog posts on the topic. In both scenarios, whether at Speaker's Corner or in the blogosphere, dialogue and exchange of ideas are facilitated through the dissemination of information.

In the context of blogs, the audience acquires a role of the utmost importance, being not just mere ‘spectators’ (Mauranen 2013a: 29), but active users who take part in discussions, express opinions, raise doubts, ask questions, and provide suggestions. At the same time, though, bloggers also need the public to get feedback on what they write. The discussion, engagement and sense of community provided by readers is what motivates most bloggers to keep creating content. As Bolander (2013: 43) notes, the two poles are “mutually dependent on one another”: without two-way communication, bloggers are left writing into a void, unsure whether their work is making an impact. Similarly, the audience depends on the blogger to get information on the latest and most significant developments in society.

Initially born as a platform for self-expression, blogs have undergone rapid expansion and diversification, giving rise to a varied ecosystem. The study by Grieve and colleagues (2010) detects two major types: the so-called ‘personal’ blog, which is devoted to the account of the blogger’s everyday life, and the ‘thematic’ one, which focuses on the discussion and exchange of information on a particular subject. At present, even though the former is still very popular, the ‘thematic’ blog has dramatically increased in popularity, with many of them moving from being single authored to being written by multiple voices, often even hosted on the websites of well-known institutions, companies, research centres and magazines (Garzone 2019: 29).

Within this context, a type of blog that is now receiving growing attention is the so-called ‘science blog’. According to Mehlenbacher (2019: 108-109), the practice of science blogging is the activity of “writing, sharing, and discussing scientific subject matter online” in which writers may be subject-matter experts, or science writers and journalists (Mahrt & Puschmann 2014). As Lapointe and Drouin (2007: 7) further clarify, these tools “enable scientists to speak directly to the people, allow people to read what scientists have to say, provide an opportunity for experts from different fields to exchange knowledge, and enable wide-ranging dialogue between real people and the ‘ivory tower’”.

As noted by Zivkovic (2012: 3-11), pinpointing the exact origin of science blogging turns out to be complex, as this genre emerged gradually from already existing online activities around the turn of the 21st century. At the very beginning of their history, early science blogs were employed to counter anti-science claims online. Then, the first key development that helped science blogging grow and gain respectability was the foundation, in 2005, of *Tangled Bank* and other 'blog carnivals', e.g., crowd-sourced online magazines in which bloggers submitted their best posts from a specific period to discover and promote each other's work: even though they are less popular now due to the rise in popularity of social media, carnivals helped build communities around different science topics. Subsequently, the second important moment was the establishment of *CognitiveDaily*, a blog that contributed to the birth of the 'research blog' type. Here, bloggers discussed peer-reviewed papers in an accessible way, using polls, animations, and videos to make the readers more engaged and interested in the topics approached. The third important moment in the history of science blogging was the creation in 2006 of blog networks such as *NPG* (belonging to the magazine *Nature*) or *ScienceBlogs* (Seed Media Group), which gave bloggers wider reach. Finally, the first edition of the *Open Laboratory* in 2007 was the last key contribution to the development of the genre. *Open Laboratory*, an annual print anthology of top science blog writing, helped define science blogging as a field and brought respectability by putting blog writing into book format.

At present, science blogs have become one of the most popular and influential platforms for science communication among researchers, scholars, and the general public. The pioneering developments of the early 2000s contributed to establishing them as a unique genre and community, paving the way for its current prominence (Bonetta 2007). Today, science blogs allow researchers to democratise, humanise, critically examine, and advance scientific discourse. Notably, their open-access nature, multimodality and intertextuality, together with the possibility for readers to engage in debates through comments, make them perfect media for the dissemination of science-related contents: they act as "virtual water coolers" (Kouper 2010: 7), as a "unique educational bridge" between experts and non-experts (Batths, Anthis & Smith 2008) and as "open dynamic spaces" (Luzón 2013a: 430), in which scientists and readers work together towards the development and transmission of information. What is more, as observed by Puschmann and Mahrt (2012) and Shema, Bar-Ilan, and Thelwall (2012), science blogs also contribute to the transparency of the scientific enterprise by providing an inside perspective of research, creating detailed posts on the day-to-day work in laboratories, addressing the challenges faced in research and the thought processes behind experiments, as well as discussing the failed studies, uncertainty, and scientific mistakes. By so doing, blogs give readers an authentic view of the reality of scientific work, thus enabling the academic activity to be perceived as an issue of the utmost importance.

All in all, from their humble beginnings in the 1990s to their exponential growth in the early 2000s, blogs have become an integral part of the online landscape. Within this context, science blogs have emerged as a prominent genre, facilitating direct communication between scientists and the public, and transforming the way in which we engage with information as well. Looking ahead, the science blogosphere will certainly continue evolving, providing scientists and researchers with ever-expanding possibilities to share their progresses with interested readers. However, to utilise blogs effectively and fully exploit their potential, researchers and communicators must understand the unique scientific and rhetorical considerations of this medium, which is why a detailed analysis of science blogging best practices and public engagement dynamics will be conducted in the following chapters.

2.2.2 YouTube educational videos for the accessibility of science

YouTube was created in February 2005 by three former PayPal employees – Chad Hurley, Steve Chen, and Jawed Karim (Soukoup 2014: 3). Noticing the absence of a platform where videos of notable events could be retrieved (Dickey 2013)[7], they decided to develop an online platform dedicated to the creation and sharing of user-generated videos (Soukoup 2014: 3) that had to be user-friendly to enable individuals without technical expertise to search and publish their own videos. The platform rapidly grew, and by July 2006, more than 65,000 videos were being uploaded daily, with the site receiving 100 million video views per day (NBC News 2006). Recognizing its immense potential, Google bought YouTube in November 2006 for $1.65 billion in stock: this acquisition marked a significant turning point in the history of this platform, propelling it to new heights and establishing it as a global media powerhouse, while still maintaining its operational independence from Google. Throughout the years, YouTube has continually evolved to cater to the evolving needs of its users and adapt to the ever-changing digital landscape: in 2007, for example, it launched its 'Partner Program', enabling content creators to monetise their videos through advertising (YouTube Team 2006). Then, it introduced various new features, including High Definition

[7] Among the most notable events that pushed the creation of this platform is the devastating Indian Ocean tsunami that occurred in December 2004.

(HD) videos in 2009, a live streaming service in 2010, and a movie rental service in 2011, which further contributed to its growth and expansion. Unlike many other social media platforms, which have proved to be ephemeral, YouTube has endured and thrived, establishing itself as "a repository of popular culture, creating a diachronic archive over time as well as synchronically expanding in its scope" (Arthurs *et al.* 2018: 3).

In 2023, YouTube stands out as the second most accessed website worldwide and the second most popular social media platform after Instagram. The platform's influence and reach are overwhelming, with users collectively watching over 1 billion hours of videos daily and uploading nearly 500 hours of new contents every minute. Furthermore, the platform's user base continues to expand at an exceptional speed, with more than 2.70 billion monthly active users around the world, e.g., 36.9% of the population of the entire world. To be more specific, on a daily basis, YouTube attracts around 500 million visitors who dedicate an average of 38 minutes per day to watch the videos and engage with the contents (Ceci 2023; Shewale 2023; DataReportal 2023; GlobalMediaInsights 2023).

At the moment, thanks to its wide variety of features and capabilities, defining YouTube turns out to be challenging: as Allgaier (2018: 5) puts it, YouTube "is in fact many different things". Amalgamating multiple roles – platform, archive, library, laboratory, database and social network, all concurrently (Snickars & Vonderau 2009), YouTube transcends the 'traditional notion' of a website (Kavoori 2011: 3): on the one hand, it allows users to upload, share and view videos – storing this material in pages that can be easily accessed and referenced anywhere and at any time – on the other, as a laboratory, it enables users to experiment, innovate and create new content. Additionally, as a social network "YouTube is not merely an archive of moving images […] YouTube is a social space" (Strangelove 2010: 4), since it facilitates discussion and interaction among users, fostering a two-way communication between content creators and their audiences through comments: it is a space where discussions can be held, opinions can be exchanged, and ideas can be debated, making it a dynamic and interactive social space. Ultimately, as stressed by Miller (2012: 17) it is "a free, public, online video archive", meaning that is accessible to anyone with Internet access, at no cost. It thus effectively contributes to the democratisation of the access to information and entertainment, enabling diverse voices, irrespective of the individual's educational background, to be heard globally.

In the specific context of YouTube, the audience is notably vast and diverse, spanning a wide spectrum of age groups, countries, and interests. However, what makes the public of YouTube especially unique is that they are not merely passive consumers of video content. On the contrary, they are active participants in the creation and distribution of these videos: they engage with what they see, they take part in discussions and often even produce content of their own. This dual role of the audience is encapsulated in the term 'produsers' (Erviti & Stengler 2016: 2) – a blend of 'producers' and 'users', which illustrates the active involvement of the audience in the shaping of the YouTube media landscape: their contribution comes in various forms, including commenting on videos, providing feedback, showing appreciation for the content, sharing their voice across different social platforms, and creating and uploading their own personal contents (Soukoup 2014).

However, what has propelled YouTube to its far-reaching popularity are its genre-specific features, which have played a pivotal role in attracting and engaging diverse audiences. Alongside its interactive and community-building nature, at the heart of these features are its various discovery mechanisms, such as the related video recommendation system, the keyword-based search engine, and the video highlight system on the homepage (Zhou *et al.* 2016; Yang *et al.* 2022), which provide targeted suggestions that make it easy for users to find and engage with content they love. Subsequently, another significant feature is the multimodal nature of its contents, which stimulates multiple senses and therefore allow for a rich layered communication experience that can cater to different learning styles and preferences. Here, information is presented through both visual and auditory channels: visuals can range from live-action footage to animation, while the auditory component can include spoken words, music, sound effects, and more. Text can also be inserted, either within the video itself or in the form of captions, subtitles, or on-screen notes. As observed by Putortì *et al.* (2019) these elements make videos a more immersive experience than texts alone, making it possible to capture and sustain the attention of viewers for a longer time, triggering deeper emotional responses, and providing easier and more efficient ways to cognitively process information. Ultimately, one last element that contributes to YouTube's effectiveness and appeal is the internal structure of its videos (Muñoz Morcillo *et al.* 2016): the employment of a well-structured storytelling – with the inclusion of stories that are inherently engaging and memorable – together with images drawn from everyday experience, metaphors and anecdotes, help explain difficult concepts, making them more understandable and improve information retention for the general public.

Yet, the content of YouTube "is evolving and dynamic" (Allgaier 2020: 5), and, since its birth, the platform has grown and developed far beyond its original purposes: at present, it has become an influential tool for both education and knowledge dissemination. So impactful has this transformation been on news sharing that Allgaier (2019) even suggest that it is headed in the right direction to replace traditional journalism. Within the educational sphere, instead, YouTube has become a hub for learning across a vast range of subjects – from STEM subjects, to languages, history, geography, and even niche hobbies (Snelson 2011). In particular, a field on which the advent of YouTube has been significantly impactful is science, as it has paved new pathways for researchers and scientists to disseminate their discoveries to other experts and to non-experts alike. More specifically, within the realm of medicine, YouTube videos have not only contributed to raising awareness and spreading specialized information on topics such as vaccines, cancer, neurodegenerative diseases and healthy habits, but they have also been instrumental in the creation and development of online communities around these issues (Soukoup 2011: 24).

While subject to controversies in the realm of science, YouTube videos are increasingly popular sources in which "science and research meet with popular culture" (Allgaier 2020: 10). By definition, a popular science educational video is "a short video that focuses on the communication of scientific contents for a broad audience on the Internet" (Muñoz Morcillo *et al.* 2016: 1), whose main aims are fundamentally to inform, educate and raise awareness on scientific concepts, discoveries, and research advancements (De Lara *et al.* 2017: 12-13). However, despite the shift of science contents producers to YouTube only started around 2014 (Martins Flores & Muniz De Medeiros 2018), this genre rapidly expanded, and, at present, the YouTube category devoted to science and technology generates a total of 12.2 billion monthly views, has around 1.3 billion subscribers and is viewed and browsed for a total amount of 766.7 million hours a month (Yang *et al.* 2022: 2).

The videos are normally produced by scientific institutions or non-governmental organizations, e.g., Universities and research centres wishing to disseminate their works to the lay public, media outlets such as television channels working on popularisation products, or independent scientists wishing to raise interest and curiosity in their own research fields (De Lara *et al.* 2017: 10). They are designed to be concise – around 10 minutes in length –

and contain eye-catching images to capture people's attention. They can cover a wide range of interesting topics – targeting the informational needs of different publics – and they usually adopt a humorous and conversational tone to create a more relaxed, accessible, and user-friendly, environment.

At present, the role played by YouTube educational videos in the realm of scientific communication is crucial: as stressed by De Lara and colleagues (2017), they are now among the media that facilitate the 'informal education' processes, namely the learning experiences that take place outside of formal instruction settings. This is due to several reasons, not least its multimodal nature, which enhances motivation and renders the understanding of the messages less cognitively demanding if compared to written-only domain-specific textual information (Pattier 2021: 2; Allgaier 2019: 2). Additionally, considering its far-reaching potential, they have the capability to reach a potentially limitless public: in particular, they are specifically apt for reaching the younger generations – the so-called 'millennials' (born between 1980 and 1995) and the 'digital natives' (born after 1995) – therefore fostering young people's interest in the realm of science, technology, and research (Erviti 2016: 9). Ultimately, by providing online access to a vast number of open-access videos on a broad spectrum of topics, they are capable of suiting the needs and interests of various audiences, ranging from people with no previous knowledge on the topics, to people who already possess a background in the field and wish to know more on the latest developments (Snelson 2011).

In short, from their beginnings to their growth in the 2010s, YouTube educational videos have become, alongside science blogs, a fundamental component of the online popular science communication environment, which, anticipating what is to come, will presumably continue evolving and diversifying. Yet, academic research on these matters is still in its infancy and more attention to this medium is needed to unlock its full potential, improve the educational resources, and to create more inclusive and accessible communication environments.

2.2.3 Comic books as catalysts for the democratization of science

Throughout much of their extensive and rich history, comic books have faced marginalization and neglect from scholars, educators, and institutions alike. For countless years, stemming from the widespread belief that they were inadequate for effectively communicating 'serious' issues, comics have been predominantly dismissed as 'insignificant funnies' (McAllister, Sewell & Gordon 2001: 4) or defined as 'dubious forms of literature' (Özçınar 2010: 165) filled with "bad art, stupid stories and guys in tights" (McCloud 1993: 2). As Locke (2005: 79) asserts, they have been 'thrice damned'

> damned as culture, being popular not 'high'; damned as a medium, being neither art nor literature but some perverse hybrid, at best suitable only for children (and retarded adults), at worst positively harmful… and damned as a genre, being the most outlandish fantasy involving absurd characters acting in the most bizarre fashion – the very antithesis, one might think, of plausibility.

According to scholarly literature (see, for example, Eisner 1985; McCloud 1993; Groensteen 2007; Zanettin 2008), the beginning of their extensive history cannot be dated, but several voices agree on tracing their origins back to ancient times, with the sequential representations of religious and non-religious subjects in historical artefacts, such as the sequences retrieved on the gravestone of the Egyptian scribe Menny[8] dated around 1,300 B.C. Moving on, other examples of early forms of comics can be retrieved in manuscripts, such as the 36-foot long coloured pre-Columbian epic story discovered by Cortés around 1519, and in tapestry, like the French well-known Bayeux Tapestry, depicting scenes of the Norman Conquest of 1066. However, McCloud (1993) and Groensteen (2007) agree on considering Rodolphe Topffer the father of the modern comic strip, since, for the first time in Europe in the mid-1800s, he created satiric stories using cartoons, panel borders and an interplay of words and pictures. However, it was not until the end of the 19th century that the comics as we know them today first appeared. This happened in the U.S., where thanks to the mass development of the daily press, comics began to be published in the Sunday pull-out supplements of the most well-known newspapers. Within this context, the birth date of comics is commonly associated with the first publication of Richard F. Outcalt's *The Yellow Kid* in 1894, which introduced

[8] These images represent a sequential portrayal of his life. They depict Menny with his family, working in his profession, and performing religious duties. The text accompanying the images lists his journeys and accomplishments, with an emphasis on his role as a scribe. The artwork and hieroglyphs on the gravestone provide insights into the life and beliefs of ancient Egyptians, highlighting the importance placed on family, work, and religion.

a new combination of text and image, speech bubbles, and various recurring characters. As far as Europe is concerned, the first comics appeared in the early 20th century in magazines such as the French *L'Epatant* (from 1908) and the Italian *Il Corriere dei Piccoli*. As the 20th century progressed, comics began to flourish and diversify, especially after the introduction of iconic superheroes such as Batman and Superman in the 1930s, which gave birth to the 'superhero' genre and started the so-called 'Golden Age' of comics (Quattro 2004). This trend persisted not only with the emergence of the Marvel comics in the 1960s – known as the 'Silver Age' of comic books – which presented characters such as Spider-Man, the Fantastic Four and X-Men, but also with the emergence of the 'Bronze Age' of comics, which saw the publications of books concerning social and moral problems. At present, generally known as the 'Modern Age' of comics (Rhoades 2008), thanks to the power of technological and social advancements, the comic book industry has transcended the superhero genre published in magazines, and has incorporated a wide spectrum of themes, characters from diverse cultural backgrounds, genders, sexual orientations, and channels – including web-based comics. What is more, the expansion of comics into other media, such as films, television, and video games, has elevated the medium to new heights of popularity and to a wide range of applications, including educational textbooks from primary school to university settings, to instructional booklets and in awareness campaigns in the healthcare field.

In contemporary times, several scholars have attempted to define the genre of comics books, and all seem to agree on the fact that the essence of this genre is represented by the sequentiality of its frames – which are arranged in purposeful sequences – the blending of the visual and verbal elements, and their objective to narrate a story or to convey information. To be precise, the most commonly accepted definition of 'comics' is the one proposed by Scott McCloud in *Understanding Comics* (1993), where, in order to clarify Will Eisner's 1985 definition of comics as 'sequential art', he asserts that these are "juxtaposed pictorial and other images in deliberate sequence, intended to convey information and/or to produce an aesthetic response in the viewer" (1993: 9). At the same time, though, as evidenced by Cohn (2005), comics are much more than simple combinations of verbal and visual elements. Rather, they have generated a unique 'language' which is more than the simple sum of the two constituent codes (Saraceni 2000, cited in Cohn 2005: 4). Comic books, in this light, are not just a hybrid form, but a well-defined medium with specific semantic and syntactic structures. These elements allow for an unparalleled method of communication and storytelling, and can appeal to a broad and varied audience of people of different age groups, interests and cultures.

However, alongside the sequentiality of its frames that evoke action and the passing of time, and the interplay of visual and verbal elements, comics are also characterized by a set of distinctive features that set them apart from other art forms. According to Canepari (2019: 117) these include, for example, the display of onomatopoeias, which creates the illusion of a real-life soundtrack, and the presence of speech and thought balloons, which render the language context-bound by evoking real dialogues. In this specific context, balloons are not just containers for texts, but their shape, size, and placement also contribute to contextualising the narrative by shaping the tone of the conversation between the characters, or by highlighting specific elements within the page. Additionally, given the fact that they provide a visual medium for conveying dialogues and thoughts, this convention grants the audience direct access to the character's spoken words and mental state, resulting in a deeper connection between the readers and the storyline. Another defining feature of comics is the presence of panels, which act as the building blocks of the comic itself. Each panel works as a unique storytelling unit and contains both texts and visuals that drive the narration, and their arrangement, position and size contribute to setting the rhythm of the story. Ultimately, the space between the panels, known as the 'gutter', is also a key feature of comics. In the words of McCloud (1993), the gutter offers readers the possibility to use their imagination to fill those gaps, thus applying their cognitive skills to connect the different panels of the story.

However, as mentioned above, since their beginnings, comics have experienced rapid expansion and diversification, not only adopting new artistic styles and storytelling techniques, but also embracing new publishing formats and genres. According to Zanettin (2008: 5-6), they can nowadays be categorized according to their primary function into 'entertainment' and 'instruction' types. The former category encompasses a class of sub-genres that are intended to engage and amuse the readers: within this category, one can find 'comedy' comics, whose heroes are mainly children and pets, that can even be used for political and social satire purposes; 'epic' comics, which comprise crime and detective fiction, science-fiction and adventure stories set in exotic and historical scenarios, and 'tragedy' comics, which often explore the morally ambiguous world of crime, and deal with themes of violence, corruption and deception.

‘Instruction’ comics, on the other hand, work as educational tools aiming at educating and enlightening the public through the presentation of the specialized information and knowledge in engaging formats, with the intention to promote critical thinking and facilitate a deeper understanding of the subject matters. According to Eisner (1985), these comics are explicitly designed to target a wide range of subjects – such as history, religion, politics, science, and social issues – with the intention of increasing “audience members’ knowledge about an issue, create favourable attitudes, shift local norms and change the over behaviours of individuals and communities” (Singhal & Rogers 2003: 288).

As far as the world of science is concerned, its first encounter with comic art took place in the United States in the late 1940s. It happened when psychiatrist Frederic Wertham, while conducting research on troubled youth in the city of New York, discovered that many of his patients were reading comics, and that these booklets were full of depictions of horror, crimes, and violence. Drawing from his extensive work of research, Wertham published a book titled *Seduction of the Innocent* in 1954, in which he put forth a controversial claim, asserting that comics were exerting a negative influence on his young and impressionable readers. At the time, both teachers and parents grew increasingly alarmed and started to harshly criticise these booklets for their inappropriate language and for trivializing serious issues, which led to both their banning from any classroom or learning environment, and to the establishment of the Comics Code Authority: this, in turn, implemented a series of guidelines and content-related restrictions to which authors had to adhere in order to publish their works (Nyberg 1998). However, in the decades that followed, the attitude towards comics started to change again: studies specifically centered on comic books began to emerge, and people started to recognise their potentialities for the enculturation of readers. In the late 20th and at the beginning of the 21st centuries, publishing houses thus began to print booklets tackling serious issues – like historical events, politics, science and literature – and, since then, the trend of employing the comic genre as a medium and tool for the dissemination of educational topics has seen a significant rise in popularity, especially in the fields of science and medicine.

In the words of Tatalovic (2009: 4), the so-called ‘science comics’ are those comics “which have as one of their main aims to communicate science or to educate the reader about some non-fictional, scientific concept or theme, using fictional techniques and narratives to convey the non-fictional information”: more specifically, they are devoted to “transport the full scientific methods, findings, and uncertainties into an easily understandable format" and to "provide ample scientific background to enable readers to delve further into the topic" (Friesen 2018: 3). This unique blend of science and art in comics is a prime example of the concept of 'sci-art', a notion advanced by Collver and Weitkamp (2018: 2) to represent the practice of using engaging narratives and illustrations to transmit domain-specific science-related contents to the lay public.

Whether in the form of short strips (e.g. Scientoons)[9], single-frame 'concept-cartoons'[10] or graphic novels, comics thus act as catalysts for the scientific popularisation process, allowing for what Locke (2005: 1) defines "a move away" from the so-called 'canonical account' (Shapin, 1990), or 'dominant view' (Hilgartner, 1990; Lewenstein, 1995; Bucchi 1998) of science communication, which postulated a one-way transfer of information from the experts to the public, with little or no space for dialogue and feedbacks. Instead of perpetuating this single-sided dissemination of information, these tools foster a more interactive, two-way dialogue with the audience, who is entertained and educated at the same time. Readers are no longer mere passive information consumers, but are called to engage with the content, to question the ideas presented, and to take action. This active involvement, in turn, facilitates a deeper understanding of the scientific concepts and ensures that the learning process is enjoyable and accessible.

Additionally, in today's ever-evolving science communication landscape, comics possess a multitude of strengths that make them an ideal tool for the enculturation of the public into the intricacies of science. First, one of their primary qualities lies in their ability to make scientific contents and principles more tangible and concrete (Jee & Anggoro 2012: 199; Farinella 2018: 3-4; Scavone *et al.* 2019: 1-2). Using visual metaphors and engaging storytelling, comics are thus able to provide visualization to phenomena that would otherwise be beyond human perception, such as complex invisible chemical and biological mechanisms or large-scale astronomical phenomena. By combining the power of texts and visuals, comics

[9] 'Scientoons' were designed and developed by Indian scientist and communicator Pradeep Srivastava. These cartoons comprise a caricature accompanied by satirical comments and/or dialogues. Alongside these elements are several basic details related to scientific research, data or specific technical information.

[10] Single frame 'Concept Cartoons' are typically composed of a single illustration accompanied by short pieces of text or dialogues. They often present a science-related situation or problem together with multiple possible solutions or viewpoints, which are included in the frame to reflect common misconceptions or alternative ideas that people may have on the topic. Their objective is to stimulate discussion and critical thinking among the public, through the analysis and reflection on the multiple viewpoints presented.

are thus able to bring scientific concepts out of the realm of the abstract and into the visible, illustrating, describing, and linking objects that are inaccessible to the naked eye to objects that are familiar and commonly encountered by the general public. This, in turn, not only amuses readers and engages their imagination, but, most importantly, allows them to form mental images, therefore contributing to clarifying and disambiguating the subjects under analysis.

Secondly, employing a visual design that divides the information into panels and speech balloons enables authors to break down the information into smaller and more digestible segments, creating a sort of scaffolding technique (Scavone *et al.* 2019) that helps guide readers through the sequential flow of specialized information. What is more, as stressed by Tribull (2017: 458), comics have "the advantage of permanence" over animations, as they allow people to read the contents at their own pace, examining visuals, digesting the domain-specific textual units, and revisiting previous pages at a comfortable rhythm, following each individual's most preferred learning and reading style.

Thirdly, another strength of strips and comic books is their use of characters that are nonhuman entities represented as human-like figures (e.g., immune cells that combat a war against viruses). This aspect is of the utmost importance since it tackles readers' internal cognitive mechanisms and enables them to relate better with what they see and read. When reading about the adventure of a character with human-like qualities such as facial expressions, body language, characteristics and emotions, readers are more likely to connect with them on a personal level: as stated by McCloud (1993), each individual's innate *pareidolia* is triggered and, as a consequence, a sense of familiarity with the character is developed, thereby facilitating a more profound interest and engagement in the topics being dealt with. Ultimately, one last strength of comics is that they allow for a rich and layered presentation of the contents which enables readers to draw multiple interpretations. In the words of Helin (2015, cited in Jonsson & Grafström 2021: 9) these tools present results and conclusions in an "unfinalizable" way, e.g., not offering definitive conclusions but encouraging readers to further reflections and debates. This aspect, in its turn, has the unique ability to trigger a natural inclination for information seeking in the public, promoting critical thinking and curiosity which extends far beyond the pages of the book.

In conclusion, popular science comic books have recently emerged and firmly established themselves as key components of the ongoing process of the democratization of science. However, despite their exponential growth and diversification, their undeniable potential, and the increasing scholarly attention they have started to receive over the last two decades, comics have been mostly studied as educational tools for teachers and students in school (Farinella 2018: 1), while their potential usage in exploring the specific challenges of scientific communication has only recently started to be examined (see Canepari 2023). At the same time, a persistent reluctance to thoroughly explore the verbal components – referred to as *logophobia* (Miodrag 2013) – has significantly hindered scholarly research, causing a significant gap in our understanding of the linguistic and discursive means employed to transmit such specialized contents. This, in turn, has given space to dissenting voices, such as Vilchez-Gonzales and Perales Palacios (2006), who contend that comics present a decontextualised, elitist, and rigid image of science, scientists, and laboratory work, therefore distorting public perception and leading to inaccurate understanding among non-expert people. In this light, it thus turns out that a more detailed study at this level of analysis needs to be conducted to gain a deeper understanding of this medium and its potentialities.

2.3 The 'power of words': the role of language studies in understanding popular science

As previously discussed, specialized discourses of science are considered to be complex to approach for readers who do not possess any specific disciplinary background: in the words of Halliday (1989: 159) "scientific texts are found to be difficult to read; and this is said to be because they are written in 'scientific language', a 'jargon' which has the effect of making the learner feel excluded and alienated from the subject-matter". As a consequence, when turning to an audience made of non-expert people, scientists, communicators and institutions alike are compelled to find the appropriate techniques to "express facts and concepts in a way that does not put off anyone but specialized readers" (Garzone 2020: 157).

These techniques involve the employment of a number of linguistic, discursive and rhetorical devices to accommodate the concepts to the general audience, together with a well-defined organization in the framing of the presentation of the arguments. In this perspective, the crucial role played by language in scientific communication, especially when addressing audiences with low levels of domain-specific knowledge or no background knowledge at all, is made clear. Early evidence of the role of language in the sciences was provided, in the early 1970s, by physicist and mathematician Niels Bohr ([1920] 1971), who highlighted that language was not a mere vehicle through which information could be disseminated, but an active agent affecting the growth of science itself (Favrholdt 1993). Since then, this concept has been further explored and expanded upon by linguistics and non-linguistics scholars alike. For instance, in the 1980s, philosopher and physicist David Bohm (1980) posited, in line with Wittgenstein's philosophy (1968) and Saussure's notion of the arbitrariness of linguistic signs (1915), that language actively contributes to the structuring and development of science. Likewise, in the 1990s, Bazerman (1988), Lemke (1990a) and Halliday (1997) added that science cannot exist independently of language, because science is itself the scientific discourse and is powered by what they referred to as 'grammatical energy', namely the linguistic and discursive means employed to talk about the various domain-specific concepts.

However, the fact that language "is a form of technology, or a resource for controlling an environment, by presenting interpretations and positioning participants in particular ways to establish knowledge" (Hyland 2010: 117) is specifically evident in the context of popular science: as previous works of literature demonstrate[11], language represents an essential element for both knowledge sharing and opinion-making, since the meaning people ascribe to the various science-related topics and to the value of the work of the research community is strictly linked to how this phenomenon is portrayed through words (Powell & Kleinman 2008; Nisbet 2009b, 2009c; Nisbet & Scheufele 2009; Brossard 2013).

In this light, it also becomes evident that communicating messages that are overly technical and difficult to comprehend, or too simplified and sensationalized, can widen the 'gulf' (Calsamiglia 2003), between experts and non-experts, resulting in misrepresentations and loss of credibility for the scientific community, and in incorrect conclusions and faulty decision-making processes for the lay public.

[11] See, *inter alia*, the studies on the framing of climate change-related issues (Nisbet 2009a; Han *et al.* 2015; Bolsen & Shapiro 2018 and Bernstein & Hoffmann 2019); on biotechnology-related topics (Nisbet & Lewenstein 2002; Nisbet *et al.* 2003; Nisbet & Huge 2006; Calsamiglia & Van Dijk 2014; Badullovich *et al.* 2020); on the issues of microplastics and their risks (Volker *et al.* 2020); on biodiversity conservation (Kusmanoff *et al.* 2020); on the uses of nanotechnologies (Cobb 2005); on the issue of COVID-19 pandemics (Rooke 2021; Huang & Liu 2022).

In this light, the study of language represents a key component in understanding how to communicate these issues more effectively and to a broader audience. More specifically, closely examining the so-called 'rhetoric' of science (Załęska 2016: 32), which, as defined in Aristotle's *Rhetoric*, is "the faculty of observing in any given case the available means of persuasion", researchers can gain insight into how scientific ideas are presented, evaluated, and accepted by different audiences. To be specific, conducting in depth investigations at the level of the *dispositio* (Załęska 2016: 36), namely the information scheme of the texts, through the *Structural Move Analysis* approach helps understand how messages are framed and how each information unit contributes to the overall meaning of the text. At the same time, looking at their *elocutio* (Załęska 2016: 39), e.g., their internal lexico-grammatical features, by means of corpora and corpus linguistics methodology to the study of discourse, helps retrieve patterns of language and comprehend how they contribute to the creation of the meanings. This knowledge can ultimately be used to improve the effectiveness of science communication, by helping communicators to tailor their messages to their intended audience, and to frame scientific information in a way that is more engaging, accessible, and persuasive.

2.3.1 The corpus-assisted approach

In the words of Baker and Mc Enery (2015: 1), corpus linguistics is "a powerful methodology – a way of using computers to assist the analysis of language so that regularities among many millions of words can be quickly and accurately identified".

Although the term 'corpus linguistics' only appeared in the 1980s (Leech 1992: 105), the use of corpora in language research has a long history. Indeed, the early 20th century witnessed the emergence of pioneering field linguists who conducted empirical studies based on observed data, laying the foundation for the subsequent development of what we now know as corpus-based research methodologies. However, it was not until the mid-1990s that linguistics experienced a dramatic shift, moving from a state of being "starved of adequate data" (Sinclair, 1991: 1) to being inundated with an overwhelming abundance of data. This shift gave impulse to the popularity of corpora, to the extent that, at present, "no linguist can ignore corpus data" (Stubbs 2004: 124).

In modern linguistics, a *corpus* identifies a collection of authentic texts, electronically stored, that are assumed to be representative of a language, or of a specific language variety, and that are made available in computer-readable form for the purposes of linguistic analyses (Sinclair 1991: 171; Tognini Bonelli 2001: 2; Hunston 2002: 2; Meyer 2002: xi-xii). Serving as representative samples of language in a particular context, domain or period, corpora can be compiled from diverse sources such as books, newspapers, websites and transcriptions of conversations or interviews, in line with the original research objectives of the linguist.

According to Chafe (1992: 80), corpus studies are "an absolutely crucial part of the linguistic enterprise". Relying on specialized softwares for efficient data processing and analysis, corpora provide researchers with solid empirical linguistic samples for the study and understanding of language structure, usage, and variation (Tognini-Bonelli 2010: 20). Using Saussurian terminology (1915), they offer insights into the so-called *langue*, namely the underlying system of language, and enable us to uncover patterns and regularities that often go beyond each one's personal consciousness, but which contribute to a deeper and more precise understanding of the structures, functions and variations of the language itself: as Hunston (2002: 3) puts it "a corpus does not contain new information about language, but the software offers us a new perspective on the familiar".

To these aims, corpus studies employ both quantitative and qualitative methodologies to approach the data, normally using evidence of frequency as the starting point for the investigation. This aspect holds significant importance in the analysis and interpretation of the outcomes, because, as claimed by Baker (2006: 47) "language is not a random affair". Frequency counts provide insights into how often certain words, phrases, or structures occur in the language under study, therefore enabling researchers both to assess the significance of specific language items for the construction of the discourse, and to establish meaningful comparisons between different genres and registers. Additionally, frequency also plays a crucial role in the identification of patterns of collocations, which represent words that frequently appear together more commonly that expected (Firth 1957): through the examination of collocational patterns, linguists can uncover the typical or preferred association between words, allowing researchers to draw valuable conclusions concerning the meaning and usage of words in context. Frequency information, then, is normally supplemented by qualitative studies conducted at the level of the lines of concordance. As Baker *et al.* (2008) observe, concordance lines, which make the study of the target word in its co-textual and contextual environment possible, play a crucial role in corpus-assisted studies because they enable researchers to identify lexico-grammatical patterns and association between words: this, in turn, provides insights into how these words are used in different contexts, how they are related to each other, and shed some light on the role they acquire in the construction of the discourse.

Given its potentialities, corpus linguistics methodology is wide-ranging and interdisciplinary: it is now employed in various fields such as lexicography, language teaching, translation studies, sociolinguistics, and computational linguistics. However, one of the fields where corpus linguistics has particularly flourished is discourse analysis.

In linguistics, *discourse* is traditionally defined as 'language in use', 'language in action', "language above the sentence or above the clause" and as "language in situational and cultural context" (Widdowson 1973; Brown & Yule 1983; Stubbs 1983; Schiffrin 1994; Gee 1999; Bhatia 2004; Blommaert 2005). Against this backdrop, it becomes evident that discourse is constructed via language, and, at the same time, that to uncover its traces, researchers must conduct linguistic analyses. However, discourse extends beyond individual sentences or clauses, but rather reflects how language is used in real-world settings. Within this context, the situational and cultural contexts of discourse production are not mere collateral factors, but are, in fact, indispensable components for a comprehensive understanding of the discourse itself. At the same time, language is not a neutral medium for communication, but a powerful tool for building and transmitting meaning: indeed, through language, people reflect and reinforce social norms, values, and power relations.

Discourse analysis as a discipline acknowledges this aspect and aims to both uncover how language is employed to shape our understanding of the reality around us, and to investigate how the various social, cultural, and historical factors affect its usage. By examining not only the surface-level structure of sentences – but also the underlying patterns, strategies, and implicit meanings that emerge from the employment of language in different contexts – researchers, on their part, are thus capable of unveiling the traces of discourse embedded in language, and, at the same time, to see how language is used as a tool for the promotion of social interaction, identity negotiation and for the preservation or questioning of the currently existing social structures.

In light of these considerations, it becomes evident that corpora and discourse approaches are 'perfect bedfellows' (Hyland 2009: 110). Thanks to its ability to reveal patterns of language use within large amounts of authentic data, corpus linguistics has become an essential tool for revealing and understanding the underlying assumptions, beliefs, and values of the speakers or writers, as well as the ways in which language is used to achieve specific communicative goals, such as persuasion, argumentation, and storytelling: in the words of Partington (2003: 7) corpora, either specialized or general, “can throw into relief the non-obvious in a single text”. More specifically, as claimed by Baker (2006: 10-21) there are four main advantages in using corpora for the study of discourse. First, is that they allow for the removal of a number of subjective cognitive biases and preconceptions that may arise among researchers when analysing the data, therefore ensuring objectivity and allowing more reliable insights to be drawn from the data. Second is what he calls “the incremental effect of discourse” (2006: 13), namely the fact that, building on large amounts of data and not on single texts, this methodology allows for the retrieval of patterns and associations that may otherwise be missed when analysing a small sample of texts. Then, the third advantage is that it enables the retrieval of both counterexamples, the so-called ‘resistant discourses’, and of the ‘dominant’ or ‘hegemonic’ ones, ensuring that the outcomes of the analysis are representative of the entire population and of the genre as a whole. Lastly, the fourth advantage is that this methodology can be easily combined with other approaches to strengthen the overall analysis.

Against this backdrop, corpus linguistics can therefore be said to represent a ‘Copernican revolution’ in the realm of linguistic inquiry, as claimed by Freddi (2014: 112), thus confirming Hoey’s claim that “corpora are not just important for the study of the *minutiae* of the language – they are central to a proper understanding of discourses as a whole, and that in turn means that there is no aspect of the teaching and learning of a language that can afford to ignore what corpus investigation can reveal” (2005: 150).

2.3.2 The structural move analysis approach

The Structural Move Analysis (SMA) approach represents an important framework employed in discourse analysis and genre studies to examine the internal organization and structure of texts. Its scope extends beyond the level of the sentence and allows for a systematic and comprehensive exploration of textual construction and dynamics.

The origins of this approach can be traced back to the pioneering work by Swales, who, in 1981, developed the discourse approach of move analysis within the more general framework of English for Specific Purposes (Biber *et al.* 2007: 25). Prior to the development of this model, the techniques for identifying discourses and discourse units were heterogeneous, and researchers struggled to establish a unified framework within this field. In the study on written texts, for example, the various segments of discourse were either identified on the basis of visual or textual clues, such as sentence punctuation and paragraphs (see, *inter alia*, Hunston 1994), or by means of noun phrases or content words at the beginning of the sentence (see Youmans 1991: 774). In spoken discourse, instead, detecting discourse boundaries proved to be more difficult, since, as claimed by scholars such as Tannen (1984), topic-shifting in conversation was not always readily identifiable and topic initiation was often unclear: here, as suggested by scholarly studies such as, among others, Brown and Yule (1983) and Gee (1986), prosodic and linguistic cues such as pauses, hesitations, false starts, interjections and changes in pitch, were used as markers of the various discourse boundaries. With the advent of this model, however, a more systematic and rigorous approach emerged, giving researchers the possibility of employing more definite and effective means for studying and detecting discourses and their constituent segments.

As anticipated, the Structural Move Analysis approach was developed in 1981 by Swales, who, in his book *Aspects of Article Introductions*, elaborated a model to help advanced non-native speakers of English (NNSs) wishing to read, write, or publish academic articles in the English language. His analysis of forty-eight introduction sections of research articles led him to postulate the existence of a series of textual segments performing specific communicative purposes, which structure the introduction sections of academic articles: *establishing a territory*, in which the author introduces the general topic and provides background information to contextualise the research, *establishing a niche*, in which the writer highlights the limitations or the unanswered questions in existing literature, thus emphasizing the need for further research, and *occupying the niche*, in which the author presents the purpose and objectives of the study, clarifying how the work aims to address the gap and contribute to the existing knowledge. According to him, by following this structural framework, NNSs could successfully enhance their academic writing skills and effectively communicate their research within the English-speaking academic community.

This framework, known as the CARS (*Create a Research Space*) model, has not only been revised and extended by several scholars, including Swales himself (1990, 2004), but it has also been successfully extended to other areas of research within English for Specific

Purposes (ESP)[12]. More specifically, this model assumes that genres are composed of a number of discernible internal components, called ‘moves’, which, as claimed by Bhatia (1993a), represent an inherent property of the genre itself, and are not construed by the reader – but rather defined by the original communicative purposes of the text. ‘Moves’ are defined as “discoursal or rhetorical units that perform a coherent communicative function in a written or spoken discourse” (Swales 2004: 228). They “are made up of a bundle of linguistic features (lexical meaning, propositional meanings, illocutionary force, etc.) which give the segment a uniform orientation and signal the content of discourse in it” (Nwogu 1997:122) and they can vary in length, even though they are normally at least one sentence long (Connor & Mauranen 1999). Some moves, the so-called ‘conventional’ or ‘obligatory’ ones, occur frequently and repeatedly in the texts, while others may be labelled as ‘optional’ because they can be retrieved in few instances. What is more, some of them often undergo a process of ‘recycling’ (Swales 2004), e.g., they occur more than once in a given text, with varied realizations. According to Swales’ original model, moves are realized through the combination of a number of lower-level textual segments, named ‘steps’ (Swales 1990) or ‘strategies’ (Bhatia 1993a), which work together to accomplish the rhetorical purpose of the move.

According to Structural Move Analysis, there are two methods for segmenting texts into moves and steps: the so-called ‘top-down’ and ‘bottom-up’ approaches, which are chosen by the researchers according to their project aims. The former begins with a pre-defined set of moves derived from existing literature on the topic. Researchers start by identifying the typical moves associated with a particular genre or register – which are normally determined through extensive analysis of large text corpora or through established

[12] In academic writing, this model has been employed to study, among others, the discourse of medicine (Williams 1999, Nwogu 1997), biology (Samraj 2002) and biochemistry (Kanoksilapatham 2005). In professional discourse, it has been applied to the study of legal discourse (Bhatia 1993a), philanthropic discourse (Upton & Connor 2001, Upton 2002), grant proposals (Connor & Upton 2004), movie reviews (Pang 2002), job application letters (Connor, Precht & Upton 2002) and birthmother letters (Upton & Cohen 2009).

More recently, this approach has been used to study both spoken and written discourses. Among the works on written texts, it is worth mentioning the analysis on the discourse of confirmation emails (Asztalos 2014), Ph.D. abstracts in English language teaching in Turkey (Özmen 2016), nanoscience and nanotechnology research articles abstracts (Hwang, Nguyen & Su 2017), literary research articles abstracts (Tanko 2017), grant proposals (Cotos 2019), conference abstracts (Yoon & Casal 2020), and e-commerce customer service webchat exchange (Xu Lockwood 2021). As far as spoken discourse is concerned, then, it is worth mentioning the research on TED talks about education (Li & Li 2021) and 60-seconds science podcasts (Ye 2021).

genre conventions. Once the moves have been identified, the researcher examines the text under analysis to test whether it aligns with these predefined moves, and eventually modifies or integrates existing literature with the newly retrieved data. On the contrary, the 'bottom-up' approach is centred on an inductive analysis that starts with without preconceived moves or assumptions about the genre structure. Researchers thus focus on identifying recurring patterns and organizing principles within the text: through a close examination of the written or spoken language samples, they gradually identify and categorise each move and step. However, a combination of these approaches – starting with a top-down analysis to establish a basic framework of moves and then refining it through a bottom-up study to capture their nuances and variations – is often used in linguistic research to gain a more comprehensive understanding of the genres and to compare moves and steps prototypes across different disciplines.

As claimed by Baker and colleagues (2007: 33), even though there are no strict rules to follow, the analysis usually unfolds in various steps. First, the analysis usually starts with the determination of the overall rhetorical purpose of the genre. Then, it moves onto the identification of the rhetorical function of each text segment in its local context and the possible move types. The third step consists in identifying a number of functional/semantic themes that have been identified with the moves and grouping them together. At this stage, conducting pilot-coding is recommended in order to test and validate the identified moves and steps with their definitions. After this specific phase, the developed coding framework is applied to the entire set of texts, which, in the end, are described according to the results stemming from this last phase of the analysis (Upton & Cohen 2009).

In light of these considerations, it becomes evident that employing the Structural Move Analysis approach to the study of texts offers several advantages. Firstly, it provides a methodical and systematic approach to reveal the organization and communicative purposes of texts: through moves and steps categorization researchers gain deeper insights into the structural patterns that underlie genres, and into the role they play in the meaning-making process. Then, the step-by-step process allows for a comprehensive understanding of the genre's internal components and their interconnectedness. Here, the employment of pilot-coding increases the reliability of the analysis, ensuring the accuracy and precision of the retrieved moves and steps. Furthermore, the creation of a framework composed of moves and steps, makes it possible to compare and contrast the discursive and rhetorical organization across different contexts. Ultimately, one last advantage of this methodology is that while it is primarily focused on the discursive elements that create the texts, it takes also into account the social and contextual factors that influence their production and reception: by looking at the context in which the text is produced as well, this methodology acknowledges that genres are not created in isolation but are influenced by a broader social, cultural, and disciplinary context, therefore allowing for a better understanding of the complex interplay between linguistic choices, social context, and communicative effectiveness within a specific register.

Within this context, applying a corpus-assisted approach to the study of the moves further strengthens these advantages. As evidenced by Biber, Connor and Upton (2007: 15-26)

> this investment of labour pays off by enabling generalizable analyses of discourse structure across a representative sample of texts from a genre. For example, once a corpus of texts has been coded for moves, we can easily analyse the typical linguistic (lexical and grammatical) characteristics of each move type. It is then possible to identify the sequences of move types that are typical for a genre, and against that background, it is also possible to identify particular texts that use more innovative sequences of move types.

In other words, through corpora, researchers can analyse a wide range of authentic examples from a specific genre or discourse community, providing more reliable and generalizable results. At the same time, they can also detect recurring patterns, variations, and frequencies of moves within a genre, leading to a more comprehensive understanding of the typical linguistic features of the moves. To be precise, frequency counts in corpora allow for the determination of whether a move is obligatory or optional, which has important repercussions on the creation of the frameworks that are specific of each genre. Then, information on patterns and collocations provides useful insights into the position of the move, both within the texts and in relation to the others. Ultimately, by combining these details, researchers are thus able to draw genre-specific prototypes containing moves, steps, and patterns, which play a key role in helping novices understand and produce texts belonging to a genre that is new to them.

Chapter 3

Materials and methods

The present chapter aims at presenting the methodological aspects that underlie this research project. The first section describes the data collection process, with special attention to the description of the sources from which the texts were gathered. The second part of the chapter, then, concentrates on the research corpus that was built purposely for this work, and gives a detailed account of its composition, its size and its sampling frame, namely the criteria that were taken into account for the extraction of the data. Lastly, the third section explains the approach adopted during the process of investigation, the steps involved in the analysis of the data, and the tools utilised.

3.1 Study material collection

As stated by Sinclair (2005: 79), the job of corpus building can be divided into two stages: design and implementation. Within this context, to handle the design phase properly, it was necessary to refer back to the original research questions that underlie the present work. Since the aim of this project was to study the linguistic and rhetorical configuration of the discourse of popular science within three different disciplinary fields – biology, chemistry and earth sciences – and across three different media, namely blogs, YouTube educational videos and comics, the compilation of a 'special purpose corpus' (Bowker & Pearson 2012) turned out to be essential.

The first step towards the creation of the corpus was the selection of the sources. This initial phase of the research was made possible thanks to different online pages and tools.

First of all, a cross-search based on the results provided by two feedreaders, or feed aggregators, was conducted. Within this context, relying on the information provided by the two free web-based apps *Feedspot* (https://www.feedspot.com/) and *Feedly* (https://feedly.com/), which constantly monitor website activities and group online contents into categories, turned out to be extremely useful in the identification of the most relevant Institutional blogs and YouTube channels specialised in science. In particular, Feedspot articles such as "100 science YouTube channels for science news, videos, research and scientific concepts in 2021" or "The top 70 chemistry blogs to follow in 2021" were extremely useful in order to obtain up-to-date insights into these contents.

Alongside the aforementioned feed aggregators, online discussion websites such as *Reddit* (https://www.reddit.com/) and *Quora* (https://www.quora.com/) were consulted to get a first-hand account of people's opinions on these resources.

Then, as far as Institutional weblogs are concerned, directories and search engines specialised in blog search such as *BlogSearchEngine* (http://www.blogsearchengine.org/) and *Eatonweb* (http://portal.eatonweb.com/) were browsed in order to retrieve a list of all the items existing in the blogosphere, under the labels 'biology blogs', 'chemistry blogs' and 'earth sciences blogs'.

Finally, other sources included in this corpus were identified thanks to the reading and watching suggestions given by authors of science-related web contents. These include, for example, online science magazines such as *EuroScientist* (https://www.euroscientist.com/), *Nature* (https://www.nature.com/), *American Scientist* (https://www.americanscientist.org), *BBC Science Focus* (https://www.sciencefocus.com/) and *The New Scientist* (https://www.newscientist.com/), which, together with conveying specialised knowledge to the audience, often also give suggestions on what to watch or read – including comics, graphic novels and books. In addition to online science magazines, also web resources specialised in the teaching of scientific subjects turned out to be useful in this context. These include, among others, websites like *Pop Culture Classroom* (https://classroom.popcultureclassroom.org/), *Science Friday* (https://www.sciencefriday.com/), *Science in Schools* (https://www.scienceinschool.org/), *Understanding Science* (https://undsci.berkeley.edu/) and *The School Library Journal* (https://www.slj.com/), which, while delivering high-quality and inclusive educational resources, also promote the use of new tools for the teaching of scientific disciplines.

Once all the information retrieved from these tools had been gathered, the sources to be included in the corpus were chosen according to six criteria: disciplinary domain, original language, reliability, authorship, activity, and the spectrum of readers/subscribers.

As far as the first factor is concerned, only resources specialised in the 'hard sciences' – chemistry, biology, and earth sciences – were taken into account, following the division found in the literature on academic subjects, such as Nesi and Gardner (2012).

In order for the corpus to be truly representative of the practice of popular science in the anglophone world, blogs, videos and comics originally written in another language and later translated into English were excluded from the initial search: this was the case, for instance, of the 'Manga Guides' series, where English editions such as *The Manga Guide to Molecular Biology* or *The Manga Guide to Physics* coincide with the translations of the original Japanese versions of the books.

As to the third feature, reliability was one of the most important elements for the selection of the sources. According to Bowker and Pearson (2012), to ensure the authenticity of the material contained in the corpus, the author of each text should be an acknowledged subject-field expert. For this reason, the sources included in this collection all belong to well-known institutions or are produced by professional science communicators, scholars, or researchers of different seniority with official affiliations, working in laboratories or in international organizations.

As a result, this corpus was designed to be a multi-author corpus, since the sources included were all developed by different voices: this choice was made in line with the criteria proposed by Bowker and Pearson (2012), who claim that in order to have a truly representative view on the type of language and discourse employed within a specific field, it is necessary to include texts coming from a range of different authors.

Finally, as far as Institutional blogs and educational videos are concerned, in order to build an up-to-date corpus of science popularisation, only weblogs and YouTube channels that were active at the moment of the analysis (between February and March 2021) were included. At the same time, the number of subscribers was also taken into consideration, given the fact that a higher number of followers means both a more diversified spectrum of readers and a greater dissemination of the contents.

Therefore, in accordance with what has been stated above, 6 blogs, 9 YouTube channels and 15 comics, belonging to 5 different comic book series, were chosen to be included in the corpus.

3.1.1 Science blogs

The six popular science blogs included in this corpus are specialised in chemistry, biology, and earth sciences, and all belong to official world-renowned institutions or magazines. They are listed in Table 1 below, together with the link to their homepage and the specification of the disciplinary domain they belong to.

BLOG NAME	WEBSITE	DISCIPLINE
On Biology	http://blogs.biomedcentral.com/on-biology/	Biology
BioBeatBlog	https://biobeat.nigms.nih.gov/	Biology
Earth&Climate News	https://www.sciencedaily.com/news/earth_climate/	Earth sciences
Science News - Earth	https://www.sciencenews.org/topic/earth	Earth sciences
Phys.org - Chemistry	https://phys.org/chemistry-news/	Chemistry
SciTechDaily Chemistry	https://scitechdaily.com/news/chemistry/	Chemistry

Table 1. List of the six popular science blogs included in the corpus.

On Biology and *Biomedical Beat Blog* are the resources included in the 'Biology Blogs' subcorpus. The former (http://blogs.biomedcentral.com/on-biology/) is part of the *BioMed Central* magazine blog network, which is a UK-based scientific publisher, producer of over 270 scientific journals, founded in 2000 and now owned by Springer Nature. In these blogs, researchers and scientists offer insights and opinions on both the studies published in the BMC open-access journals and on the latest news in the field. *On Biology* deals specifically with topics such as microbiology, cell biology, molecular biology, and physiology. It was listed among the "50 Best Biology Blogs and Websites" by Feedspot in 2021 and 2022[13], and it currently counts around 70k followers on both the blog page and on the main social networks. *Biomedical Beat Blog* (https://biobeat.nigms.nih.gov/), on the other hand, was initially an electronic newsletter distributed between January 2005 and July 2013. Nowadays, it constitutes a blog belonging to the National Institute of General Medical Sciences, one of the National Institutes of Health in the American department of Health and Human Services. It is specialised in the transmission of contents related to the biology of cells and genes, molecular structures, human biology, and techniques for genetic therapies. Among the contributors we find science communicators, leading scholars and practitioners (e.g., researchers in laboratories). This blog, which was started in 2013 and now counts around 40k subscribers, was featured in Feedspot's "20 Best Biomedical Blogs and Websites" in both 2021 and 2022[14], and was included in the reading suggestion lists of several international medicine-themed blogs.

[13] Available at: https://blog.feedspot.com/biology_blogs/
[14] Available at: https://blog.feedspot.com/biomedical_blogs/

As far as the ‘Earth Sciences Blogs’ corpus is concerned, the two sources that were selected are *Science News - Earth* (https://www.sciencenews.org/topic/earth) and *Earth&Climate News* (https://www.sciencedaily.com/news/earth_climate/). *Science News - Earth* is a blog that belongs to a wider network of blogs called *Science News*, which, in turn, represents the voice of the US Society for Science & the Public (SSP). The latter was founded in 1921 as an independent magazine specialised in science, medicine, and technology, and it now counts around 2.5 million subscribers, both on the blog webpage and on social networks. The *Science News Earth* blog specialises in natural sciences, and its aim is to report on advancements in studies on environment, climate change, earth and space. It featured as Ata Scientific’s “14 Science Blogs Everyone should follow” in 2016[15] and in Feedspot’s “100 Best Science Blogs and Websites” in 2021 and 2022[16]. *Earth&Climate News* blog belongs, instead, to *Science Daily,* an American website that aggregates press releases and articles about science. Written by scientists and scholars belonging to official institutions, such as research centres, Universities and laboratories around the world, *Earth&Climate News* features breaking news about the latest scientific discoveries on climate change, environment, earth, oceans, volcanoes and animals. This blog, which now counts more than 1 million subscribers and social network visitors, was featured in Feedspot’s “100 best Science Blogs and Websites” in 2021 and 2022, in the “70 best Global Warming Blogs and websites”[17] and in the “35 Best Ecology Blogs and Websites to follow in 2022”[18].

Finally, *Chemistry News* and *Phys.org - Chemistry* are the sources from which the texts included in the “Chemistry Blogs” subcorpus were taken. The former, https://scitechdaily.com/news/chemistry/, is a news blog that belongs to *SciTechDaily*, an online platform established in 1998, devoted to the transmission of the latest science and technology findings. The authors of these blogs include scientists, researchers and engineers working both as practitioners and as scholars within Academia. *Chemistry News*, in particular, features the most recent chemistry news and studies from universities and institutes from around the world. Topics debated on this platform include biochemistry, chemical engineering, material science and the science beyond nanoparticles and polymers. This blog was listed among the “70 Best Chemistry Blogs and Websites to follow” in both

[15] Available at: https://www.atascientific.com.au/14-science-blogs-follow/
[16] Available at: https://blog.feedspot.com/science_blogs/
[17] Available at: https://blog.feedspot.com/global_warming_blogs/
[18] Available at: https://blog.feedspot.com/ecology_blogs/

2021 and 2022[19], and currently counts more than 150k subscribers and social network visitors. *Phys.org chemistry* blog (https://phys.org/chemistry-news/) can, instead, be found within the *Phys.org* news portal, which is s a UK-based science, research and technology news aggregator that brings together the most significant news from official institutions, laboratories and scholars. The mission of this platform is to provide the most complete and comprehensive coverage on analytical chemistry, biochemistry and material science. It was listed among the "70 Best Chemistry Blogs and Websites to follow", the "20 Best Biochemistry Blogs and Websites to follow" by Feedspot in 2020, 2021 and 2022[20] and among the "The best 500 links about the future"[21] by *Futuria.io*, an English and French blog magazine devoted to the study of scientific advancements for the life in the future.

3.1.2 Science–themed YouTube channels

The nine channels from which the texts included in the 'YouTube subcorpus' were taken are listed in Table 2, together with the link to their homepage and the specification of the disciplinary domain they belong to.

CHANNEL NAME	WEBSITE	DISCIPLINE
IBiology	https://www.youtube.com/c/ibiology/videos	Biology
Kurzgesagt - In a nutshell	https://www.youtube.com/user/Kurzgesagt	Biology
Osmosis	https://www.youtube.com/c/osmosis/featured	Biology
Minute Earth	https://www.youtube.com/user/minuteearth	Earth sciences
Be smart	https://www.youtube.com/c/itsokaytobesmart/videos	Earth sciences
TedEd	https://www.youtube.com/teded/videos	Earth sciences
Reactions	https://www.youtube.com/c/ACSReactions/videos	Chemistry
Crash Course	https://www.youtube.com/user/crashcourse	Chemistry
The American Chemical Society	https://www.youtube.com/user/AmerChemSoc/featured	Chemistry

Table 2. List of the YouTube channels included in the corpus.

First of all, the YouTube videos subcorpus specialised in biology was composed by assembling the data from three different channels: *IBiology*, *In a nutshell* and *Osmosis*. *IBiology* (https://www.youtube.com/c/ibiology/videos) is an American educational YouTube

[19] Available at: https://blog.feedspot.com/chemistry_websites/
[20] Available at: https://blog.feedspot.com/biochemistry_blogs/
[21] Available at: https://www.futuria.io/resource-portal-best-500-links-futu

channel started in 2009, which conveys specialised knowledge in the field of biology through open-access free short videos. The videos, which are narrated by leading scientists that work in the Academia or in laboratories, deal with topics such as microbiology, cell biology, stem cells treatments and genetics. Their aim is to both create contents for the general public and support schoolteachers of science. The channel has more than 150k subscribers and nearly 11 million views. *In a Nutshell (Kurzgesagtz)* (https://www.youtube.com/user/Kurzgesagt) is an educational YouTube channel which has both a German and an English version. It was created in 2013, and in December 2021 it was ranked as the world's 374th most subscribed channel, with more than 18 million followers and almost 2 billion views. The videos are typically 4-16 minutes in length and are narrated by scriptwriter and editor Steve Taylor, who created the contents together with professional scientists and science communicators. They deal with scientific, technological, political and philosophical issues: of particular importance, in this context, are the videos concerning biology (e.g., cells, bacteria, viruses and parasites). Finally, *Osmosis* (https://www.youtube.com/c/osmosis/featured) is an American biology-themed YouTube channel. It was started in 2015 and it has now over 2.4 million subscribers and more than 1 billion views. The authors of the channel are scientists and science communicators who work together with the *WikiProject Medicine* team, namely the Wikipedia team that works on the development of contents related to medical and scientific topics. *Osmosis* is made of short simple videos around 5-6 minutes long, which are devoted to the transmission of scientific contents in the fields of biology and health sciences.

The YouTube videos subcorpus specialised in earth sciences was compiled by assembling the data from three different channels: *Minute Earth*, *(It's ok to) be smart* and *TedEd. Minute Earth* (https://www.youtube.com/c/minuteearth/featured) is an American YouTube science-themed channel that was started in 2011 by a group of scientists, writers, and illustrators working at Neptune Studios, Texas (US), and that has now nearly 3 million subscribers and around 400 million views. The channel offers more than 200 videos that focus on the natural scientific aspects of the world and teach viewers about the functions of Earth. More specifically, topics debated in these videos include migratory patterns, geography, ecology, atmospheric science, earth history and geology. *Be smart* (https://www.youtube.com/c/itsokaytobesmart/videos) is a US-based YouTube channel created in 2012 by Joe Hanson, PhD researcher, science writer, biologist and YouTube educator, in partnership with PBS Digital Studios, Texas (US). The channel houses short educational videos, around 10-15 minutes long, which address scientific issues such as the story of the universe, climate change, atmosphere, life on earth and tectonics. It currently has more than 4.5 million subscribers and around 400 million views. Finally, *TedEd* (https://www.youtube.com/teded/videos) is, again, an American educational channel, which was started in 2011 with the aim of extending TED's mission of transmitting specialised knowledge to the world. *TedEd*, which has now more than 16 million subscribers and 3 billion views, supports learning by helping teachers and students around the world, and encourages interested people outside school to get involved in scientific topics. The channel houses short, animated videos around 6 minutes long, which discuss topics such as nature, climate change, earth history and meteorology. These videos are created by TED speakers, as well as educators, designers, animators, screenwriters, academic researchers, and science writers.

Lastly, the YouTube videos subcorpus specialised in chemistry was composed by assembling the data from the following channels: *Reactions*, *Crash Course* and *The American Chemical Society*. *Reactions* (https://www.youtube.com/c/ACSReactions/videos) is an American educational YouTube channel started in January 2014 by director of programming Adam Dylewski, which is now produced by the American Chemical Society in association with PBS Digital Studios, Texas (US). The mission of the channel is to "uncover the hidden chemistry all around us"[22] through short, animated videos (around 10 minutes long), which show experiments, expert interviews and demos to explain issues such as food chemistry, medicinal drugs and the chemistry of human and bodies. It currently has nearly 400,000 subscriptions and more than 55 million views. Then, *The American Chemical Society* channel, (https://www.youtube.com/user/AmerChemSoc/featured), was started in February 2009 and has now nearly 50,000 subscriptions and more than 10 million views. Its aim is to both inform the public about the activities of the Society and to bring chemistry into people's everyday lives. The channel contains short videos – 5 to 15 minutes long – containing expert interviews, press conference recordings, highlights of newly-published research and articles, and science talks. Of relevance in this context are the videos belonging to the "ACS Education Serie", namely a number of videos devoted to the enculturation of the public into the world of chemistry. Topics debated in these videos include food chemistry, 'everyday life' chemistry and experiments on chemical reactions. Finally, the US-based channel *Crash*

[22] As specified in the channel's "information" section available at https://www.youtube.com/c/ACSReactions/about

Course (https://www.youtube.com/user/crashcourse) is another educational science-themed channel that was started in 2006 by John and Hanks Green, vloggers and content creators. Each week, the channel produces educational videos – 10 to 15 minutes in length – that deal with various topics: of relevance in this context are the *Crash Course Chemistry* and *Crash Course Organic Chemistry* playlists. What is more, in order to make its contents as useful as possible to its 13.5 million subscribers and 2 billion viewers, *Crash Course* channel hires experts such as PhD researchers, scientists and science communicators to work on the creation of the videos and uses humour to blend entertainment together with educational contents.

3.1.3 Science comic books

The 15 popular science comic books included in the corpus are listed in Table 3 below, together with the indication of the date of publication and the specification of the disciplinary domain they belong to. The complete references to the following books can be found in the bibliography section of this work.

COMIC BOOK	DISCIPLINE
The Cartoon Guide to Biology, 2019.	Biology
Science Comics: The Brain – The ultimate thinking machine, 2018.	Biology
Vampires and Cells, 2012.	Biology
The basics of cell life – with Max Axiom Super Scientist, 2010.	Biology
The Cartoon Guide to the Environment, 1996.	Earth sciences
Science comics: Wild weather – storms, meteorology and climate, 2019.	Earth sciences
Exploring ecosystems – with Max Axiom super scientist, 2019.	Earth sciences
Understanding global warming – with Max Axiom super scientist, 2008.	Earth sciences
Adventures in science: The lonely Existence of Asteroids and Comets, 2012.	Earth sciences
Adventures in science: The secret lives of plants, 2012.	Earth sciences
Adventures in science: When Volcanoes Erupt, 2012.	Earth sciences
The Cartoon Guide to Chemistry, 2005.	Chemistry
The Dynamic World of Chemical reactions – with Max Axiom Super Scientist, 2011.	Chemistry
The Solid Truth about States of Matter – with Max Axiom Super Scientist", 2019.	Chemistry
Ghosts and Atoms, 2012.	Chemistry

Table 3. List of the comic book series included in the corpus.

HarperCollins Publisher's *Cartoon Guide to* series takes on a range of different topics, such as statistics, environment, physics, genetics, algebra and many more. They are authored by illustrator and New York Times best-selling author Larry Gonick, together with experts in different fields: environmental engineer Alice Outwater worked on the *Cartoon Guide to the Environment*¸ Stanford University scholar Craig Criddle co-authored the *Cartoon Guide to Chemistry*, and Professor David Wessner contributed to the *Cartoon Guide to Biology*. These comics are intended to be comprehensive, but, at the same time, fun and easy-to-understand guides to the basics of the disciplines. More specifically, the *Cartoon Guide to Environment* deals with topics such as forests and water, communities of life on land and in water, food and energy webs, populations, agriculture, commercial hunting, and pollution and environmental actions.

The *Cartoon Guide to Chemistry* covers, instead, the basics and some history of the discipline, including topics such as the atomic structure, the periodic table, the chemical bonds, reactions and solutions, heat and energy, the states of matter, acid and basis, organic chemistry and thermodynamics. Finally, *The Cartoon Guide to Biology* starts by talking about life's essential organic chemistry, cell structure, food energy, cellular respiration, DNA, gene regulation and reproduction, and later moves on to the discussion on multicellular organisms with complex organ systems, different species, ecosystems, energy flows and chemical cycles, and ends by showing what happens when biological systems are disrupted.

First Second Publishing's *Science Comics: Get to Know your Universe!* books are a series of science-themed illustrated books that are intended to offer a complete introduction to each topic. The books included in this corpus are focused on the following subjects: the brain, with its anatomy and functions, and the weather, together with issues connected to climate change and extreme meteorological phenomena. They are suitable for both students and people with a passion for science. Authors of these books include cartoonists and illustrators working together with experts in the specific fields. The biology-themed book included here is *The Brain – The Ultimate Thinking Machine*, which explores topics such as the evolution of the brain, brain functionality and brain composition through the story of a young girl named Fahama, who needs to learn about the brain as fast as possible to escape from the clutches of a mad scientist and his zombie assistant.

The earth sciences-themed books selected for this corpus was, instead, *Wild Weather - storms, meteorology and climate*, which concentrates on climate and weather-related issues, such as floods, landslides, tornadoes and forest fires. In this book, readers follow a moody weatherman in his attempt to debunk myths and misconceptions about meteorology, answering questions such as “Does the rotation of the Earth affect wind currents?”, “How do weather satellites predict the future?” and “What is the difference between weather and climate?”. No books belonging to this series could be classified as ‘chemistry science comics’, which is why they were not included in this subcorpus.

The *Max Axiom Super Scientist* comic books are a collection of popular science comics written by multiple authors and published by Capstone Press. These books aim at introducing readers to the world of science and technology, and, in addition to the storyline, they also provide recommendations for additional reading resources, web links where to learn more about the contents, and a final glossary. This series, which is suitable for kids, more expert students and everyone interested in these subjects, has an engaging graphic novel format that encourages people to learn the history, science, and application of the technology we see and use every day. The protagonist is Max Axiom, a scientist with superpowers, who takes science out of the classroom and into the real world in order to explain its impact on our everyday lives. The biology-themed book included in this corpus is *The Basics of Cell Life*, a comic devoted to the world of cells, in which the protagonist helps readers understand how these are the building blocks of life, through the exploration of topics such as cell division, metabolism, cell functions and genetics.

As far as the discipline of earth sciences is concerned, two comics are included in this corpus. First of all, *Exploring Ecosystems*, which is focused on exploring concepts such as the ecosystems and biomes of the Earth, the energy sources for the planet and the different species. Secondly, *Understanding Global Warming*, in which the issue of global warming and its effects on Earth are discussed, together with topics such as the melting of glaciers, climate changes, the heating of the planet and the possible threats these phenomena pose to people’s lives.

Finally, comics on chemistry included in this corpus are *The Dynamic World of Chemical Reactions* and *The Solid Truth about States of Matter*. The former describes in detail the chemistry of molecules, atoms, and the dynamics of chemical reactions around us. On the contrary, the latter is entirely devoted to the description of the states of matter and the associated processes.

Capstone Press *Vampires and Cells* and *Ghosts and Atoms* belong to the book collection named 'Monster Science'. In this series of comics, which are suitable for both young and more mature students, and for adults who are just interested in learning more about science, concepts are explained through monsters such as zombies, vampires, aliens and ghosts. More specifically, *Vampires and Cells* uses vampires and other fictional creatures to explain the real-world biology of cells, covering topics such as the organelles and the processes of mitosis and meiosis in a fun and easy-to-understand way. *Ghosts and Atoms* is, instead, focused on chemistry, and tackles topics such as atomics models, elements, molecules and particle accelerators.

Finally, the last three comics included in the corpus are three books that belong to the *Adventures in Science* series, all specialised in earth sciences, published by Capstone Press and written by well-known illustrators and science communicators. *The lonely existence of asteroids and comets* is about the solar system, and explains concepts such as the role of asteroids, meteorites and comets in the space. *The secret lives of plants!* focuses, quite patently, on the ecosystem of trees and plants on Earth, and, in addition to explaining the different types of fruits and flowers, as well as the chemical reactions that underlie the ecosystem, also stresses the importance of the preservation of the environment for our everyday lives. Finally, *When volcanoes erupt* is all about volcanoes, and, apart from describing the composition of volcanoes and the different types of eruptions, tackles issues such as earthquakes, natural disasters, and the scientific studies that contribute to the prediction of such phenomena.

3.2 The *Science Popularisation* corpus

Once the sources were selected, the corpus was assembled in a number of consecutive methodological stages.

First, texts were extracted from the above-mentioned Institutional blogs, YouTube channels and comics. In order for this corpus to be truly 'representative' (Biber 1993; Stubbs 2004) of the language of popular science, and to get, at the same time, a balanced sample of the use of the language under analysis, the texts were extracted on the basis of the following criteria proposed by scholars such as Sinclair (1991, 2005), Mc Enery *et al*. (2006), Biber *et al*. (1998) and Bowker and Pearson (2012): integrity of the texts, variety of sources, text types and time frame.

Thus, it was established to include only full texts in the corpus, which made it necessary to exclude from the data collection process the articles or the video scripts which were not complete: blog text files are generally around 700 to 1,200 tokens long and video scripts around 1,500. There is more variability in comics, which vary between 2,500 and 45,000 tokens.

Subsequently, to study the language of popular science across three different genres, three balanced subcorpora were created – YouTube corpus, Blogs corpus and Comics corpus (see Fig. 4 below) – extracting the text from the three different media proportionally.

Furthermore, as far as text types are concerned, in blogs, only posts were taken into account, while in YouTube channels, data were taken from the scripts of the videos, removing the lateral time references. In comics, instead, only the parts inserted within the storyline were copied, thus excluding the index, bibliography and authorial comments.

Lastly, as far as weblogs and videos are concerned, a five-year time span was set so as to be sure, on the one hand, to reach the established number of words, and, at the same time, to choose elements that were recent and as close as possible to the moment of analysis.

During the second stage, data were manually collected. However, given the different nature of the media under analysis, diversified data extraction methods were required. In blogs, for example, posts were copied and pasted directly from the web into a document. As far as YouTube videos are concerned, data were gathered by copying and pasting the scripts: within this context, the videos with automatically generated scripts were excluded due to frequent spelling mistakes and irregularities in the punctuation system. Finally, as concerns comics, for most of them an electronic version did not exist, therefore, pages had to be digitalised. Of the 15 books under analysis, 9 were scanned with an OCR software. However, four of them were originally written by hand and, as a consequence, the program did not manage to recognise the characters properly: in these cases, the pages had to be keyed-in entirely by hand. Nevertheless, even for the texts that were digitalised automatically, a cross-check on the punctuation and the spelling of the words was necessary to exclude possible mistakes.

Subsequently, using computer-based query software for the analysis of the texts required the data to be converted into *.txt* files with UTF-8 encoding in order to be processed, which is something that implied a number of modifications to the original texts, such as the removal of all the images, links and videos. The following Fig. 1 shows an example of a file ready for automatic text analysis.

```
REA_2016-07-19.txt - Blocco note di Windows
File  Modifica  Formato  Visualizza  ?
Alright viewers it's time to hit the gym.
And if you're trying to bulk up, you know you need protein to help build muscle.
But how does that work?
How much protein do you need?
How much is too much?
Ahhh it's all so confusing!
First things first, there's three different types of muscles; skeletal, cardiac and smooth.
We'll be talking about skeletal muscles.
You know, biceps, triceps, quads, and so on.
They're the most adaptable tissues in the human body and can be molded through working
out or … by sitting on the couch.
The way you can build muscles is by … well, damaging them.
Not real damage, like a major tear that will keep you on the sidelines.
When you do intense exercise like resistance training, little microtears occur in your
muscles that need to be repaired.
But before we talk about repair, we need to talk protein.
Proteins are essential because they are made of amino acids, which are responsible for
most of the reactions and processes in living cells.
Your main source of amino acids is through proteins in your diet.
Foods like meat, fish, eggs, and seitan are chockful of amino acids, some more so than
others.
How Does Protein Build Muscle?
```

Figure 1. File ready for automatic text analysis.

Afterwards, each text file was labelled individually to easily identify the source from which the item was taken. As for blogs and videos, the label was created by including two pieces of information: the first letters of the name of the source and the publication date, using the format YY-MM-DD. Therefore, all the files had names such as *biob_2016-01-17* (post published on 17th January 2016 on the blog BioBeatBlog) or *ted_2017-08-19* (video posted on the TedEd channel on 19th August 2017), as can be seen in Figure 2.

BIOB_2016-05-13.txt	24/02/2021 19:09	Documento di testo
BIOB_2016-05-25.txt	24/02/2021 19:08	Documento di testo
BIOB_2016-06-08.txt	24/02/2021 17:45	Documento di testo
BIOB_2016-09-07.txt	24/02/2021 19:05	Documento di testo
BIOB_2016-10-12.txt	24/02/2021 19:01	Documento di testo
BIOB_2016-11-02.txt	24/02/2021 19:00	Documento di testo
BIOB_2016-12-12.txt	24/02/2021 17:46	Documento di testo
BIOB_2017-01-24.txt	24/02/2021 18:07	Documento di testo
BIOB_2017-03-20.txt	24/02/2021 18:06	Documento di testo

Figure 2. Folder containing labelled blog files.

To provide additional clarity, the labels employed to identify the sources from which blog texts were taken are as follows: ONB for 'On Biology', BIOB for 'BioBeatBlog', ECN for

‘Earth&Climate News’, SNE for ‘Science News Earth’, PHY for ‘Phys.org – Chemistry’ and SCI for ‘SciTechDaily’.

Similarly, the labels that designate the channels that provided the materials for the *YouTube subcorpus* are the following: BIO for ‘IBiology’, KUR for ‘Kurzgesagt – In a Nutshell’, OSM for ‘Osmosis’, MIN for ‘Minute Earth’, OTBS for ‘Be Smart’, TED for ‘TedEd’, REA for ‘Reactions’, CC for ‘Crash Course’ and ACS for ‘The American Chemical Society’.

As for comics, instead, the label was composed of the initial letters of the discipline and the name of the comic, such as *CHEM_Ghostsandatoms*, which refers to the book titled *Ghosts and Atoms*. The other labels included in this research work include B_Basicsofcelllife (‘The basics of cell life – with Max Axiom Super Scientist’), B_Cartoonguides (‘The Cartoon Guide to Biology’), B_Thebrain (‘Science Comics: The Brain – The ultimate thinking machine’), B_Vampireandcells (‘Vampires and Cells’), CHEM_Cartoonguides (‘The Cartoon Guide to Chemistry’), CHEM_Chemicalreactions (‘The Dynamic World of Chemical reactions – with Max Axiom Super Scientist’), CHEM_Statesofmatter (‘The Solid Truth about States of Matter – with Max Axiom Super Scientist’), ES_Cartoonguides (‘The Cartoon Guide to the Environment’), ES_Exploringecosystems (‘Exploring ecosystems – with Max Axiom Super Scientist’), ES_Globalwarming (‘Understanding global warming – with Max Axiom Super Scientist’), ES_Secretlivesofplants (‘Adventures in science: The secret lives of plants’), ES_Lonelyexistence (‘Adventures in science: The lonely Existence of Asteroids and Comets’), ES_Volcanoeserupt (‘Adventures in science: When Volcanoes Erupt’), ES_Wildweather (‘Science comics: Wild weather – storms, meteorology and climate’). See Figure 3 below.

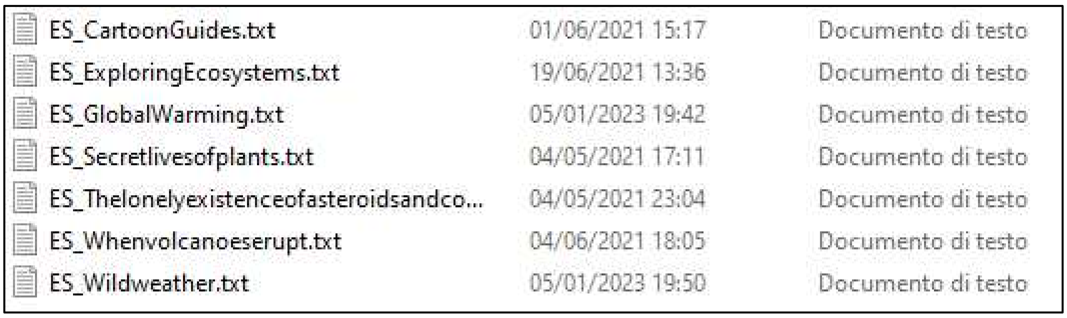

Figure 3. Folder containing labelled comic files.

As a last step, the files were grouped into the corresponding folders, which again were labelled individually, with a name containing the following details: discipline and type of medium, such as *biology_videos* for the folder containing the YouTube videos specialised in biology, or *chemistry_comics* for the folder with the chemistry-themed comic books.

In the end, all the folders were assembled, and the corpus was compiled and named *Science Popularisation Corpus*. As readers can see in Fig. 4, the corpus is composed of three subcorpora, in line with the original research questions of this work, each one representing a different medium: YouTube, blogs and comics. Each subcorpus is then further subdivided into the three disciplines under analysis, namely biology, chemistry and earth sciences.

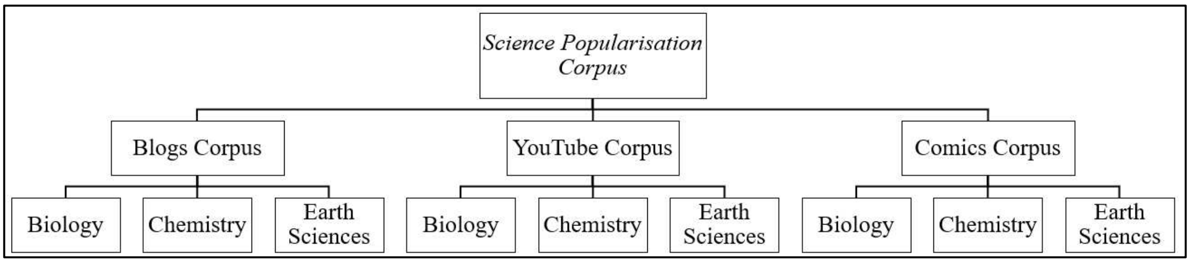

Figure 4. Tree diagram of the *Science Popularisation* corpus.

As stated above, more than one source was selected for each subcorpus in order to have a wider variety of data, and, as a consequence, a more complete view on the discourse and language of popular science within three different media.

For this reason, the YouTube subcorpus is built by assembling the data extracted from the following channels, as displayed in Fig. 5 below: 'Reactions', 'CrashCourse' and 'The American Chemical Society' for chemistry, 'IBiology', 'In a nutshell' and 'Osmosis' for biology and 'Minute Earth', 'TedED' and 'Be Smart' for earth sciences.

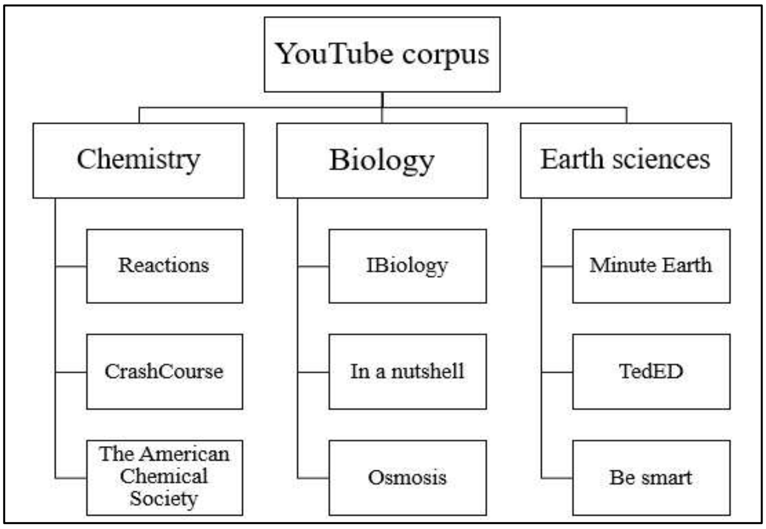

Figure 5. Tree diagram of the YouTube subcorpus.

The blogs subcorpus is composed of ‘SciTech Daily’ and ‘Phys.org – Chemistry’ for chemistry, ‘BioBeatBlog’ and ‘On Biology’ for biology, and ‘ScienceNews Earth’ and ‘Earth&Climate News’ for earth sciences, as represented in Fig. 6.

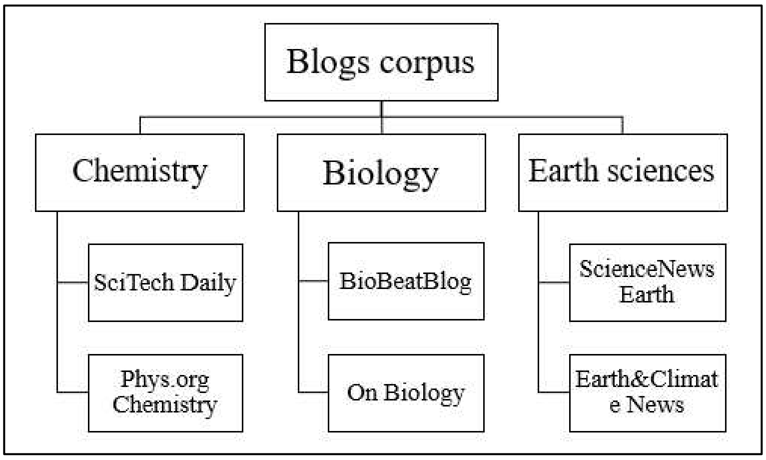

Figure 6. Tree diagram of the Blogs subcorpus.

Finally, the comics subcorpus is built by assembling the data extracted from the following channels, as displayed in Fig. 7: ‘The Cartoon Guide to Chemistry’, ‘The solid truth about states of matter’, ‘Ghosts and atoms’ and ‘The dynamic world of chemical reactions’ for chemistry, ‘The Cartoon Guide to Biology’, ‘The Brain: the ultimate thinking machine’, ‘Vampires and cells’ and ‘The basics of cell life’ for biology, and for earth sciences ‘The Cartoon Guide to Environment’, ‘Wild weather: storms, meteorology and climate’, 'Exploring ecosystems', 'The lonely existence of asteroids and comets', 'Understanding global warming', 'The secret lives of plants' and 'When volcanoes erupt!'.

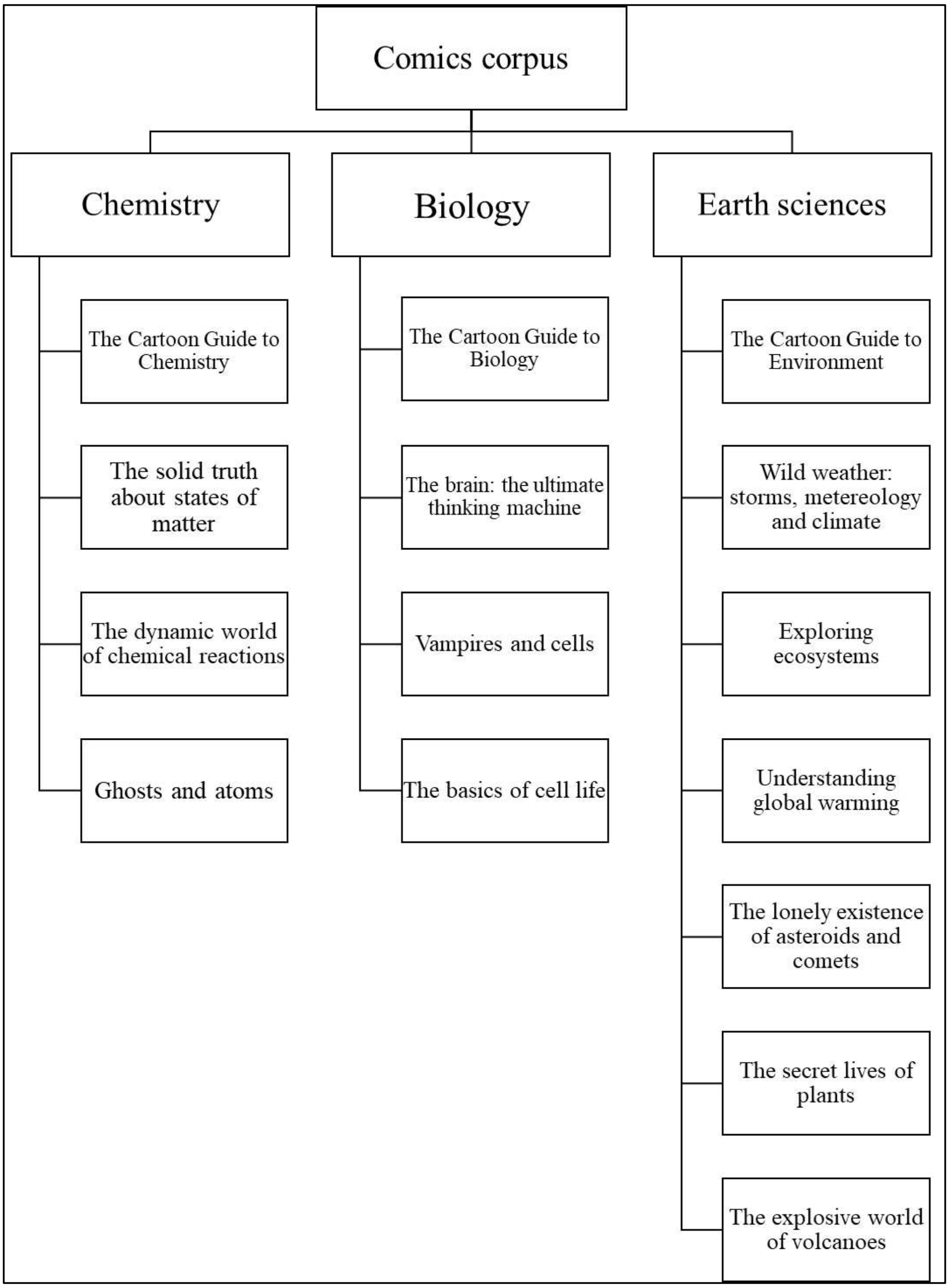

Figure 7. Tree diagram of the Comics subcorpus.

The Science Popularisation Corpus, therefore, consists of a total of 504,762 tokens and includes 364 text files, as Table 4 and 5 show.

SCIENCE POPULARISATION CORPUS	WORD COUNT
YouTube Subcorpus	170,445
Blogs Subcorpus	167,254
Comics Subcorpus	167,063
TOTAL	**504,762**

Table 4. Science Popularisation Corpus overall composition.

SCIENCE POPULARISATION CORPUS	FILE COUNT
YouTube subcorpus	139
Blogs subcorpus	210
Comics subcorpus	15
TOTAL	**364**

Table 5. Science Popularisation Corpus file composition.

The following tables (6, 7 and 8) show each subcorpus with the breakdown of the exact number of words.

YOUTUBE SUBCORPUS	WORD COUNT
Chemistry	57,239
Biology	57,111
Earth Sciences	56,095
TOTAL	**170,445**

Table 6. YouTube Subcorpus composition.

BLOGS SUBCORPUS	WORD COUNT
Chemistry	54,878
Biology	55,191
Earth Sciences	57,185
TOTAL	**167,254**

Table 7. Blogs Subcorpus composition.

COMICS SUBCORPUS	WORD COUNT
Chemistry	54,053
Biology	57,167
Earth Sciences	55,843
TOTAL	**167,063**

Table 8. Comics Subcorpus composition.

Lastly, the following tables 9, 10 and 11 show each subcorpus with the exact number of text files included.

YOUTUBE SUBCORPUS	FILE COUNT
Chemistry	57
Biology	19
Earth Sciences	63
TOTAL	**139**

Table 9. YouTube Subcorpus file count.

BLOGS SUBCORPUS	FILE COUNT
Chemistry	75
Biology	69
Earth Sciences	66
TOTAL	**210**

Table 10. Blogs Subcorpus file count.

COMICS SUBCORPUS	FILE COUNT
Chemistry	4
Biology	4
Earth Sciences	7
TOTAL	**15**

Table 11. Comics Subcorpus file count.

3.3 Methodology of investigation

As stated in the introductory section of this work, the purpose of the present research project is to study how domain-specific science-related knowledge is transmitted in Institutional blogs, YouTube educational videos and comics. Specifically, it aims, on the one hand, at studying how the specialized information is discursively organised and arranged to achieve a logical, coherent and successful communication of the message. On the other hand, it plans to study the linguistic devices and their associated discursive techniques that are responsible for the transmission of the contents and for the engagement and involvement of the lay people into the discourse of science.

For this reason, two different investigations are conducted: first of all, attention is paid to the structural move patterns that contribute to the surface-level conceptual organization of the texts, and then the focus shifts to the study of the micro-textual features, e.g., the lexico-grammatical elements employed in the building of the discourses.

In this light, in order to answer the aforementioned research questions, both qualitative and quantitative techniques of analysis are employed: as a consequence, this work can be regarded as a 'mixed-methods' study (Creswell 1994, 1998; Dörnyei 2007; Clark *et al.* 2008; Creswell *et al*. 2011). Quantitative approaches are, in the words of Creswell *et al.* (2003), aimed at testing objective theories, examining variables, analysing numbered data, and generalizing findings thanks to the employment of statistical procedures. In qualitative approaches, on the other hand, researchers analyse data inductively and interpret their meaning according to contextual elements and variables. Mixed-methods research patterns, by analysing the data at two different levels, give, instead, the "opportunity to compensate for inherent method weaknesses, capitalise on inherent method strengths, and offset inevitable method biases" (Greene 2007: xii), consequently improving the validity of research findings and making the results accessible to diverse audiences (Dörnyei 2007).

However, as stated by Clark *et al.* (2008), several different types of mixed-methods studies can be identified, depending on whether the qualitative or quantitative components are collected and analysed sequentially or concurrently. 'Sequential' mixed-methods indicate a group of procedures in which data are collected in sequence (either qualitative or quantitative first), and in which the results identified during the first part of the study act as a starting point for the second. 'Concurrent' methods, instead, represent a category in which quantitative and qualitative data are collected and analysed simultaneously and separately, and in which the results are later compared and integrated to provide a more general picture of the phenomenon at different levels.

On this basis, when looking at the overall design of this research project, it is possible to assign it to the 'concurrent' mixed-method type of study. This is because, as shown in Figure 8, there is no dominant method: qualitative data analysing the move structure of the texts and quantitative data resulting from the corpus-assisted analysis are collected and analysed in a separate and parallel manner. Their results are only later integrated, and they are used to answer the research questions at two different levels of analysis.

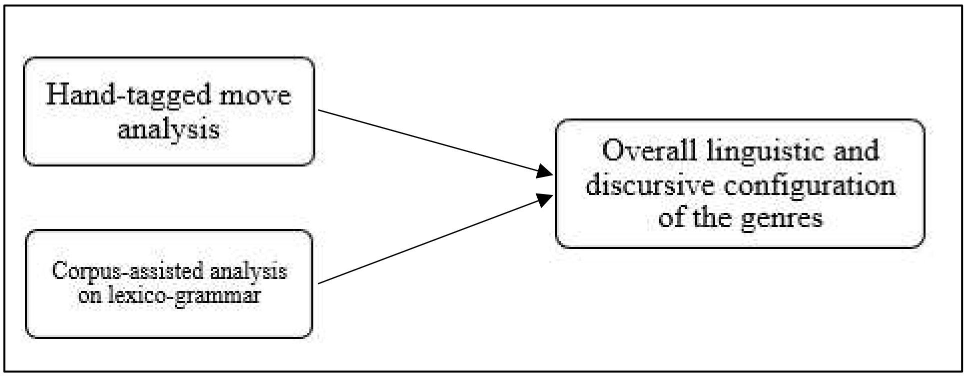

Figure 8. Visual representation of the design of the research project.

However, when looking at the two phases of the study separately, it is possible to notice that the mixed-method type changes. When examined individually, both the move analysis and the corpus-assisted analysis show that there is a primary method that guides the project and a secondary method embedded in it: in this case, the results of the first method act as a starting point for the second part of the analysis, and the outcomes of this last phase are usually employed to integrate or comment on the first. More specifically, move analysis can be classified as 'sequential exploratory', as the investigation starts with a qualitative study on the hand-tagged moves retrieved in the text, and only later moves on to the quantitative account of the frequencies and patterns to explore the discursive configuration (see Fig. 9).

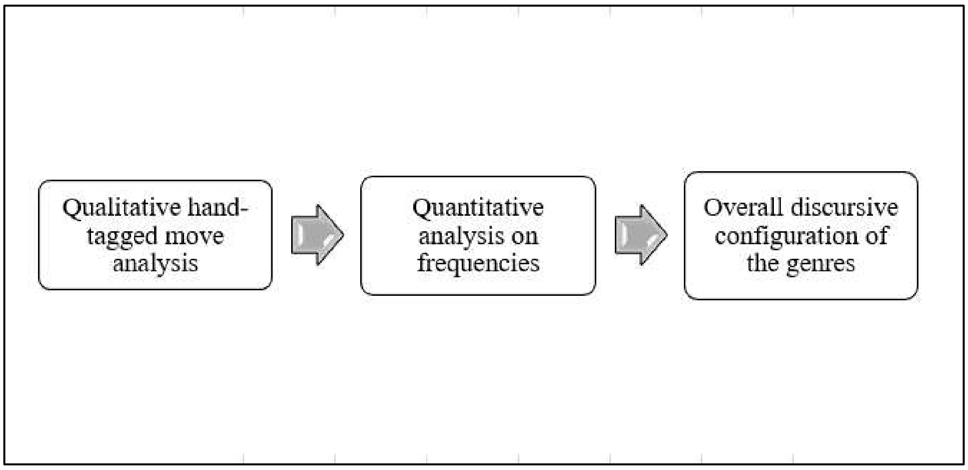

Figure 9. Visual representation of the design of the move analysis phase.

On the contrary, corpus-assisted analysis can be defined as 'sequential explanatory', since the starting point is represented by the quantitative results extracted from the computerised study, and it only later implements co-text analysis of the occurrences to look at the meanings and functions of each device (see Fig. 10).

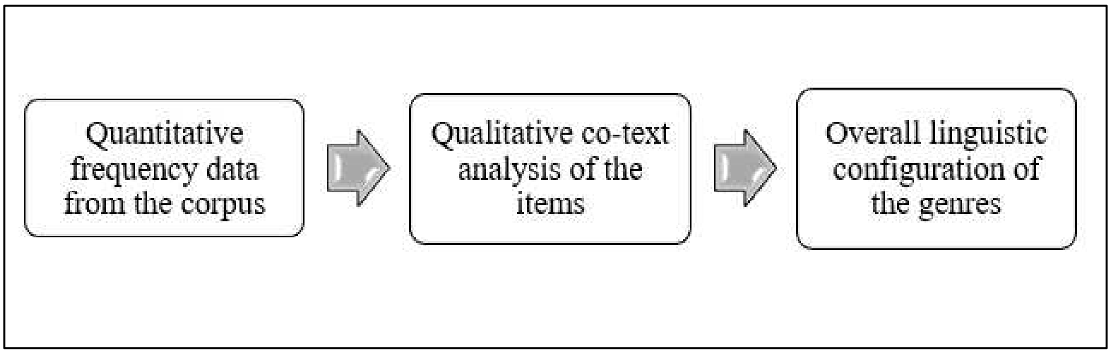

Figure 10. Visual representation of the design of the corpus-assisted analysis phase.

3.3.1 Move analysis

As previously mentioned, the first phase of the work focused on the analysis of the discursive configuration of science popularisation within the three media under investigation: blogs belonging to well-known institutions, YouTube educational videos and science comics.

This phase of the study was made possible thanks to the application of move analysis to the study of discourse. As stated in the previous chapter (see par. 2.3.2), this approach is grounded in Swales' (1981) Structural Move Analysis model, which was developed with the original aim of teaching non-native speakers of English (NNSs) to read, write and publish research articles in English: this model postulates the existence of a number of segments called 'moves' and 'steps', which allow for the construction of the discourse within a specific context (Biber *et al.* 2007). More specifically, 'moves' represent text sections that perform specific communicative functions, while 'steps' are smaller fragments that, when combined, realise the move (Connor *et al.* 2007).

More specifically, for this study, the first phases of the so-called 'top-down' approach were implemented. As described by Upton (2002), Biber *et al.* (2007) and Upton and Cohen (2009), the first step in a top-down approach is to develop the analytical framework, thus determining the set of possible move types according to an *a priori* determination of the main communicative functions. This framework is later applied to all the texts, or to a representative sample within a larger population, which are segmented into moves and steps, and subsequently classified according to their type, frequency, rhetorical purpose, and pattern.

In the present analysis, the first phase of the work consisted in a careful reading of the texts to understand the general content and the overall purpose of the genre. After that, a second reading of the text was conducted with the aim of defining text segments. At this point, previous models were consulted to get an overall idea of the moves that are typically found in the genre. Then, a pilot study on a smaller portion of texts was conducted to test and fine-tune the definitions and purposes of each move and step. Once this phase reached an end, all the texts were read again and each segment was assigned a label: moves were identified with numbers (e.g., 1, 2, 3, 4) and steps with capital letters (e.g., A, B, C, D). As a final phase, each move was classified by type, and other elements such as move frequency, order, rhetorical aim and move patterns were studied to have a more detailed idea on the role of each segment within the overall textual context. In the end, the results were discussed both in light of the previous studies on the topic and of the original research questions of this work.

As far as the YouTube educational videos are concerned, the reference model were the ones developed by Chang and Huang (2015) and Li and Li (2021) concerning TED talks: however, after careful reading of the texts, the integration of such models with the one by Nwogu (1991) on medical research papers turned out to be necessary in order to have a more detailed account of the moves. On the contrary, as far as blog posts are concerned, the models by Nwogu (1991), Kanoksilapatham (2007a) and Luzon (2013a) were taken into consideration as a starting point for this part of the study. In this case as well, modifications and adjustments to the original structures proposed by the authors turned out to be necessary. Finally, as regards science comic books, no previous model analysing move structure in this genre was present: consequently, a self-designed data-driven taxonomy based on the close reading of the corpus turned out to be inevitable. The results of this first part of the study are presented in chapter 4.

3.3.1.1 Sample size determination

For this part of the investigation, the overall size of the corpus made it necessary to extract a limited number of texts from the entire population of the files (364 documents). As a consequence, statistics was employed in order to determine the size of the sample.

As stated by Holton and Burnett (1977: 71) one of the real advantages of using statistical methods in these contexts "is their ability to use smaller groups to make inferences about larger groups, that otherwise would be prohibitively expensive to study". What is more, as claimed by Bartlett, Kotrlik and Higgins (2001), statistics also helps avoid the choice of inadequate or excessive sample sizes which, by generalizing results that otherwise could not be applied to the entire population of the elements under analysis, negatively influence the quality and accuracy of research.

Within this context, Cochran's (1977) sample size determination formula was applied to the *Blogs* and *YouTube* subcorpora. As for the *Comics* subcorpus, no sample size was extracted, since its size (15 documents) made it possible to analyse them all. Cochran's (1977) sample size formula is the following:

$$n = \frac{\frac{(t)^2 * pq}{d^2}}{1 + \left(\frac{t^2 * pq}{d^2 N}\right)}$$

In this context, *t* score represents the number of standard deviations a given proportion is away from the mean, and it corresponds here to 1.96, which is the value for selected alpha level of .05. *p* and *q* represent the standard deviation of the scale, which was estimated at 5, while *d* stands for the acceptable margin of error, namely the percentage that tells how much the results reflect the views of the overall population: here the confidence level was set at 95%, therefore the acceptable error was 5%. Finally, the value *N* represents the population size, namely the total number of elements in the group under analysis.

On this basis, 135 files were extracted from the *Blogs* subcorpus, and 103 from the *YouTube* subcorpus. In the end, once the number of items was set, the documents were extracted from the overall population randomly. The graphs displayed in Fig. 11 and 12 provide a visual representation of this phase.

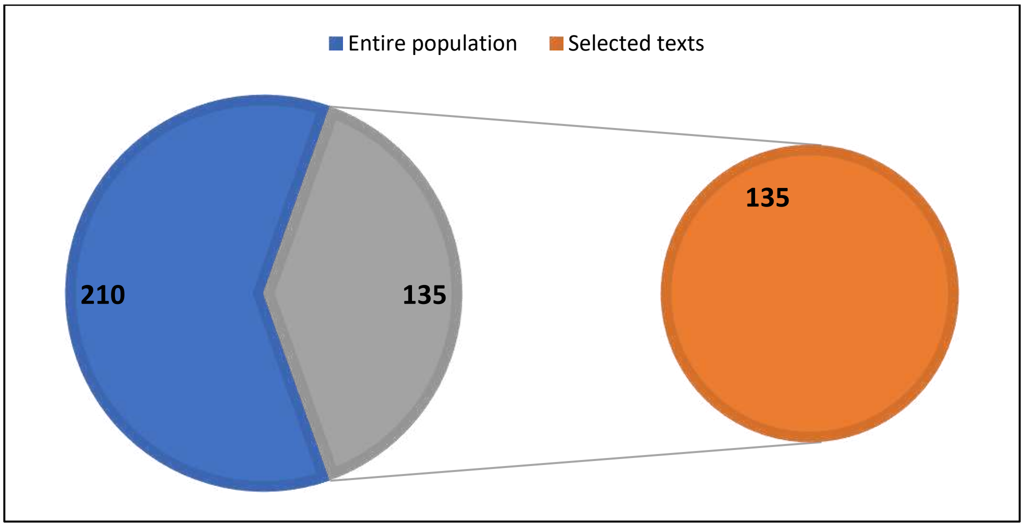

Figure 11. Visual representation of the number of blog texts selected for move analysis.

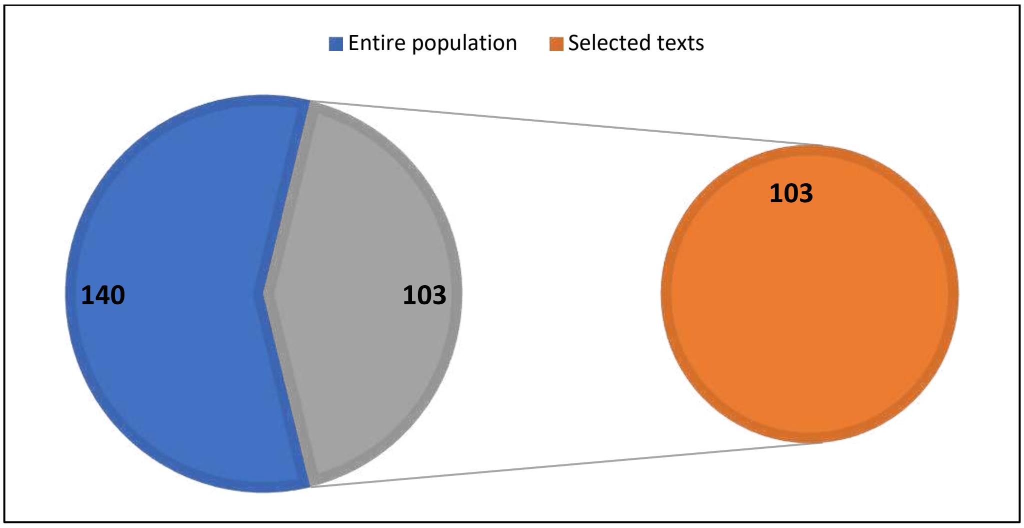

Figure 12. Visual representation of the number of YouTube texts selected for move analysis.

3.3.2 Corpus-assisted analysis

The second phase of this work, instead, entailed a thorough examination of the linguistic items that allow for the lexicalisation of the various discursive and rhetorical strategies employed to transmit the specialised contents.

This part of the research project was realised thanks to the application of the tools and methodology of corpus linguistics to the study of discourse. As evidenced in the previous chapter (see par. 2.3.1), corpus linguistics is "the study of language based on real life language use" (Mc Enery & Wilson 1996: 1), which draws on evidence from large databases of electronically stored texts to identify the patterns and structures that underlie the construction of discourse. Within this context, the combination of quantitative and qualitative methods not only makes it possible to gain information concerning the frequencies of occurrence of each linguistic item, but it also enables the uncovering of specific discursive strategies that are coded, either explicitly or implicitly, in particular settings of language use.

To be precise, the investigation conducted for the present research project can be classified as 'corpus-based' (Biber 2015: 163) since it takes previously developed language models as the starting point of the analysis on the linguistic items expressing the *docere* and *delectare* rhetorical goals (Załęska 2016). In this context, the corpus under analysis is used to study the patterns of variation and distribution of such techniques across three different popular scientific genres: blogs, YouTube videos and comic books. As stated in the introduction to this work, these two poles, which lexicalise, respectively, the techniques for content transmission and for reader engagement, were purposely chosen for this investigation as they embody the two core tenets that underlie this genre (see, *inter alia*, Myers 1990, 2003; Moirand 2003).

More specifically, in the first phase of this study, a comprehensive review of previously published models in academic literature was conducted. As far as the study on authorial presence is concerned, the works taken as reference were those by Tang and John (1999), Hyland (2001, 2008), and Fu and Hyland (2014). As for the investigation into definitions and definitional chains, the model proposed by Pilkington (2018, 2019) was taken as reference for the classification of the data. Ultimately, the studies by Webber (1994), Hyland (2002b) and Zou and Hyland (2020) were selected for the study on questions, and the 2005 and 2008 works by Hyland were consulted for the analysis on reader pronouns.

Following this initial phase, the work developed a quantitative study based on the frequencies of each device. The linguistic items under analysis were extracted through CQL queries such as `[word="you"]`, which allowed for the retrieval of all the samples in the corpus. Here, looking at the Frequency column in the search results made it possible to observe their raw frequencies, which were subsequently normalised to 10,000 words to facilitate the comprehension and comparability of the data (Evison 2010: 126).

At a later stage, the study focused on identifying, through implementing co-text analysis of the occurrences, the rhetorical and discursive functions of each device: here, AntConc's KWIC (*Key Word in Context*) tool, which displays the searched word or phrase in its linguistic context, was employed to examine the collocational networks of each target word. In this context, concordances were manually sorted to highlight the relevant grammatical patterns, and a span of N-4 and N+4 words was taken into account: the sole exception concerned the investigation into definitions and definitional chains, wherein a broader linguistic context was required to accurately identify and classify the instances. Additionally, in this phase, consulting the grammar by Halliday and Matthiessen (2014) turned out to be necessary for an accurate description and categorization of the retrieved language patterns.

In the end, the results stemming from the joint quantitative and qualitative analyses were discussed both in light of the previous studies on these topics, and of the original research questions of this project: such data are thus displayed in chapter 5.

3.3.3 Tools employed

As far as the first phase of the work is concerned, the hand-tagging of moves and steps was made possible thanks to the use of the web-based tool *CATMA* (*Computer Aided Textual Markup and Analysis*), version 6.5.2.

CATMA (https://app.catma.de/catma/) is an online open-source tool developed at the University of Hamburg and currently used by over 60 research projects worldwide, which is specifically focused on textual markup and analysis. This tool was chosen for this work because it offers a unique combination of different features, which could not be found in other text analysis tools. Above all, it allows for collaborative annotation and analysis, namely it enables both individual and group work investigations. As such, as stated by Horstman *et al.* (2019, 2020), this tool proves to be extremely useful because of its 'undogmatic' approach, which means that it does neither prescribe defined annotation schemata or rules, nor does it force the user to apply rigid taxonomies to the text: this aspect turns out to be extremely beneficial because each user can create, expand, and modify their own individual sets of tags. Ultimately, this tools also allows for the retrieval of quantitative data, such as frequency counts of the selected items, and makes it possible to download and export them as .xml files for further studies.

In this specific context, CATMA turned out to be extremely useful not only for the hand-tagging annotation of the moves and steps that were retrieved in the texts, but also for highlighting the different move patterns across the genres and the frequency of occurrence of each segment. Therefore, the selected texts were first uploaded on the tool, maintaining the .txt format and the UTF-8 codification. Some metadata were then added to specify the title of the text, the discipline and the genre they belonged to. The following picture (Figure 13) shows the file ready for the computer-assisted hand-tagging annotation.

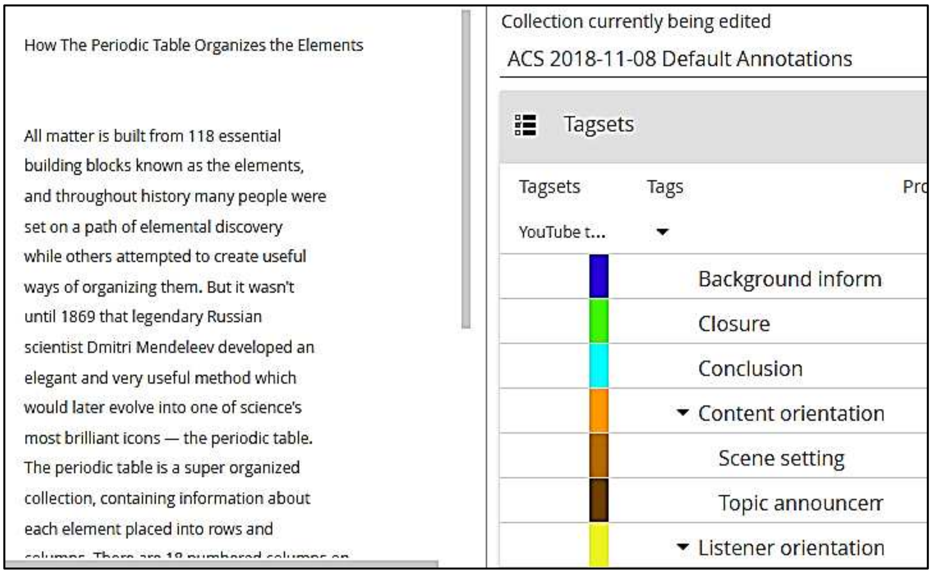

Figure 13. Example of file ready for computer-assisted hand-tagging annotation

Before moving on to the annotation phase, the list of tags (*tagset*) for moves and steps was created, and each one was assigned a different colour to be more easily recognisable. (see Fig. 14 below).

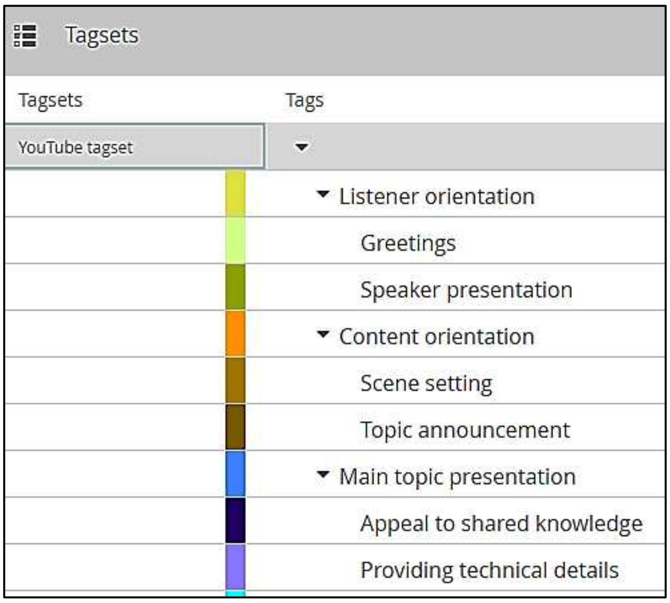

Figure 14. Example of tagset created for the analysis of YouTube data

In the end, all the texts under analysis were manually tagged (Fig. 15) and the results exported in .xml file.

Figure 15. Example of hand-tagged text taken from the YouTube subcorpus.

On the other hand, as regards the second phase of this work, the study at the *elocutio* level of textual organization was realised through the employment of the corpus tool AntConc, in its 4.2.0. version released in 2022. In the words of its developer, AntConc (https://www.laurenceanthony.net/software/antconc/) is a freeware multi-platform corpus analysis software program that allows users to analyse text data in various languages (Anthony 2004, 2005). It was first developed and launched in 2002 by Laurence Anthony, Professor of Applied Linguistics at Waseda University in Japan, and it is now used by students, teachers and researchers worldwide for a wide range of applications, including language teaching, corpus linguistics research and text mining. More specifically, this tool not only includes an easy-to-use, intuitive graphical user interface that makes the navigation across the data straightforward, but it also provides powerful text analysis features that allow researchers to explore, visualise and interpret, both quantitatively and qualitatively, large electronic text datasets.

In the context of this work, after uploading the .txt files with UTF-8 encoding into the software, various queries were generated to extract the text segments that were relevant to the aims of the project. More specifically, the Concordance tool was employed to search for specific words or phrases within the corpora and to study the context in which they appeared, making it possible to identify patterns or relationships between the different linguistic items. Then, the Collocate tool was used to investigate into the different word patterns, providing insight into the ways in which specialised and non-specialised words are used together in natural language. Additionally, AntConc's frequency analysis feature made it possible to retrieve a number of quantitative data regarding the distribution of the specific linguistic items, which, in turn, not only helped to shape the direction of the ensuing analyses and interpretations, but also allowed for a deeper understanding of the role played by each target word in the construction of the discourse.

Chapter 4

Exploring the rhetorical *dispositio*: the structural move analysis approach

The present chapter is devoted to the analysis of the data retrieved from the *Science Popularisation Corpus*. The aim is to investigate the discursive and rhetorical configuration of the three media under analysis from a macro-textual point of view, namely by analysing the *dispositio* of the contents through the employment of the *structural move analysis* approach to the study of the texts, as specified in paragraph 4.1. With this in mind, sections 4.2, 4.3 and 4.4 are dedicated, respectively, to the presentation of the results that stem from blogs, YouTube videos and comic book texts. These sections are then further divided into smaller segments, which are focused on aspects such as the presentation of the Structural Move model developed for each genre, the description of the rhetorical aim, frequency, position, and the structural pattern of the moves. In the end, two paragraphs are devoted, respectively, to the comparison of the research outcomes with the already existing models and to the overall comment on the discursive and rhetorical strategies employed to convey the contents.

4.1 Popular science and the rhetorical *dispositio* of the contents

As stated in the previous chapters, the term 'popular science' refers to a genre that is aimed at disseminating specialised scientific concepts to the public at large. However, given the different needs, interests, knowledge and expertise of the public, the main problem of science popularisation is not only the accurate transfer of information, but also the adaptation of its arguments to audiences other than the academic one. For this reason, various channels of communication may be exploited: as a result, linguistic and discursive material can be added or removed from one version to another. Within this context, popular scientific discourse therefore turns out to be a "social process consisting of a large class of discursive-semiotic practices" (Calsamiglia & Van Dijk 2004: 371), consequently making it necessary to "explore the different settings in which knowledge circulates, setting out from the supposition that science forms part of the practices of human communities" (Calsamiglia & Ferrero 2003: 147).

In this light, to thoroughly analyse how discourse is framed in the three media under analysis, the present research project starts from a macro-textual perspective on the texts and explores the rhetorical *dispositio* of the contents (Załęska 2016: 36). In Aristotelian terms, the *dispositio* is the second stage of discourse organisation, and refers to the effective and orderly arrangement of the content within a speech or a written text (Lanham 1991: 171). To this aim, the *Structural Move Analysis* approach (Swales 1981, 1990) is applied to the study of the collected texts, and the results of this part of the work are shown in the following sections 4.2, 4.3 and 4.4.

4.2 Structural move analysis in blog posts

In this phase of the analysis, the initial stage involved identifying the different move types present in each blog post. As a preliminary step to this task, in order to have an overall idea of the typical discursive configuration of the genre, three studies devoted to the analysis of the move structure in specialised texts were consulted: the work by Luzón (2013a) on the rhetorical categories in research-commenting science blog posts, the framework elaborated in 1991 by Nwogu on popular science medical texts, and the model by Kanoksilapatham (2007a) regarding biochemistry research articles.

4.2.1 Moves and steps prototypes

The detailed textual analysis of the extracted blog posts, together with the findings retrieved from the aforementioned scholarly studies, made it possible to identify a number of recurrent elements that compose this specific type of texts.

First of all, as far as the surface-level textual pattern is concerned, all the samples included in the corpus were found to consist of three macro-segments: introduction (whose aim is to inform the reader about the purpose and direction of the study), body (in which the writers present the materials, methods, evidence and results of their research) and closure, which is the segment that summarises the main points, highlights the implications of the results and highlights the future research directions.

However, a thorough reading of the texts made it possible to identify a number of divergencies in terms of the internal discursive organisation of posts. The majority of the posts, accounting for approximately 82% of the overall population, were found to be oriented towards presenting new research on specific topics and therefore contained accurate descriptions of the problem being analysed and the experimental procedure employed: for the present work, these texts were labelled as ‘research’ blog posts. On the other hand, the remaining 18% had a different focus and function. Rather than emphasizing current research and experiments, these posts were primarily intended to provide didactic explanations of fundamental scientific concepts, such as the functions of the cells or the mechanisms behind chemical reactions: within the scope of this study, such texts were labelled as ‘didactic’.

As far as the discursive configuration of the so-called ‘research’ texts is concerned, their three main constitutive parts – introduction, body and closure – are composed of a total of 8 moves: three in the initial part, two in the central, and three in the closure. Moreover, most of these move types comprise multiple sub-segments, referred to as ‘steps’: the present analysis retrieved 20 of them. Five steps belong to Move 1, three to Move 3, four to Move 4, two to Move 5, three to Move 7, and three to Move 8. The framework containing the list of moves and steps can be found in the following table (12), while the detailed analysis of each segment is provided in section 4.2.4.

INTRODUCTION	
1. Move 1	**Presentation of the necessary background information**
• Step 1A	Reference to shared knowledge
• Step 1B	Main problem statement
• Step 1C	Short explanation of the aforementioned problem
• Step 1D	Reference to the historical background
• Step 1E	Reference to an anecdote
2. Move 2	**Reference to previous studies or to the state of the art**
3. Move 3	**Announcement of the research**
• Step 3A	Research statement
• Step 3B	Research relevance explanation
• Step 3C	Main findings list
BODY	
4. Move 4	**Presentation of the research**
• Step 4A	Reference to the authors of the research
• Step 4B	Materials and methods description
• Step 4C	Experimental procedure description

• Step 4D	Reference to academic products of research
5. Move 5 • Step 5A • Step 5B	**Description of the outcomes of the research** Research outcomes list Research outcomes detailed explanation
CLOSURE	
6. Move 6	**Comment on the implications of the results**
7. Move 7 • Step 7A • Step 7B • Step 7C	**Explication of the strengths, unsolved problems and future directions** Description of the unsolved problems Description of the strengths of the research project Description of possible future directions
8. Move 8 • Step 8A • Step 8B • Step 8C	**Conclusion of the post** Suggestions for further resources on the topic References to academic products of the research Acknowledgements

Table 12. Move and step structure prototype for science blogs 'research' texts.

On the contrary, as concerns, the 'didactic' texts, their overall discursive configuration turned out to be slightly different. Their three segments are composed of a total of 6 moves: two of them are located at the beginning, one in the central part, and three in the conclusion. Then, as far as the steps are concerned, the present analysis retrieved 13 of them. Three belong to Move 1, two to Move 2, three to Move 3, three to Move 5 and two to Move 6. Table 13 below summarises the move structure prototype that was elaborated for the so-called 'didactic' blog posts, and section 4.2.4 below gives a detailed description of each move and step type.

INTRODUCTION	
1. Move 1 • Step 1A • Step 1B • Step 1C	**Presentation of the necessary background information** Reference to shared knowledge Reference to the historical background Reference to an anecdote
2. Move 2 • Step 2A • Step 2B	**Topic announcement** Topic announcement Topic short explanation

BODY	
3. Move 3 • Step 3A • Step 3B • Step 3C	**Topic development** Definition of the topic Description and/or classification of the topic Description of the processes/explanation of the issues
CLOSURE	
4. Move 4	**Explanation of the relevance of the topic**
5. Move 5 • Step 5A • Step 5B • Step 5C	**Explication of the unsolved problems and future scenarios** Description of the unresolved problems Description of the possible future scenarios Emphasis on the need for further research
6. Move 6 • Step 6A • Step 6B	**Conclusion of the post** Suggestions for extra resources about the topic Call for action

Table 13. Move and step structure prototype for science blogs 'didactic' texts.

4.2.2 Moves and steps frequency and distribution

The second element to be analysed was the frequency of occurrence of each move and step. Each segment was classified into *obligatory* and *optional* according to the extent to which they had been used across the texts. Swales (1990) stated that moves and steps occurring in more than 50% of the texts had to be considered as 'obligatory', while those occurring in less than half of the articles had to be classified as 'optional'. Here, however, the cut-off point was set at 60%, following the models proposed by Kanoksilapatham (2005, 2007a): as such, moves and steps appearing in more than 60% of the blog posts were labelled as 'obligatory', while those occurring in less than 60% of the texts were tagged as 'optional'.

In this part of the analysis, 'research' and 'didactic' blog posts were kept separate, in order to have a more detailed view on the behaviour of moves and steps in these two different sub-genres. Tables 14 and 15 below report their frequency counts within the so-called 'research' texts. The tables show both the raw frequencies, namely the number of items retrieved in the texts, and the percentage of occurrences, which, for the moves, was calculated with the following formula: (n. of occurrences / n. of texts) * 100. As for the steps, the percentage of occurrence was retrieved by applying the following method: (n. of occurrences / n. of moves) * 100.

Move type	Number of observations	Percentage of frequency (out of 110)
Move 1	66	60%
Move 2	33	30%
Move 3	110	100%
Move 4	110	100%
Move 5	110	100%
Move 6	110	100%
Move 7	110	100%
Move 8	110	100%

Table 14. Overall distribution of the 8 move types in the 'research' blog posts.

As the table shows, 7 moves out of 8 turn out to be 'obligatory': this implies that a 'research' blog post is typically composed of 7 moves. The most frequent are Move 3 (Announcement of research), Move 4 (Presentation of the research), Move 5 (Description of the outcomes of the research), Move 6 (Comment on the implications of the results), Move 7 (Explication of the strengths, unsolved problems and future directions) and Move 8 (Conclusion of the post), which were retrieved in all the texts under analysis. Move 1 (Presentation of the necessary background information) can also be classified as obligatory, even though the frequency of occurrence was lower than the previous ones (60%). However, Move 2 (Reference to previous studies or to the state of the art), must be labelled as 'optional', since the frequency was attested at 30%. Figure 16 gives a visual representation of the distribution of the moves in the 'research' blog posts.

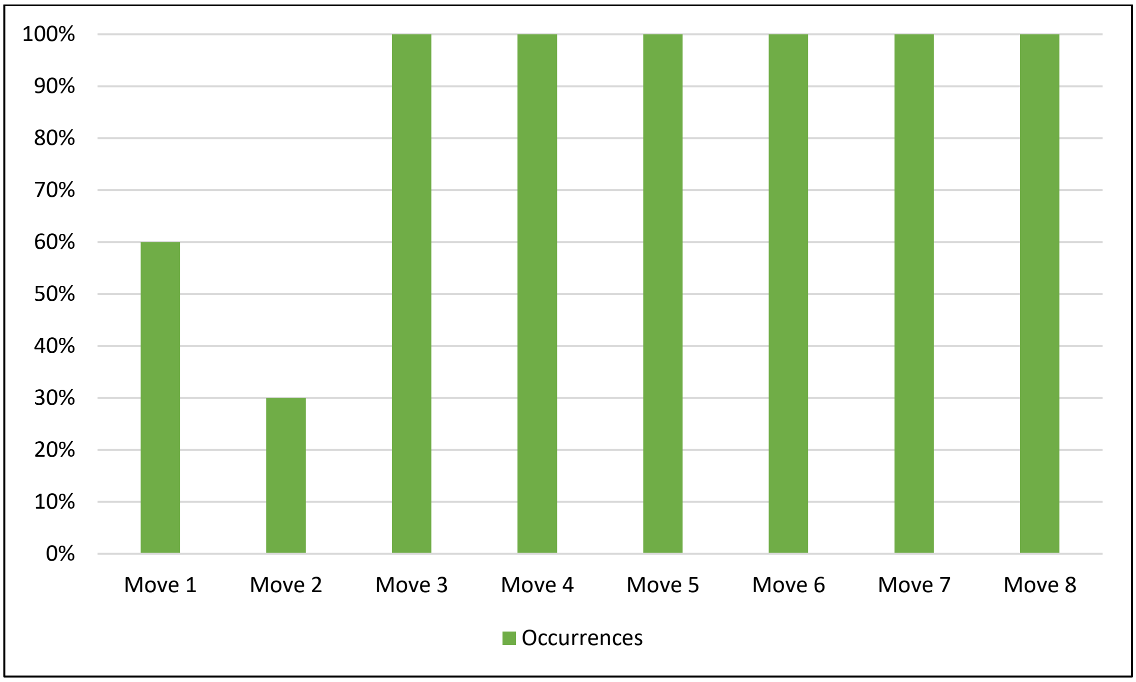

Figure 16. Visual representation of the move distribution in the 'research' blog posts.

Step type	Number of observations	Percentage of frequency
Step 1A	66/66	100%
Step 1B	66/66	100%
Step 1C	66/66	100%
Step 1D	15/66	23%
Step 1E	5/66	3%
Step 3A	110/110	100%
Step 3B	110/110	100%
Step 3C	110/110	100%
Step 4A	110/110	100%
Step 4B	60/110	55%
Step 4C	110/110	100%
Step 4D	12/110	11%
Step 5A	110/110	100%
Step 5B	110/110	100%
Step 7A	80/110	72%
Step 7B	31/110	28%
Step 7C	110/110	100%
Step 8A	75/110	68%
Step 8B	35/110	32%
Step 8C	77/110	70%

Table 15. Overall distribution of the 21 steps in the 'research' blog posts.

As readers can observe in the table above, 14 steps out of 20 turned out to be ‘obligatory’, while 7 of them ‘optional’. The most frequent steps are 1A (Reference to shared knowledge), 1B (Main problem statement), 1C (Short explanation of the aforementioned problem), 3A (Research statement), 3B (Research relevance explanation), 3C (Main findings list), 4C (Experimental procedure description), 5A (Research outcomes list), 5B (Research outcomes detailed explanation), 4A (Reference to the authors of the research) and 7C (Description of possible future directions), occurring with a frequency attested at 100%. Then, 8C (Acknowledgements), 7A (Description of the unsolved problems) and 8A (Suggestions for further resources on the topic) were the second most frequent steps, occurring with a frequency of around 70%. Among the ‘optional’ ones, we find, instead, Step 7B (Description of the strengths of the research project), 28%, 8B (References to academic products of the research), 32%, 4B (Materials and methods description), 55%, 1D (Reference to the historical background), 23%, 4D (Reference to academic products of research), 11%, and 1E (Reference to an anecdote), 3%. Figure 17 provides a visual representation of the distribution of the steps in this type of blog posts.

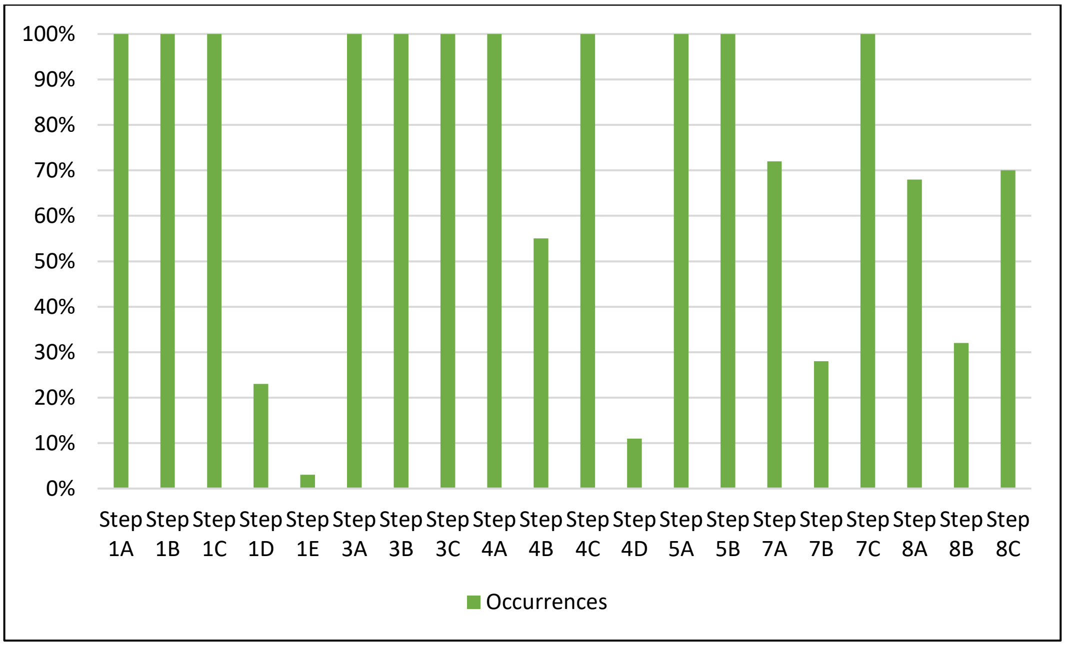

Figure 17. Visual representation of the steps distribution in the ‘research’ blog posts.

It thus emerges that Move 1 (Presentation of the necessary background information) and Move 3 (Announcement of the research) are mostly composed of 3 steps, Move 4 (Presentation of the research), Move 5 (Description of the outcomes of the research) and

Move 7 (Explication of the strengths, unsolved problems and future directions) of 2 steps, while Move 8 (Conclusion of the post) of only 1 step. Table 16 below, instead, reports the frequency counts for moves within the so-called 'didactic' texts.

Move type	Number of observations	Percentage of frequency (out of 25)
Move 1	15	60%
Move 2	25	100%
Move 3	25	100%
Move 4	25	100%
Move 5	25	100%
Move 6	25	100%

Table 16. Overall distribution of the 6 move types in the 'didactic' blog posts.

As can be observed from the table, 6 moves out of 6 turn out to be 'obligatory', which shows that a 'didactic' blog post is typically composed of 6 moves. The most frequent ones are Move 2 (Topic announcement), Move 3 (Detailed explanation of the issues), Move 4 (Explanation of the relevance of the topic), Move 5 (Explication of the unsolved problems and future scenarios) and Move 6 (Conclusion of the post), since they were retrieved in all the texts under analysis. Move 1 (Presentation of the necessary background information), can as well be labelled as 'obligatory', since the percentage of occurrence is attested at 60%, even though it was not as frequent as the previous ones. Figure 18 shows the visual representation of the move distribution within the 'didactic' blog posts.

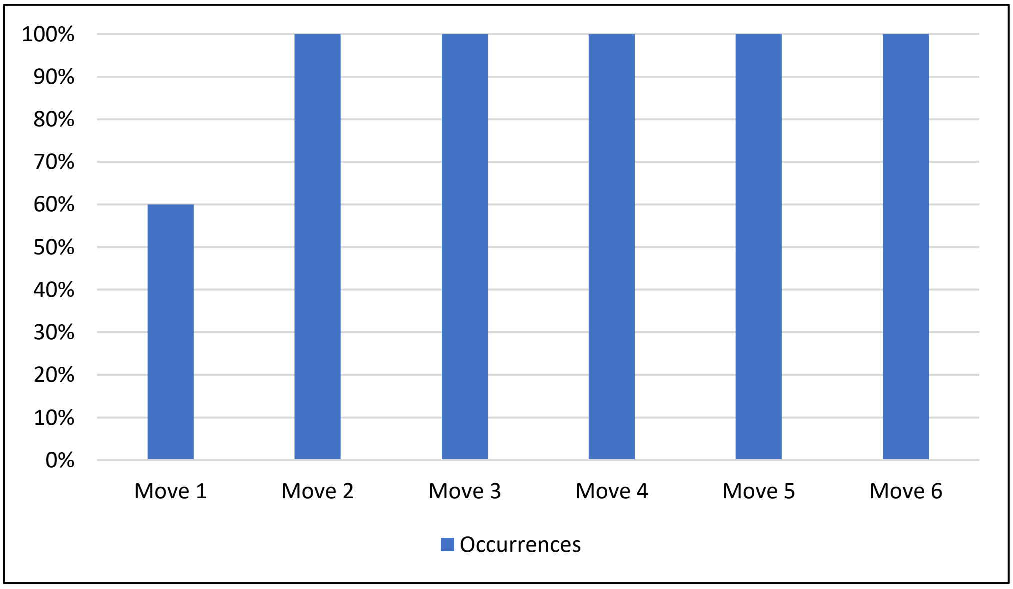

Figure 18. Visual representation of the distribution of the moves within the 'didactic' blog posts.

Table 17 displays the frequency counts for steps within the ‘didactic’ texts.

Step type	Number of observations	Percentage of frequency
Step 1A	15/15	100%
Step 1B	5/15	33%
Step 1C	8/15	53%
Step 2A	25/25	100%
Step 2B	25/25	100%
Step 3A	25/25	100%
Step 3B	25/25	100%
Step 3C	25/25	100%
Step 5A	25/25	100%
Step 5B	25/25	100%
Step 5C	25/25	100%
Step 6A	20/25	80%
Step 6B	15/25	60%

Table 17. Overall distribution of the 12 steps in the ‘didactic’ blog posts.

As Table 17 above shows, 11 out of 13 steps can be labelled as ‘obligatory’, while 2 of them are ‘optional’. The most frequent ones are Step 1A (Reference to shared knowledge), 2A (Topic announcement), 2B (Topic short explanation), 3A (Definition of the topic), 3B (Description and classification of the topic), 3C (Description of the processes/explanation of the issues), 5A (Description of the unresolved problems), 5B (Description of the possible future scenarios) and 5C (Emphasis on the need for further research). Another ‘obligatory’ step is 6A (Suggestions for extra resources on the topic), found in 80% of the moves, and 6B (Call for action) with a frequency attested at 60%. Among the ‘optional’ ones, we find, instead, Step 1C (Reference to an anecdote), 53% and 1B (Reference to the historical background), 33%. Figure 19 shows the visual representation of the distribution of the steps within this sub-genre of blog posts.

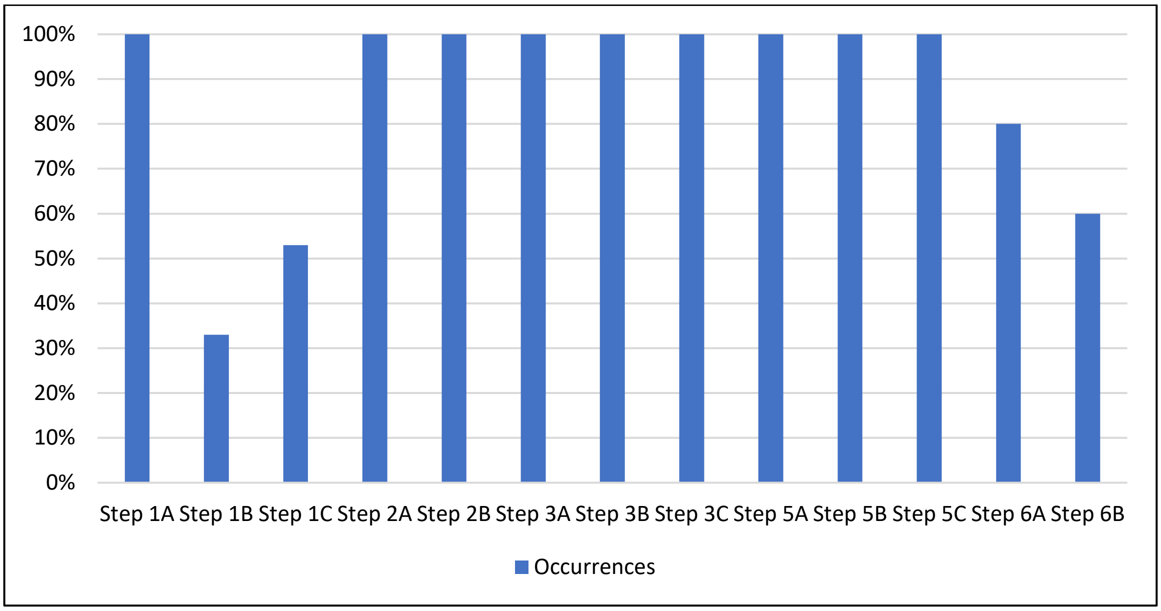

Figure 19. Visual representation of the step distribution within the 'didactic' blog posts.

As a consequence, it appears that Move 1 (Presentation of the necessary background information) is generally only composed of 1 step. Move 2 (Topic announcement) and Move 6 (Conclusion of the post) are normally made up of 2 steps, while Move 3 (Detailed explanation of the issues) and Move 5 (Explication of the unsolved problems and future scenarios) generally contain 3 steps.

4.2.3 Moves and steps position and patterns

During the following phase, the position of each move and step was recorded, together with the most common patterns found in each section. Evidence from the texts under analysis show that there exists a hierarchical order for the organisation of the moves in blog posts. Thus, following the division proposed by Nwogu (1991), moves and steps were grouped into *initial*, *medial* and *final*.

As far as the so-called 'research' texts are concerned, the 'initial' moves are Move 1 (Presentation of the necessary background information) in the introduction, Move 4 (Presentation of the research) in the body of the text, and Move 6 (Comment on the implications of the results) in the closure. The 'medial' moves are Move 2 (Referring to previous studies or to the state of the art) in the introduction, and Move 7 (Explication of the strengths, unsolved problems and future directions) in the final part. Lastly, the 'final' moves are Move 3 (Announcement of the research), Move 5 (Description of the outcomes of the research) and Move 8 (Conclusion of the post), which are located, respectively, in the introduction, body and closure sections of the posts.

More specifically, since the majority of the aforementioned moves is composed of multiple steps, this categorisation could also be applied at this sub-level of analysis. For example, steps 1A (Reference to shared knowledge), 1B (Main problem statement), 3A (Research statement), 4A (Reference to the authors of the research), 5A (Research outcomes list), 7A (Description of the unsolved problems) and 8A (Suggestions for further resources on the topic) are found to almost always occur as initial segments. On the contrary, steps 1D (Reference to the historical background), 1E (Reference to an anecdote), 3C (Main findings list), 4D (Reference to academic products of research), 5B (Research outcomes detailed explanation), 7C (Description of possible future directions) and 8C (Acknowledgements) almost always function as final segments of each move. In between these two extremes are located the so-called 'medial' steps, which, in this context, are represented by steps 1C (Short explanation of the aforementioned problem), 3B (Research relevance explanation), 4B (Materials and methods description), 4C (Experimental procedure description), 7B (Description of the strengths of the research project) and 8B (References to academic products of the research).

As far as 'didactic' texts are concerned, Move 1 (Presentation of the necessary background information) in the introduction, Move 3 (Detailed explanation of the issues) in the body and Move 4 (Explanation of the relevance of the topic) in the closure, are classified as 'initial' moves. Move 5 (Explication of the unsolved problems and future scenarios) is identified as the 'medial' move, while Move 2 (Topic announcement) and Move 6 (Conclusion of the post) can be labelled as 'final' moves. As for the steps, then, 5 of them behave as initial segments, namely 1A (Reference to shared knowledge), 2A (Topic announcement), 3A (Definition of the topic), 5A (Description of the unresolved problems) and 6A (Suggestions for extra resources on the topic). Four steps are usually located in the centre of the move: Step 1B (Reference to the historical background), 3B (Description and/or classification of the topic), and 5B (Description of possible future scenarios). Lastly, Step 1C (Reference to an anecdote), 2B (Topic short explanation), 3C (Description of the processes/explanation of the issues), 5C (Emphasis on the need for further research) and 6B (Call for action) can instead be labelled as 'final'.

What is more, a thorough analysis of the order of the moves and steps within ‘research’ blog posts first, and on ‘didactic’ texts later, made it possible to retrieve a number of recurrent patterns. Overall, in ‘research’ posts the order of the moves turned out to be consistent. First of all, in the introduction, one of the most relevant patterns was M1>M2>M3, as in example 1, in which the text opens by providing background information, briefly refers to the state of the art for that particular issue and then immediately announces the research and its main findings.

(1) **M1:** *We now all know that animal and plant cells have specialised subdivisions called organelles. These organelles are surrounded by a semi-permeable barrier, called a membrane, that both organises the organelles and insulates them from the rest of the cell’s mix of proteins, salt, and water. This set-up helps to make cells efficient and productive, aiding in energy production and other specialised functions. But, because of their semi-permeable membranes, organelles can’t regroup and reform in response to stress or other outside changes.* **M2:** *Until recently, who those rapid responders were and how they worked has been a mystery.* **M3:** *Recent research has led biologists to learn that the inside of a cell or an organelle is not just a lot of different molecules dissolved in water. Instead, we now know that cells contain many pockets of liquid droplets (one type of liquid surrounded by a liquid of different density) with specialised composition and function that are not surrounded by membranes.* (BIOB_2018-01-03)

However, this was not the only pattern that could be retrieved in this part of the text. As a matter of fact, in 67% of the cases, Move 2 is omitted, and the articles goes directly into the announcement of the research from the description of the background knowledge (M1>M3), as in example 2. Similarly, in 40% of the instances even Move 1 is not included, and the post opens *in medias res* by directly talking about the research (see example 3).

(2) **M1:** *If you’ve ever felt a slimy coating on your teeth, scrubbed grime from around a sink drain or noticed something growing between the tiles of a shower, you’ve encountered a biofilm. Made up of communities of bacteria and other microorganisms, biofilms thrive where they can remain moist and relatively undisturbed. As a biofilm matures, bacteria within it begin using a chemical communication system known as quorum sensing. This system allows bacterial cells to “sense” their growing population, transmit information throughout the community, and produce virulence factors that transform the relatively harmless individual cells into a coordinated, disease-causing collective.* **M3:** *To study how bacteria form biofilms and become virulent using quorum sensing, an interdisciplinary team of researchers at Princeton University developed experimental devices that mimic realistic bacterial settings.* (BIOB_2016-05-13)

(3) **M3:** *Scientists have identified a new family of proteins that, like the targets of penicillin, help bacteria build their cell walls. The finding might reveal a new strategy for treating a range of bacterial diseases*. (BIOB_2016-10-12)

Secondly, as far as the body is concerned, all the texts were found to adopt the same pattern, namely M4>M5, as exemplified in (4): this means that, in this section, the detailed explanation of the research always precedes the description of the outcomes.

> (4) **M4:** *Sabine Petry and her colleagues at Princeton University developed a new imaging method for watching microtubules as they develop and found an important clue to the mystery. They adapted a technique called total internal reflection fluorescence (TIRF) microscopy, which lit up only a tiny sliver of a sample from frog egg (Xenopus) tissue. This allowed the scientists to focus clearly on a few of the thousands of microtubules in a normal cell. They could then see what happened when they added certain proteins to the sample.* **M5:** *It was only after they added XMAP215 as well as gamma-tubulin to the sample that they saw new microtubules form and grow. It turned out that XMAP215 plays two roles in microtubule development—helping form new tubules and helping them grow longer.* (BIOB_2018-07-03)

Lastly, it was observed that the order of the moves in the final part of the posts followed a standardized pattern as well. Specifically, Move 6 always preceded Move 7, which, in turn, came before Move 8. This consistent ordering suggests that when concluding a blog post, authors generally begin by commenting on the relevance of the results, then proceed to the presentation of the strengths, unsolved problems and future directions of the research. In the end, the conclude by suggesting additional materials on the topic or by thanking the individuals who contributed to the work (See example 5).

> (5) **M6:** *These findings suggest a new way of targeting biofilms, which are notoriously difficult to eradicate: instead of aiming to destroy the biofilm structures themselves, just manipulate the communication lines.* **M7:** *If the strategy works in living organisms—which will take time and research to determine—interfering with quorum sensing might be an effective way to combat MRSA and many other bacterial infections.* **M8:** *This work was funded in part by NIH under grant DMR140268* (BIOB_2016-05-13)

Move order in 'didactic' blog posts proved to be similar to the one identified for 'research' texts. Openings generally begin with a reference to the necessary background information, and immediately proceed to announce the topic under analysis (M1>M2). The central section, then, is composed of only one move (Move 3), in which the issues under discussion are announced and then explained in detail. Ultimately, the final part is built by assembling three moves – Move 4, 5 and 6 – which always occur in the same order: M4>M5>M6. This specific pattern indicates that before concluding the text (M6), authors generally dedicate a section to explaining the relevance of the issues under analysis (M4) and to describing a number of problems that remain to be solved (M5).

A greater variability in patterns can be found, however, among the steps. In ‘research’ posts, Move 1 was found to have 5 steps. In 61 instances out of 66, Step 1A (Reference to shared knowledge) opened the article, generally followed by 1B (Main problem statement), 1C (Short explanation of the aforementioned problem), and, when present, 1D (Reference to the historical background), as in (6). However, in 5 cases, Step 1E (Reference to an anecdote) was also included in the move and acted as opening step, as in example 7.

> (6) **1A:** *When we normally think of blood, chances are we think of the color red.* **1B:** *But blood actually comes in a variety of colors, including red, blue, green, and purple.* **1C:** *This rainbow of colors can be traced to the protein molecules that carry oxygen in the blood. Different proteins produce different colors.* (BIOB_2019-02-14)

> (7) **1E:** *One day last fall, molecular biologist Laura Landweber surveyed the Princeton University lab where she'd worked for 22 years. She and her team members had spent many hours that day laboriously affixing yellow Post-it notes to the laboratory equipment—microscopes, centrifuges, computers—they would bring with them to Columbia University, where Landweber had just been appointed full professor.* **1B:** *Landweber is particularly fond of Oxytricha trifallax, a ciliate with relatives that live in soil, ponds and oceans all over the world.* **1C:** *The kidney-shaped cell is covered with hair-like projections called cilia that help it move around and devour bacteria and algae. Oxytricha is not only bizarre in appearance, it's also genetically creative.* (BIOB_2018-03-28)

Move 3, which turned out to be composed of 3 moves, showed a higher degree of stability: in almost all the instances, the order of the steps was 3A>3B>3C (announcement of research - the stress on its relevance - list of findings), as in (8). However, another recurrent pattern that emerged from the analysis was 3A>1B/1C>3B>3C, as shown in example (9), where a step from Move 1 was included in this context, with the aim of making the explanation of the research clearer and more accessible to the public.

> (8) **3A:** *Researchers use mouse cells like these to tease out the molecular methods that cancer uses to invade new tissues in the body.* **3B:** *It turns out that actin plays an essential role.* (BIOB_2017-03-20)

> (9) **3A:** *A new study has added another twist to the CRISPR story.* **1B:** *CRISPR is what we will discuss in the next lines.* **1C:** *CRISPR is an immune system in bacteria that recognises and destroys viral DNA and other invading DNA elements, such as transposons.* **3B:** *Scientists have now adapted CRISPR into an indispensable gene-editing tool now widely used in both basic and applied research.* (BIOB_2016-06-08)

The organisation of steps in Move 4, 5 and 7 was, altogether, the most standardised. In the former, all the instances followed the pattern 4A>4B>4C>4D (reference to the authors - materials and methods - description of the experimental procedure - reference to the academic products of research). However, steps 4B and 4D only occurred, respectively, in 31% and 11% of the posts: they were, therefore, omitted in most cases and the authors thus jumped directly from the mention of the authors of the research to the description of the experiment itself. See the following example:

> (10) **4A:** *Biomedical and technical experts at the Pittsburgh Center for HIV teamed up to generate these HIV models at near-atomic resolution.* **4C:** *First, structural biologists used a technique called cryo-electron microscopy (cryo-EM) to get information on the shape of an HIV capsid as well as the capsid-forming proteins' connections to each other and to cyclophilin A. Then experts fed the cryo-EM data into their visualisation and simulation programs to computationally model the physical interactions among every single atom of the capsid and the cyclophilin A protein.* **4D:** *The work was published in Nature Communications and was funded in part by NIH under grants R01GM085043, P50GM082251, P41GM104601, R01GM067887 and P30GM110758.* (BIOB_2016-05-25)

The same happens in Move 5, where the retrieved pattern was 5A>5B in 100% of the texts under analysis, as can be seen in (11). This pattern demonstrates that authors consistently choose to present the research outcomes by mentioning the result first and providing a description afterwards.

> (11) **5A:** *In another 2017 study, Ebright and his team looked at the antibiotic rifampin.* **5B:** *Rifampin has always been essential for the treatment of tuberculosis. The scientists traced this resistance to RNAP. They found that tuberculosis RNAP has learned how to make changes to prevent rifampin from binding to it, rendering the drug less effective.* **5A:** *However, at the same time, the researchers found potentially new types of drugs, called AAPs (Nα-aroylN-aryl-phenylalaninamides), that kill tuberculosis bacteria by binding to a different, completely separate, binding site on RNAP.* **5B:** *Because AAPs target this new site, they are proving effective, even against rifampin-resistant tuberculosis bacteria.* (BIOB_2019-08-07)

Move 7 was observed to consistently follow Move 6. The extracted pattern can be represented as 7B>7A>7C, where 7B involves stating the strengths of the research, 7A consists in addressing the unsolved problems, and 7C indicates the suggestion of possible future directions. This pattern can be seen in example 12. However, the analysis revealed that only Step 7C was present in 100% of the cases, showing that it was common to find this step immediately following Move 6.

> (12) **7B:** *Oxytricha is providing very valuable insights to the burgeoning field of genome editing. It can teach us a lot about the possibilities of maintaining genome integrity in the face of destructive forces that can corrupt it, including cancer.* **7A:** *However, still much needs to be discovered and techniques improved.* **7C:** *Landweber hopes that her lab's discoveries in Oxytricha will help improve our understanding of events that can lead to cancer. She prepares to apply her knowledge of ciliate biology to combating cancer, and she plans to continue*

seeking to understand exactly how Oxytricha can manage the chromosomal chaos that would be catastrophic to human cells. (BIOB_2018-03-28)

Finally, in Move 8, no step was identified to be present in 100% of the texts. Step 8C (Acknowledgements) was frequently the only step retrieved in Move 8, and consistently served as the concluding element of the article. When other steps were present, Step 8A (Suggestions for further resources on the topic) typically opened the move, immediately followed by 8B (References to academic products of research).

(13) **Move 7:** *Even with promising stories such as these, the battle against disease-causing bacteria is far from over, and RNAP research will be a big part of this next chapter. "Bacteria will always acquire resistance," Ebright says. "But for large, complex protein machines such as RNA polymerase that carry out complex tasks, there are many ways to interfere with their function and, thus, many opportunities to find new drugs."* **8C:** *Ebright's research is supported in part by NIGMS under grant 1F32GM119195.* (BIOB_2019-08-07)

Similarly, even within the moves belonging to the so-called 'didactic' blog posts, the steps exhibited a variety of patterns. In Move 1, for instance, only Step 1A (Reference to shared knowledge) was present in 100% of the posts, while Steps 1B and 1C were frequently omitted. Step 1A typically served as the opening step, although in some cases, 1B and 1C were also used as initial segments. In Move 2, Step 2A (Topic announcement) always preceded Step 2B (Topic short explanation). However, an alternative pattern was identified as well: 2A>2B>1C/1D. This indicates that Step 2A could also be used as the opening segment of the post, followed by a brief explanation of the concepts, an anecdote, or the historical background of the topic under analysis. Move 3 consistently followed the pattern 3A>3B>3C, which means that the concepts were first announced, then explained in detail and finally exemplified. Move 5 often followed the pattern 5A (Description of the unresolved problems)>5B (Description of the possible future scenarios)>5C (Emphasis on the need for further research). However, Step 5A was occasionally omitted, resulting in Step 5C serving as the opening segment: in such cases, the pattern was 5C>5B. Finally, in the last move, M6, no step occurred in 100% of the texts. Typically, the general pattern involved Step 6A (Suggestions for extra resources on the topic) as the opening step, anticipating Step 6B (Call for action).

One last element that emerged from the analysis of blog posts was the so-called 'recycling' of patterns (Swales 1990: 140; 2004: 230), namely the use of a specific move or step more than once in the same text. In the context of the present analysis, recycling was found to occur especially among the steps. For example, in ‘research’ blog posts, it was observed that steps 1A and 1D were often repeated and incorporated within Move 3: this implies that these steps were frequently revisited and expanded upon during the explanation of the research. Similarly, in Move 5, the pattern of 5A > 5B was consistently repeated whenever a new research outcome was introduced, which marks a structured approach to presenting the research findings.

In ‘didactic’ blog posts, on the contrary, the step devoted to the statement of the topic was found to be repeated several times across moves 2 and 3. At the same time, the pattern 3A>3B>3C, like 5A>5B in ‘research’ posts, was proposed again each time a new issue was introduced.

4.2.4 Moves and steps description

On the basis of the results displayed in the previous sections, it was possible to obtain a detailed description of the role and employment of moves and steps within both ‘research’ and ‘didactic’ blog posts.

Presentation of the necessary background information, labelled as Move 1, was retrieved in both ‘research’ and ‘didactic’ blog posts within the Introduction. It is most often, though not imperatively, an initiation move with a length that varies between 1 to 5 sentences. Here, it occurs with a frequency as high as 60%, and can thus be considered as ‘obligatory’. Its major rhetorical function is to provide information serving as background explanation to the issues under analysis. It is also aimed at grabbing the attention of the audience by inserting interesting anecdotes, engaging thought experiments, historical references or shared well-known pieces of information. More specifically, this move unfolds in 5 steps. Step 1A serves as an introductory segment where authors establish common ground with their audience by mentioning generally known concepts related to the issues under analysis (Example 14). Steps 1B and 1C, then, involve the quick introduction and explanation of the main problem that forms the basis of the research (Examples 15 and 16). Step 1D is dedicated to presenting the historical development of the issues under discussion and therefore justifies the need for conducting the research and provides context for the current analysis (Example 17). Lastly, Step 1E is employed by authors as a means to captivate their audience's attention (Example 18).

(14) **1A:** *It is a well-known fact (and it is one of the greatest ironies in biochemistry!) that life on Earth could not have begun without water; yet water stymies come chemical reactions necessary for life itself.* (PHY_2017-10-23)

(15) **1B:** *Debilitating conditions such as Alzheimer's and Parkinson's diseases represent one of the major medical challenges of the modern world.* (ONB_2017-07-04)

(16) **1C:** *Alzheimer's and Parkinson's diseases are members of a larger class of conditions characterised by the misfolding and aggregation of specific disease-related proteins. The underlying molecular mechanism in these diseases is protein aggregation, which ends in solid macroscopically visible deposits of the aggregating protein composed of bundles of fiber-like structures, commonly known as amyloid.* (ONB_2017-07-04)

(17) **1D:** *Historically, the San Andreas Fault system has produced a massive quake about every 150 years. But for whatever reason, it has been pretty quiet in the San Andreas since 1906, when an estimated magnitude 7.9 quake along the northern portion of the fault devastated San Francisco.* (SNE_2019-07-12)

(18) **1E:** *Imagine an army of tiny soldiers stationed throughout your body, lining cells from your brain to every major organ system. Rather than standing at attention, this tiny force sweeps back and forth thousands of times a minute.* (BIOB_2019-07-03)

Referring to previous studies or to the state of the art, labelled as Move 2, is found in 'research' blog posts only and it works as medial move within the Introduction. It is considered as an optional move and its major rhetorical function is to place the study within the context of the on-going research in the field, thus highlighting the reason why the new study is conducted. An example of Move 2 is the following:

(19) **Move 2:** *Substantial drug discovery efforts over the past decade have focused on the development of antibodies targeting the native and aggregated forms of disease-related proteins, and antibodies against alpha-synuclein are currently undergoing clinical trials worldwide.* (ONB_2017-07-04)

Announcement of the research is found in both 'research' and 'didactic' blog posts in the Introduction. In 'research' posts, it is tagged as Move 3 and it typically either follows Move 2, or, in specific contexts, it opens the article. In 'research' posts, its major rhetorical function is to state the type of research being conducted (realised through step 3A, example 20), together with its purpose and relevance (Step 3B, example 21), while listing, albeit briefly, its main findings (step 3C, example 22): it is thus composed of 3 steps. An example can be found in examples 1-2-3 (paragraph 4.2.3).

(20) **3A:** *Scientists at MIT have developed a new catalyst material that provides design principles for producing fuels from carbon dioxide emissions.* (SCI_2016-11-15)

(21) **3B:** *These findings are vital for our everyday lives, because they suggest a route toward using the world's existing infrastructure for fuel storage and distribution, without adding net greenhouse emissions to the atmosphere.* (SCI_2016-11-15)

(22) **3C:** *The discovery could be used in a conversion process to drastically reduce ethylene production costs and cut related carbon dioxide emissions by up to 87%. Also, this new redox catalyst makes that technique more energy efficient and less expensive while reducing greenhouse gas emissions. What is more, ethylene is an important feedstock for the plastics industry, among other uses, so this work could have a significant economic and environmental impact.* (SCI_2020-04-26)

Presentation of the research, labelled as Move 4, is found in the Body of the so-called 'research' blog posts. It is always an initiation move of a length that varies between 1 to 5 sentences, and that can be labelled as 'obligatory'. Its major rhetorical function is to provide a detailed description of the research. Given the importance of this move within this context, several steps contribute to its discursive realisation: Step 4A, which mentions the name and institutional affiliation of the authors (23), 4B, which describes the materials employed (24), 4C, which recounts the experimental processes and justifies the choice of certain procedures and techniques (25), and, when present, 4D, where the authors inform their public about publications, posters and academic conferences in which these outcomes are presented (26).

(23) **4A:** *In the present study, the group, including a master's student Yuki Nakaya and Associate Professor Shinya Furukawa at Hokkaido University's Institute for Catalysis, focused on the intermetallics (PtGa) of platinum (Pt) and gallium.* (SCI_2020-06-04)

(24) **4B:** *Using laboratory equipment, we used water, jelly and laser imaging to demonstrate how magma flows through Earth's crust to the surface through magma-filled cracks called dykes.* (ECN_2018-02-22)

(25) **4C:** *In our current study, we have combined the single-molecule fluorescence technique with multiple biophysical assays to understand the effect of a novel class of therapeutic molecules, namely nanobodies, on alpha-synuclein aggregation.* (ONB_2017-07-04)

(26) **4D:** *The results of this study were recently published at Frontiers in Zoology.* (ONB_2019-07-26)

Description of the outcomes of the research (M5) is another obligatory move, retrieved only in the central part of the so-called 'research' blog posts. It normally patterns with another item, Move 4, which always comes in first position: this move thus works as closing segment of the body of the post. Its major rhetorical function is to provide a detailed description of the specific outcomes of the research, and it is realised through two steps: 5A, in which the results of the research are introduced (27), and 5B, where each outcome is explained in detail.

> (27) **5A:** *In addition, we discovered that the MGMT gene, which is another gene that is known to be implicated in the development of breast and ovarian cancers, is also methylated in white blood cells.* (ONB_2018-08-09)

> (28) **5B:** *Just like BRCA1, when MGMT is methylated, it poses more of a cancer threat to the carrier. Our results demonstrated that, similar to methylated BRCA1, the frequency of methylated MGMT was similar in both the adult and newborn females (13.1% and 12.3%, respectively). This result indicates that methylated MGMT is also present from the early life of the carriers.* (ONB_2018-08-09)

Comment on the implication of the results, labelled as Move 6, is retrieved only in 'research' blog posts. Given its frequency (100%), it can be defined as an obligatory move and it is normally found in the opening part of the Closure. Its major rhetorical function is to interpret and comment on the research outcomes, particularly emphasising the importance of the various research outcomes. Given the relevance of this part, authors usually dedicate two or more entire paragraphs to this move. An example is the following:

> (29) **Move 6:** *The fact that the methylation of these genes is present from the early life of the carriers suggests their possible use as biomarkers for early detection of females susceptible for breast and ovarian cancers. Such a tool could help predict (and possibly even prevent) up to 30% of breast cancer and 35% of ovarian cancer cases.* (ONB_2018-08-09)

Explication of the strengths, unsolved problems and future directions is found in 'research' and 'didactic' posts alike, and, in both cases, it constitutes an obligatory move. In 'research' posts, it is tagged as Move 7 and it typically follows Move 6, which allows it to be classified as 'medial'. In this context, its major rhetorical function is twofold: it simultaneously aims at analysing what still needs to be done within that particular field (through Step 7A, example 30), and what turned out to be successful and useful for the studies (Step 7B, example 31). What is more, it also offers the space for scientists to pinpoint particular questions or improvements that could be addressed in the future (Step 7C, example 32).

> (30) **7A:** *It thus becomes clear that more research is needed to develop reliable and accurate tests to identify these epigenetic markers.* (ONB_2018-08-09)

> (31) **7B:** *Using genetics as a first line biomarker allows for the study of smaller, but more homogeneous groups of individuals who present with similar underlying biological causes. This approach also offers targeted translational studies, for example, testing treatments in*

model systems and then bringing treatments deemed safe and effective to individuals with the same genetic abnormalities. (ONB_2018-07-30)

(32) **7C:** *Future work should concentrate on the identification of methylation profiles that mark health status and predict mortality.* (ONB_2016-10-03)

Finally, Move 8 (*Conclusion of the post*), is a common feature in both 'research' and 'didactic' blog posts, and in both cases it serves as the concluding segment of the entire text. In 'research' posts, M8 has the primary rhetorical function of concluding the article, and it accomplishes this by providing suggestions to the readers on where they can find additional information on the topic (Move 8A, example 33). Additionally, it also serves as an opportunity for authors to express gratitude towards colleagues or institutions that contributed to the development and realization of the study (Step 8B, example 34). However, there are instances where the academic products of research, which are sometimes found in Move 4, are included in this section, creating an additional step known as Step 8C.

(33) **8A:** *Tune into The Mount Sinai Hospital Facebook on the 7th of August at 1pm EST / 5pm GMT to hear myself, Dr. Paige Siper, speak in more depth about the topic of research into biomarkers of Autism at the Seaver Center. And learn more about the Seaver Autism Center at [hyperlink]* (ONB_2018-07-30)

(34) **8C:** *Lu's research is funded by NIH grants.* (BIOB_2018-06-20)

As far as 'didactic' blog posts are concerned, the analyses described in the previous sections made it possible to bring to the fore a number of similarities and differences with the so-called 'research' texts. The first aspect to be considered is that only 6 moves and 14 steps are identified in this context.

Move 1 has the same frequency of occurrence, length, position and rhetorical aim in both types of texts. What is different, however, is the number of steps involved. In this case, only three steps are to be found in the move, namely 'Reference to shared knowledge' (1A), 'Reference to the historical background' (1B), and 'Reference to an anecdote' (1C).

Secondly, Move 2 in 'didactic' texts is not aimed at situating the research within the state of the art, but is devoted to the announcement of the topic. It was retrieved in all the texts under analysis, usually closing the introductory segment of the article. Its main rhetorical function is to grab the attention of the readers by briefly stating what the post will be about (2A) and by providing a short explanation of the issue under analysis (2B). These two steps correspond to 3A and 3C in ‘research’ blog posts.

Move 3 corresponds, in this specific context, to the so-called *Topic development*, and it is the only move that constitutes the body of the article. It is composed of three steps. 3A is dedicated to the announcement and definition of the concept (35). 3B provides a comprehensive description of the item mentioned in 3A, offering relevant information and context (36). 3C, instead, is where the development of the topic continues, focusing on the explanation of various problems or issues connected to the concept under analysis (37).

> (35) **3A:** *Here are profiles of other amazing organisms that are entering the research world: sea lempreys, parasitic lampreys native to the Northern Hemisphere.* (BIOB_2019-05-15)

> (36) **3B:** *The Tasmanian devil, the world’s largest carnivorous marsupial, is in danger of extinction. In the past two decades, its population in the wild has plummeted by nearly 80 percent. One of the main causes is Tasmanian devil facial tumor disease. Animals with the disease develop tumors in and around their mouths. The tumors make it hard for the animals to eat, often leading to starvation. Sea lampreys, instead, are parasitic fish that latch onto other fish using suction-type mouths. Lampreys then feed on the host’s blood and body fluids. Though harmful to other fish, these parasites have two traits that make them interesting research organisms.* (BIOB_2019-05-15)

> (37) **3C:** *As an example, this means that at present, Washington DC is just a little too cold (34 degrees F in January) for palms to successfully propagate in the wild, but that you can expect range expansion in the coming decades as average winter temperatures warm up.* (ECN_2018-03-19)

Explanation of the relevance of the topic, tagged as Move 4, broadly corresponds to Move 6 in ‘research’ posts. M4, similarly to M6, holds a high frequency of occurrence, often appearing in 100% of the posts, and it is positioned in the opening part of the Closure section. It typically consists of two or three paragraphs that provide a comprehensive explanation of why the topic is relevant (Example 38).

Explication of the unsolved problems and future scenarios, labelled as Move 5, broadly corresponds to Move 7 in ‘research’ posts: it also exhibits a high frequency of occurrence, appearing in 100% of the posts, and is located in the central part of the Closure section. However, there is a difference in content between Move 5 and Move 7. The former does not include a reference to the strengths of the research methods, as seen in M7 of ‘research’ posts. Instead, M5 focuses on the explication of unresolved problems connected to the analysed issues (Step 7A, example 38), and on the need for further studies on the topic (Step 7C, example 39). In the end, space is also dedicated to the depiction of future scenarios and the possible threats the issue at hand poses to life (Step 7B, example 40).

> (38) **7A:** *The reaction still has secrets to reveal. The team is digging into two of them. First, how do the 12-membered rings that support the chromium form? In the experiments, the rings self-assemble around the chromium. What factors dictate that formation? Also, how can the protons be controlled to prevent them from binding to the electron-rich chromium and form additional bonds with nitrogen? Answering these questions could lead to learning how to control the reaction's environs and lead to a catalyst that is fast, efficient, and long lasting, to convert nitrogen to ammonia.* (PHY_2016-03-08)

> (39) **7C:** *More high-resolution datasets from around the world-such as "terrestrial datasets with plants and pollen and vertebrates from the Southern Hemisphere"-would be helpful to parse out the Deccan Traps' influence in both extinction, if there was any, and recovery.* (SNE_2020-07-17)

> (40) **7B:** *Benzene exposure can cause immediate health problems, including skin and throat irritation, dizziness, and longer-term effects such as leukemia.* (SNE_2020-12-23)

Finally, Move 6 (*Conclusion of the post*) corresponds to Move 8 in 'research' texts. In this context, it serves as concluding segment of the article and has a dual purpose: firstly, it aims to suggest additional resources that readers can access to acquire further knowledge (35), and secondly, it also seeks to elicit actions from the readers (36).

4.2.5 Comparison with existing literature

As stated at the beginning of the present chapter (paragraph 4.2), three previous studies on the move structure in specialised texts were consulted with the intention of retrieving an initial overview concerning the typical textual organisation of the genre.

The models from which the present results deviate the most is Kanoksilapatham's (2007a) framework concerning biochemistry research articles. The main reason for this difference lies in the fact that this study focuses on scientific popularisation, while Kanoksilapatham's model analyses science discourse written for experts.

First of all, in the 2007 model, the texts follow the IMRD (Introduction-Methods-Results-Discussion) pattern, thus showing four sections clearly marked on the basis of their distinct communicative purpose (Kanoksilapatham 2007a: 103). In the present analysis, on the contrary, only three sections were identified - introduction, body and closure. However, within this context, the differences are primarily found in the initial and central part of the texts. In popular science texts, the opening section functions as an attention-grabbing device, with steps devoted to the description of an interesting historical background, ironic anecdotes, engaging questions or thought experiments. Introductory sections of research articles, on the contrary, immediately focus on the weaknesses of existing literature to motivate research or on the general description of findings and procedures, leaving little or no space to emotions. Moreover, reference to established knowledge or to previous literature is inserted, in research articles, within the discussion sections only, while in popular science tests they are used as way to introduce readers to the topic gradually. Furthermore, in popularisation, the space dedicated to the description of the materials, methods and statistical procedure is limited, with authors mentioning only the aspects that are useful to support their arguments. On the contrary, in research articles, these aspects are given great prominence. Indeed, moves 4, 5, 6 and 7 in Kanoksilapatham's model, which are dedicated to the presentation of research and the discussion of methodological issues and results, are often condensed into a more general move within popular science blogs. Instead of having separate moves for each aspect, popular science blogs tend to integrate these elements into a single section focused on presenting the research and its findings. Likewise, no instances of Move 8 (Restating methodological issues) and Move 13 (Consolidating results) from Kanoksilapatham's model can be retrieved in popular science blogs. These moves, which emphasize methodological details and the consolidation of research outcomes, are more commonly associated with academic research articles rather than popular science communication. Lastly, when it comes to commenting on the outcomes (M11 in Kanoksilapatham's model), popular science blogs only focus on highlighting the relevance and significance of the discoveries, without mentioning their possible limitations.

Secondly, there is a noticeable difference in the order of the moves and patterns between research posts and science blogs. The former typically adhere to a more fixed structure, following a specific sequence of moves that allows for consistent organization and presentation of the research content. The latter, on the other hand, exhibit more variability in the arrangement of moves. While Move 1, which aims to capture readers' attention, often opens the article in popular science texts, there are instances where it may be omitted or embedded within another segment, such as Move 3.

Thirdly, another notable difference concerns the frequencies of occurrence of each segment, which underscores the divergence in how arguments are presented in these two types of writing. Kanoksilapatham (2007a) noted that the comment on the results occurred in 90% of the cases, while in popular science this frequency is attested at 100%, and the same goes for the suggestion for further research (53% of occurrences in research texts and 100% in blog texts). On the contrary, no instances of statistical procedures and equipment descriptions were found in the present analysis, while 6 (10%) and 16 (13%) instances respectively were retrieved in the 2007 model. Analogously, describing materials, as a move in research articles, appeared with a frequency as much as 100%, while in popular science constituted a step occurring in 32% of the cases.

The second framework taken as reference is the one proposed by Luzón (2013a), which addresses the rhetorical categories in research-commenting popular science blog posts. In her work, Luzón identifies 5 rhetorical categories and 7 sub-categories that are found to be recurrent in all the texts under analysis. However, she did not elaborate a proper prototype with fixed sequences of moves and steps, since she claimed that their order was not stable. The findings that stem from Luzón's work share both similarities and differences with this specific work.

First of all, in contrast to her studies, the present analysis demonstrates that it is possible to develop a framework of moves and steps within popularisation blogs, and, at the same time, to classify each of them into 'initial', 'medial' and 'final' according to their position. Additionally, this analysis shows that multiple recurrent patterns among moves and steps can be identified: this is the case, for example, of Move 6 in 'research' blog posts, which was found to always precede Move 7, or of Move 5 in 'didactic' blog posts, which always occurred in combination with the one devoted to highlighting the relevance of the topic.

Secondly, the framework stemming from the evidence provided by the present analysis also allowed for the identification of two sub-genres of blog posts, namely 'research' and 'didactic', with a higher number of moves and steps each: 8 moves with 21 steps for 'research' blogs, and 6 moves and 14 steps for 'didactic' blogs.

Thirdly, some similarities and differences also concerned the moves and steps themselves: what Luzón calls 'contextualising the research' and 'announcing the new finding or the new contribution to the discipline' were also found in the corpus under analysis, with broadly the same frequency of occurrence and the same rhetorical aim. However, the present study pointed out that both moves are realised by several different steps that add different details to the discourse. Similarly, the so-called 'Presenting, explaining, and evaluating results' and 'Drawing implications or highlighting the significance of the study' could also be retrieved in this corpus, although with different percentages of occurrence (100% in both cases). Also, what in the present work is labelled as Move 2 was not identified as a separate segment in Luzón's work but included into the broader Move 1. The same happens with Move 8, which is devoted, in my analysis, to the suggestions for further investigations on the topic and acknowledgements: in her model, this was not seen as a separate move, but it was included in the more general segment aimed at commenting on the significance of the work and on the implications for the society.

However, what appears to agree with Luzón's model is the overall discursive configuration. The present work confirmed that the authors of popularisation blogs use a deductive pattern for the presentation of the issues. The posts generally open with references to well-known topics or attention-catching elements, such as anecdotes and thought experiments. What follows, then, is a brief statement introducing the research and its outcomes, which is elaborated further on in the body of the post. Materials and methods are reported selectively, mentioning only the aspects that are useful to support the argument. In the end, the concluding paragraph serves as highlighting authors' role as civic scientists (Luzón 2013a: 441): space here is left for the comment on the relevance of the research outcomes, the implication for people's lives, the possible future directions of the discipline and on the suggestions for extra resources.

Finally, the model which appears to be in closer agreement with the present study is the one elaborated by Nwogu in 1991, which is aimed at analysing the rhetorical moves in popular science medical texts (referred to as *Journalistic Reported Versions* - JRV).

Firstly, the number of moves retrieved in the two studies was similar: 9 in Nwogu and 8 in the present analysis, starting with the first segment serving as background to the problem, then moving on to the indication of the research question and description of previous studies, and later stopping to the description of the research. In the end, both studies share a commonality in their final moves, which are dedicated to commenting on the results and emphasizing the implications and potential future directions of the research being discussed.

Secondly, in line with the abovementioned framework, the present study also elaborates a framework of sequenced moves, with these items showing some internal variations and falling into three broad divisions – initial, medial, and final – according to their most typical position. Consequently, as claimed by Nwogu himself (1991: 120) this data-driven analysis confirmed that the tendency for information to be organised according to a well-identified schema "suggests that the production of such texts cannot be unmotivated".

Lastly, the pattern of information structure evidenced in this context are in line with what Nwogu (1991) retrieved from his corpus: at the beginning, the initial move functions as 'lead', since it provides the background information the public needs to be 'lured' into reading of the text. This is generally followed by the presentation of the research, its major outcomes and the comment on the implications of these results, which demonstrates that the author is aware of the need to hook and draw the reader into reading the entire text. In the end, the concluding section is devoted to the emphasis on the importance of further research and of information gathering on these topics, which is what encourages the reader to keep updated on these concepts.

4.2.6 Overall discussion of the results

Evidence from the textual analysis presented in the previous sections made it possible to draw a series of observations concerning the discursive configuration of popular science in blogs.

Above all, these findings support the contemporary view of science popularisation, which assumes that this genre does not consist in a simplification or a distortion of the information, but in a 'recontextualisation' of the concepts (Calsamiglia 2003) for non-specialist readers. Most importantly, the analysis showed that in weblogs, for the scientific concepts to be 'redrafted and remodelled' (Zou & Hyland 2019) for a potentially heterogeneous readership, authors employ a well-identified combination of move and step patterns (see Tables 12 and 13). This aspect, in turn, proves that popular science discourse in blogs cannot be regarded as a 'rhetoric-free' activity, and, as a consequence, that the *dispositio* (Załęska 2016: 36) of the concepts in texts is not unmotivated (Nwogu 1991).

Within this specific context, bloggers act as 'civic scientists' (Luzón 2013a) contributing to the so-called 'democratisation of science' (Mahrt & Puschmann 2014), hence acquiring the role of science communicators talking to people: in this light, it thus becomes clear that all the specific discursive and rhetorical strategies employed are 'reader-oriented', that is to say, tailored to the needs of the audience, who needs to be instructed and, at the same time, wants to be involved. As a result, authors not only have to meet the *docere* aim, but also serve the *delectare* function (Załęska 2016).

In order to instruct the public properly, bloggers have to avoid the "lengthy and sustained argumentation of the journal article" and have to "offer a more succinct and reader-friendly presentation of the concepts" (Zou & Hyland 2019: 715). With this in mind, the first choice they make is the adoption of a deductive rhetorical pattern (Hyland 2009), which starts with the presentation of the necessary background information, then moves on to the statement of the research, the description of its importance, and closes with the reference to its main outcomes and the references to its authors. Examples of this structures can be found, for instance, in 'research' posts. Here, the opening section often serves to contextualize the issues under analysis and sets the stage for the subsequent discussion (Move 1 and Move 2). Following this, the post typically proceeds with the announcement of the research and its main outcomes (Move 3, steps 3A, 3B and 3C), and, in addition to that, with the references to the scientists involved (Move 4, Step 4A).

Given the characteristics of the weblog as a medium, which generally hosts posts that are around 1,500 to 2,000 words in length, popular science bloggers also tend to adapt to this feature by focusing on the information that is of immediate value and potential benefit for readers. As a result, they tend to concentrate on explaining and commenting on the outcomes of research and their relevance to people's everyday lives, allocating less space to the detailed explanation of the materials, methods and academic outcomes of such works.

When it comes to conveying the core message of posts, which includes describing research outcomes and their implications, authors adhere to specific discursive patterns that aim to ensure easy understanding for a lay audience. These patterns provide a consistent structure for presenting information in a clear and accessible manner. One common pattern observed in research texts is the use of the 5A>5B structure. Following the introduction of a research outcome, authors provide a definition, immediately clarifying the meaning of the result. This step helps readers grasp the key concepts and terminology associated with the research findings. Subsequently, the outcome is described in more detail, offering further explanation and elaboration. In 'didactic' texts, this section is even more detailed, since, as shown with pattern 3A>3B>3C, after the denomination, definition and description of the issues, an example is given for clarification purposes, in line with the models proposed by Loffler-Laurian (1984) and Calsamiglia and Van Dijk (2004).

Finally, another important way in which authors instruct their readers is by inserting direct quotations from interviews with professional scientists, and by mentioning the affiliations of the scientists that conducted the research. This is an important way to emphasise the credibility of the article, thus guiding the public towards well-informed choices and towards the creation of a scientific-based personal point of view on controversial scientific issues.

Secondly, in addition to providing an easy-to-read text, bloggers also have to grab their attention and draw them into the discussions on the domain specific science-related topics.

To capture their readers' attention, bloggers exploit various rhetorical strategies. One common approach is to open their articles *in medias res*, thus directly starting by announcing the research project and quickly listing its main outcomes (Move 3, steps 3A, 3B, 3C). Furthermore, authors also incorporate specific attention-grabbing devices in the initial move: this is the case, for example, of humorous and ironic anecdotes, rhetorical questions or challenging thought experiments (Step 1E in 'research' posts and Step 1C in 'didactic' posts).

However, once they have attracted the public's attention, bloggers need to keep their readers interested, and to do this, they exploit different strategies. One involves referencing the historical background of the issue (Step 1D in 'research' posts and Step 1B in 'didactic' posts), which highlights the progress made in the field through research and emphasises the potential benefits of further studies for the society. Then, they also employ links that bring to external resources: they take advantage of the hypertextual allowances of blogs to insert references to other sites, such as Wikipedia pages, YouTube channels or official institutions' websites. These elements, together with the suggestions for extra materials inserted in the final section of the texts (Move 8 in 'research' posts, Move 6 in 'didactic' posts), turn out to be engaging for the public, who is given the opportunity and encouraged to keep expanding the knowledge on the topic.

In the end, authors also try to establish a sort of common background with their audience, with the intention of making them feel more involved in the topics. To do this, they mainly rely on the establishment of a shared floor when opening the article, which is either realised through the initial step in Move 1, labelled as 'Reference to shared knowledge', or through the so-called 'Reference to an anecdote'. With the former, authors mention generally-known facts of the world, popular culture and beliefs, and some 'semi-technical lay knowledge' (Calsamiglia & Van Dijk 2004: 384) about the topic, while with the latter, blogger mention ironic or commonly known anecdotes in which readers may feel interested.

Finally, as already stated in paragraph 4.2.1, evidence from this analysis also allowed for the identification of two sub-genres of the popular science blog post, namely ‘research’ and ‘didactic’ texts.

On the one hand, ‘research’ texts exhibit greater length and structural complexity, as evidenced by the higher number of moves identified (8) in this context, as opposed to the other sub-genre (6). The aim of this specific type of blog posts is to present one or more research projects conducted on the topic. As a result, authors devote a portion of the argumentation to describing the work, including details such as the names of the contributors, materials and methods employed, and the experimental procedure. Additionally, references to academic outputs resulting from these works, such as conferences, papers, and poster presentations are also mentioned. These blog posts are addressed to an audience who already possesses some knowledge on such matters, which is why authors frequently insert one move devoted to listing previous studies conducted in that specific area. Likewise, the occasional absence of segments devoted to presenting background information indicates that authors are aware that their potential readers may already be familiar with the subject matter. Ultimately, there are two additional elements that characterize these types of posts: the utilization of steps 7B and 7C. 7B specifically highlights the strengths of the research methodologies employed and explains why the project has been successful. On the other hand, step 7C is dedicated to emphasizing potential future directions that the research could take, providing insight into the possibilities for further exploration.

In contrast, the so-called ‘didactic’ texts exhibit a lower structural complexity, as indicated by the lower number of moves and steps identified in this context. The aim of these posts is to teach and educate an audience that lacks in-depth knowledge about specific topics within a particular discipline. Consequently, the central focus of these texts is on providing accurate definitions, descriptions, classifications and explanations of the main topic and its related unresolved issues. As a consequence, these posts make no specific references to the state of the art or to technical aspects of the studies, and no acknowledgements to research contributors are provided. More specifically, in line with the definition proposed by Moirand (2003: 190), these texts can be said to display a ‘didactic’ type of explanation, namely a way of transmitting the contents that is, above all, aimed at defining the objects under analysis, describing their constitutive parts, listing their main features, and explaining their functions, in the attempt to answer questions such as ‘what is…?’ ‘how is x made?’ ‘what are the main problems connected to x?'. Unlike the previously analysed sub-genre, these posts prioritize the accurate presentation of information necessary for understanding the topics at hand. This is why M1 was identified in 100% of the texts analysed.

4.3 Structural move analysis in YouTube video scripts

As far as YouTube video scripts are concerned, two studies were taken as reference models for the development of the framework: the one by Chang and Huang (2015) on the discursive organisation of TED talks, and the one elaborated by Li and Li (2021) concerning the rhetorical configuration of TED videos about education. However, after an in-depth reading of the texts, the integration of such models with the one elaborated by Nwogu in 1991 about medical research papers turned out to be necessary to have a more detailed account of the moves.

4.3.1 Moves and steps prototypes

As far as the surface-level textual pattern is concerned, all the samples included in the corpus were found to be made up of three macro-segments – introduction, body and closure – whose aims are, respectively, to welcome the listeners and inform them about the topic under discussion, to explain the contents, and to summarise the main points and greet the audience.

As displayed in the following table (18), YouTube video scripts are composed of a total of 6 moves: two of them are located in the introduction, three in the body and one in the closure. Moreover, these moves were found to be composed of 26 steps. Three of them are in Move 1, four in Move 2, three in Move 3, six in Move 4, four in Move 5 and six in Move 6. The following table (Tab. 18) summarises the move and step prototype that was elaborated for YouTube educational videos, while section 4.3.4 displays the detailed analysis of each segment.

INTRODUCTION	
1. Move 1 • Step 1A • Step 1B • Step 1C	**Listener orientation** Greetings Speaker presentation Speaker presentation (position and role)

2. Move 2 • Step 2A • Step 2B • Step 2C • Step 2D	**Content orientation** Context description Topic announcement Speech outline Acknowledgements (to sponsors)
BODY	
3. Move 3 • Step 3A • Step 3B • Step 3C	**Presentation of the necessary background information** Reference to shared knowledge Reference to an anecdote Attention-grabbing devices
4. Move 4 • Step 4A • Step 4B • Step 4C • Step 4D • Step 4E • Step 4F	**Topic development** Statement of the topic Description and/or classification of the topic Explanation of the necessary grounding concepts Explanation of problems connected to the topic and the necessity of research Research materials and methods Research outcomes
5. Move 5 • Step 5A • Step 5B • Step 5C • Step 5D	**Topic development - conclusion** Explanation of the relevance of the topic Main conclusion statement Summary of the main points Description of possible future scenarios/future research directions
CLOSURE	
6. Move 6 • Step 6A • Step 6B • Step 6C • Step 6D • Step 6E • Step 6F	**Video conclusion** Acknowledgements (to colleagues) Acknowledgements (to the public) Announcement of future videos Suggestions for extra resources about the topic Invitation to subscribe or comment Call for action

Table 18. Move and step structure prototype for YouTube video scripts

4.3.2 Moves and steps frequency and distribution

The investigation into the distribution of the moves made it possible to observe that each textual segment was consistently present in all video scripts under analysis, as shown in Tab. 19 and Fig. 20 below. Therefore, in line with Kanoksilapatham's models (2005, 2007a), they were labelled as 'obligatory'.

Move type	Number of observations	Percentage of frequency (out of 103)
Move 1	103	100%
Move 2	103	100%
Move 3	103	100%
Move 4	103	100%
Move 5	103	100%
Move 6	103	100%

Table 19. Overall distribution of the 8 move types in YouTube video scripts.

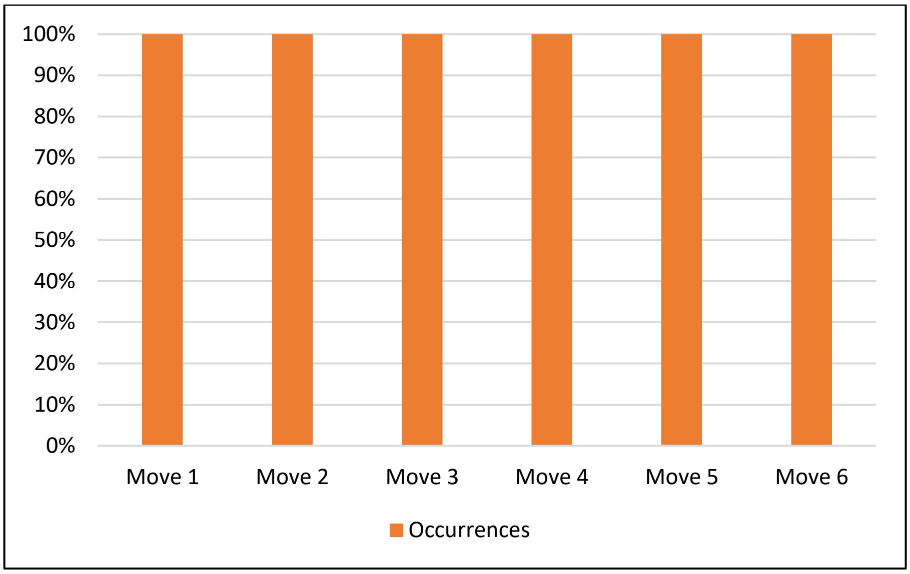

Figure 20. Visual representation of the move distribution in YouTube video scripts.

On the contrary, as regards the steps, 20 out of 26 appeared to be 'obligatory', while 7 were classified as 'optional', as illustrated in the following Tab. 20 and Fig. 21.

Step type	Number of observations	Percentage of frequency
Step 1A	48/48	100%
Step 1B	48/48	100%
Step 1C	35/48	73%
Step 2A	48/48	100%
Step 2B	48/48	100%
Step 2C	35/48	73%
Step 2D	6/48	13%
Step 3A	103/103	100%
Step 3B	46/103	45%
Step 3C	20/103	19%
Step 4A	103/103	100%
Step 4B	103/103	100%
Step 4C	65/103	63%
Step 4D	103/103	100%
Step 4E	21/103	20%
Step 4F	103/103	100%
Step 5A	103/103	100%
Step 5B	103/103	100%
Step 5C	77/103	75%
Step 5D	103/103	100%
Step 6A	20/48	42%
Step 6B	36/48	75%
Step 6C	22/48	45%
Step 6D	35/48	73%
Step 6E	41/48	85%
Step 6F	35/48	73%

Table 20. Overall distribution of the 27 steps in YouTube video scripts.

As shown, among the so-called 'obligatory' steps, the most frequent ones are Step 1A (Greetings), 1B (Speaker presentation), 2A (Context description), 2B (Topic announcement), 3A (Reference to shared knowledge), 4A (Statement of the topic), 4B (Description and/or classification of the topic), 4D (Explanation of problems connected to the topic and the necessity of research), 4F (Research outcomes), 5A (Explanation of the relevance of the topic) and 5D (Description of possible future scenarios), which were retrieved in all the texts under analysis. What follows are steps 6E (Invitation to subscribe or comment), 85%, and steps 1C (Speaker presentation – position and role), 2C (Speech outline), 5C (Summary of the main points), 6B (Acknowledgements – to the public), 6D (Suggestions for extra resources about the topic) and 6F (Call for action), which show a frequency of occurrence around 70%. In the end, steps 4C (Explanation of the necessary grounding concepts) occurs with a frequency attested around 60%.

Then, among the 'optional' steps we find 3B (Reference to an anecdote), 45%, 6A (Acknowledgements – to colleagues), 42%, 6C (Announcement of future videos), 40%, 4E (Research materials and methods), 20%, 3D (Attention-grabbing techniques), 19%, and 2D (Acknowledgements – to sponsors), 13%. Figure 21 provides a visual representation of the distribution of the steps in YouTube educational video scripts.

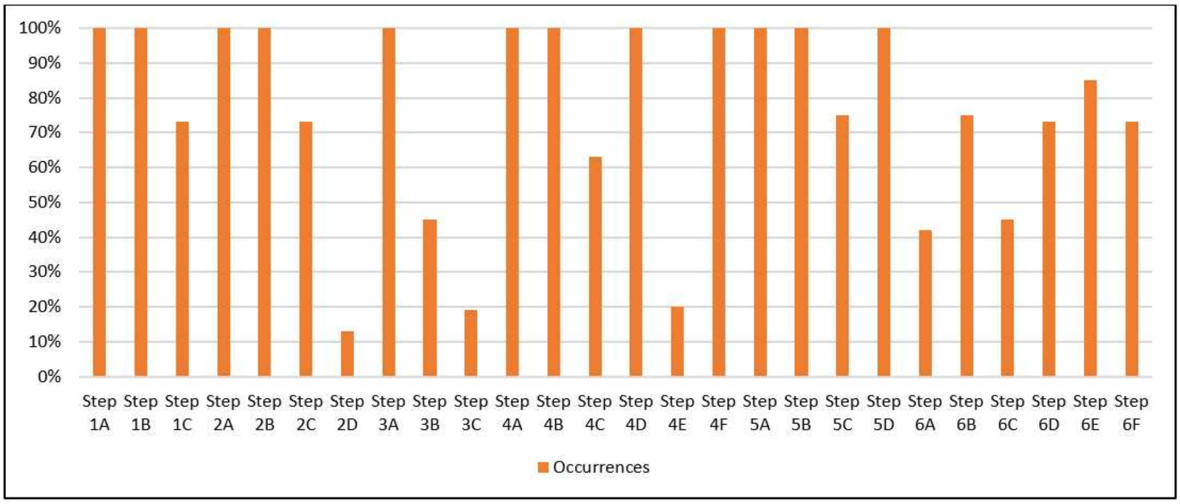

Figure 21. Visual representation of the steps distribution in YouTube video scripts

In light of these results, the present analysis made it possible to highlight that Move 1 (Listener orientation) and Move 2 (Content orientation) are normally composed of three steps, Move 3 (Presentation of the necessary background information) of one, Move 4 (Topic development) and Move 6 (Video conclusion) of five, and, finally, Move 5 (Topic development – conclusion) of four.

4.3.3 Moves and steps position and patterns

In line with the model proposed by Nwogu (1991), video scripts' Move 1 (Listener orientation), Move 3 (Presentation of the necessary background information) and Move 6 (Video conclusion) can be labelled as 'initial', Move 4 (Topic development) as 'medial', while Move 2 (Content orientation) and Move 5 (Topic development - conclusion) as 'final' segments within the overall framework.

As far as the steps are concerned, 1A (Greetings), 2A (Context description), 2B (Topic announcement), 3A (Reference to shared knowledge), 3B (Reference to an anecdote), 4A (Statement of the topic), 4B (Definition and/or classification of the topic), 5A (Explanation of the relevance of the topic), 5B (Main conclusion statement), 6A (Acknowledgements – to colleagues) and 6B (Acknowledgements – to the public) almost always occur as initial segments within each move. On the contrary, steps 1C (Speaker presentation – position and role), 2D (Acknowledgements – to sponsors), 3C (Attention-grabbing techniques), 4F (Research outcomes), 5D (Description of possible future scenarios), 6E (Invitation to subscribe or comment) and 6F (Call for action) almost always occur in a concluding position. In between these two extremes we can find the so-called 'medial' steps, which, in this context, are 1B (Speaker presentation), 2C (Speech outline), 4C (Explanation of the necessary grounding concepts), 4D (Explanation of problems connected to the topic and the necessity of research), 4E (Research materials and methods), 5C (Summary of the main points), 6C (Announcement of future videos) and 6D (Suggestions for extra resources about the topic).

Overall, the order of the moves across these texts turned out to be uniform. Within the introduction, the prevalent order was Move 1>Move 2, which suggests that speakers generally allocate initial moments to greet the audience, introduce themselves and to present the topics, as in example 41. This, however, was not the only pattern that could be retrieved within this section: as a matter of fact, 5% of the texts under analysis showed that it is possible for Move 2 to precede Move 1, as in (42).

> (41) **M1:** *Hi. My name is Jared Rutter, and I'm a Professor of Biochemistry and an Investigator of the Howard Hughes Medical Institute at the University of Utah.* **M2:** *And I'm gonna tell you today, in the next 15 minutes or so, some of the things that I find most fascinating about the mitochondria.* (BIO_2020-01-20)

> (42) **M2:** *So today we're going to study one of the most important sources of oxygen in the world. The Amazon rainforest covers 40% of South America, contains nearly 400 billion trees, and creates one-fifth of our planet's oxygen. The river basin feeding the mighty Amazon carries one-fifth of Earth's river water into the Atlantic ocean every day. But the river at the center of this is NOT the biggest river on Earth. There's one that's even bigger…* **M1:** *Hey smart people! Joe here.* (OTBS_2018-10-23)

As far as the body of the videos is concerned, a consistent pattern was identified in all the texts under analysis: Move 3>Move 4>Move 5. This implies that, in YouTube videos, the explanation of the specialised issues entails a preceding clarification of pertinent background aspects that are essential for comprehension. At the same time, the subsequent section is devoted to the summary of the key points, the description of the relevance of such issues and to the explanation of possible future scenarios. Example 43 illustrates this pattern.

> (43) **M3:** *As we all now, root canals aren't fun. A dentist drills off the top of an infected tooth to access the soft tissue inside. Then the infected dental pulp is removed and replaced with tiny rubber rods, called gutta percha, and the repaired tooth is capped with a crown.* **M4:** *What's left behind in the mouth is basically a dead tooth with an enamel tombstone. Now scientists say they have found a way to use peptide hydrogels to stimulate growth of new blood vessels and dental pulp. Kumar and colleagues say the new process could help save infected teeth. Their quest began with peptides that self-assemble into a gel when injected under the skin of rats and mice. They wondered if the hydrogel, which has been shown to stimulate blood vessels, could be tweaked to enhance regeneration of dental soft tissue.* […] **M5:** *If these studies go well, the researchers plan to move the hydrogel into human clinical studies, and have filed a patent for the redesigned peptide. Kumar and Nguyen say future versions of the peptide will likely contain analgesics and antimicrobial domains to potentially reduce the likelihood of reinfection and hopefully make root canals a little less unpleasant.* (ACS_2018-08-22)

Finally, in the final part of the videos, it turns out to be customary for speakers to move from the summary of the main points (Move 5) to dedicated section encompassing final greetings, expressions of gratitude towards audience and contributors, and the announcement of future videos (Move 6):

> (44) **M5:** *In this episode, we learned: how to write reaction mechanisms or maps of reactions, that strong acids in water should be considered hydronium ions or sources of protons, and electron rich atoms or regions of molecules are attracted to electron-poor atoms or regions of molecules.* **M6:** *Next time we'll look more closely at that positively charged carbon with the empty p-orbital as we begin reactions of alkenes. Thanks for watching this episode of Crash Course Organic Chemistry. If you want to help keep all Crash Course free for everybody, forever, you can join our community on Patreon.* (CC_2020-07-23)

Turning, then, to the internal arrangement of the segments within each move, a variety of different patterns was identified. In this context, M1 exhibited the highest level of standardization, with Step 1A (Greetings) functioning as the opening segment of the video, followed by 1B (Speaker presentation) and, optionally, Step 1C, aimed at specifying the role and institutional affiliation of the speaker:

> (45) **1A:** *Hi!* **1B:** *I'm Dr. Caitlin Conn* **1C:** *and I'm an Assistant Professor of biology at Berry College in Georgia.* (BIO_2021-02-03)

Move 2, comprising four distinct steps, exhibited a variety of patterns. The most frequently observed was 2A>2B>2C, as exemplified in (46), where a segment devoted to the setting of the scene opens the move, followed by the announcement of the topic and by the outline of the speech. Conversely, the least frequent pattern, encountered only three times, was 2D>2A>2B: here, the move shifts from the acknowledgements to sponsors to the description of the setting, as illustrated in example 47. Lastly, it is worth noting that a total of 10 occurrences of the pattern 2B>2A>2C (example 48) were identified. These instances entail the immediate presentation of the subject matter to the audience right at the beginning of the video.

> (46) **2A:** *If you think about it, oxygen is pretty dang amazing. Molecular oxygen, O2, is responsible for life on Earth as we know it. And the fire from combustion reactions, which need oxygen, is a foundation of civilisation.* […] **2B:** *So here's what you'll see in the next 30 minutes: oxygen, oxygen and oxygen!* **2C:** *We'll get to plenty of fun chemical reactions, I promise. But first we have to learn how to recognise chemical structures and use IUPAC rules to name them.* (CC_2020-05-20)

> (47) **2D:** *This episode is sponsored by Dropbox.* **2A:** *Your body is about ⅔ water. Earth's surface is about ⅔ oceans. This is not a coincidence. All of our lives began in water. Every plant and animal living on dry land today can trace its family tree back to the sea.* **2B:** *So here's what we will look at today: the importance of water in every aspect of our lives.* (OTBS_2016-11-23)

> (48) **2B:** *Today's episode is about something very important: stratospheric carbon quantum resonan... just kidding! IT'S BABY TURTLES!* **2A:** *OK, you're about to see one of the cutest things ever, but first I want you to ask yourself a question: Do you remember where you were ten years ago, at this exact day and time?* […] **2C:** *Ok, then, the five areas I will allude to in my talk are listed here. Take some time to read.* (OTBS_2016-10-17)

The move devoted to the explanation of the necessary background information (Move 3) consists of one obligatory step, 3A, and two optional steps, 3B and 3C. In the most common patterns, the sequence begins with Step 3A (Reference to shared knowledge), which immediately transitions into the *Topic development* move, as exemplified in (49), or follows the pattern 3A>3B>Topic development, as in (50). However, in a few cases, steps 3B and 3C can also be utilised as attention-grabbing devices, thereby opening the sequence at the beginning of the videos, as shown in (51) and (52).

> (49) **3A:** *As we all remember, carbons in a triple bond have sp-hybridisation.* **Topic development:** *And if an sp-hybridised alkyne is found at the end of a molecule, it's called a terminal alkyne. Terminal alkynes always have a hydrogen atom attached to them. And the*

increased s-character of the bond means that a hydrogen attached to those carbons is very weakly acidic, with pKas around 25. (CC_2020-12-17)

(50) **3A:** *As you surely know, microbes are everywhere, on your phone, in your water bottle, on your hands before you wash them, on your hands after you wash them, and literally everywhere else on top of you too. Microbes are omnipresent at any moment, and there is nothing we can do about it.* **3B:** *So, millions of years ago we made a pact, we give them shelter and food, and in turn they work for us. But the more we learn about this partnership, the more it looks like a cold war.* **Topic development:** *Inside our mother's womb, humans start out sterile. When we are born and traveling through the birth canal, billions of our mother's bacteria cover every single part of our bodies. Mother's milk for example, contains special sugars that are meant to feed and support certain groups of microbes, work as a decoy for others, and help to modulate the immune system. It takes up to two years, until a healthy microbe community has formed.* (KUR_2017-10-05)

(51) **3B:** *In February of 1942, Mexican farmer Dionisio Pulido thought he heard thunder coming from his cornfield. However, the sound wasn't coming from the sky. The source was a large, smoking crack emitting gas and ejecting rocks. This fissure would come to be known as the volcano Paricutin, and over the next 9 years, its lava and ash would cover over 200 square km.* (TED_2020-07-13)

(52) **3C:** *Imagine aliens land on the planet a million years from now and look into the geologic record. What will these curious searchers find of us?* (TED_2017-12-04)

The move devoted to the explanation of the domain-specific topic (M4) consists of 6 steps. The constituents within this move exhibit a consistent and stable order, following the pattern 4A > 4B > 4C > 4D, as shown in (53). It begins with the statement of the topic under analysis and progresses to its definition and classification. Subsequently, it proceeds with the description of some fundamental preliminary concepts and the primary issues associated with the topic. Furthermore, when outlining the research and its outcomes, the pattern shifts to 4D>4E>4F, as demonstrated in (54).

(53) **4A:** *Kawasaki disease isn't at all related to the motorcycle and engine company* **4B:** *Kawasaki disease is a vasculitis, or an inflammation of the blood vessels, that mostly affects the coronary arteries but can also affect any large- or medium-sised arteries as well.* **4C:** *Remember that, with Kawasaki disease, the immune system attacks the arteries. Whatever the case, when the endothelial cells in the blood vessels are attacked, they become damaged which exposes the underlying collagen and tissue factor found in the middle layer of the blood vessel, or the tunica media.* **4D:** *And this leads to a few serious problems. First, these exposed materials increase the chance of blood coagulation. Secondly, damaged endothelial cells in coronary arteries means weak artery walls, which can lead to coronary aneurysms.* (OSM_2018-06-26)

(54) **4D:** *Studying viruses can be tricky detective work. Just when scientists think they've homed in on an exploitable weakness, a virus can shift its makeup through mutation.* **[…] 4E:** *The team's method is based on surface enhanced Raman spectroscopy, or SERS. SERS enables*

researchers to detect interactions between individual molecules through changes in how they scatter light. This level of precision prompted the team from Rutgers, led by Laura Fabris, to test SERS' ability to detect viral RNA. They focused their work on influenza A. To detect the virus's RNA, the team fused gold nanoparticles with a "beacon DNA" specific to influenza A. **4F:** *In the presence of influenza A RNA, the beacon generated a strong SERS signal, whereas in the RNA's absence, it did not. More importantly, the beacon produced measurably weaker SERS signals as viral mutations accumulated. Ultimately, the researchers could detect RNA changes spanning as few as two nucleotides.* (ACS_2020-08-20)

Topic development – conclusion, labelled as Move 5, comprises four steps. The order of the constituents is generally consistent: in most of the analysed texts, this move commences with a detailed description of the study's relevance to that topic (Step 5A), it then proceeds to the summary of the main points of the video (5C) and ends with the depiction of potential future scenarios (5D), as in example 55. However, another frequent approach to the organisation of this move involves, as shown in example 56, starting with a question that recalls the title or main issue statement (5B), transitioning to the summary of the results (5C) and ending with the emphasis on the significance of the presented issues or research (5A).

(55) **5A:** *Without the Amazon's trees and this continent-wide rain cloud conveyer belt, areas like this would probably be desert, like other regions at the same latitude.* **5C:** *So, we've learnt that this green ocean is filled with living geysers, that act as green pumps responsible for 90% of the water that reaches the atmosphere of the continent.* **5D:** *Unfortunately, these so called "Lungs of the planet" are destined to be destroyed by human hand. We must take action.* (OTBS_2018-10-23)

(56) **5B:** *So, in the end, is the weather becoming more extreme?* **5C:** *The answers say that, above all, while weather will always be a chaotic system, shifts in our climate do increase the likelihood of extreme weather events. Moreover, as we said earlier, scientists are in near universal agreement that our climate is changing - and that human activity is accelerating those changes.* **5A:** *But fortunately, with our studies, we can identify what human behaviors are impacting the climate most, with the tracking of which boundary conditions are shifting. So even though next month's weather might always be a mystery, we can work together to protect the climate for centuries to come.* (TED_2020-08-25)

Finally, Move 6 typically begins with acknowledgements, either to the public or to colleagues who contributed to the project (6A or 6B). The move then shifts to encouraging the public to comment or subscribe to the channel (6E), and to take action to improve the situation depicted (6F), as in (57). However, it is also possible to encounter pattern 6E>6D>6A, where the invitation to comment or subscribe precedes the recommendation of additional materials and acknowledgements (ex. 58). Similarly, the pattern 6C>6E>6A can also be observed: here, the segment announcing future videos opens the final section of the video and precedes both the section devoted to the interaction with the public and the acknowledgements. See example (59).

(57) **6B:** *So, now I want to acknowledge colleagues who actually gave me some slides for this talk, so, including the slides I had, Cyril Zipfel provided a few interesting slides for this part of my talk.* **6E:** *Don't forget to tell me what you think in the comments.* **6F:** *And remember: each one of you out there can make a difference!* (BIO_2018-05-02)

(58) **6E:** *Hey, you know what else would be sweet? If you click that subscribe button, because that way you get a weekly dose of chemistry awesomeness from Reactions.* **6D:** *And be sure to check out other food fun, like why bacon smells so good, or learn about ice cream science.* **6A:** *Hey! Thanks for watching!* (ACS_2016-10-21)

(59) **6C:** *If you want to learn more about climate science, don't miss our next video on coral reefs, here, only on It's Ok To Be Smart!* **6E:** *And don't forget to use #OurToLose when commenting or when looking for more info: you'll find out a bunch of different ways in which climate change is impacting our lives.* **6A:** *And with that, I'd like to thank you very much for your attention!* (OTBS_2016-11-23)

4.3.4 Moves and steps description

Through the analyses displayed in the previous sections, a detailed description of the purpose and function of each move and step was attained. Above all, *Listener orientation* (M1) is an obligatory move opening the introductory section of the videos. It concerns issues that are not directly related to the topic of the talk, because they are aimed at establishing a connection with the audience and welcoming them into the discussion. The move is composed of three obligatory steps, namely 1A, which is devoted to the opening greetings (ex. 60), 1B, dedicated to the personal presentation of the speaker (ex. 61) and 1C, which specifies the role the speaker occupies within official institutions (ex. 62).

(60) **1A:** *Hey, smart people!* (OTBS_2019-07-14)

(61) **1B:** *I'm Sheng Yan He.* (BIO_2018-05-02)

(62) **1C:** *I'm a Professor at Michigan State University, and I'm an Investigator of the Howard Huges Medical Institute.* (BIO_2018-05-02)

Secondly, *Content orientation* (M2) is an 'obligatory' move typically utilised to conclude the introductory section of the videos. This segment, which is composed of four steps, serves to introduce the topic to the viewers. It commonly begins with two obligatory steps, 2A and 2B, which respectively set the scene and announce the topic under analysis: see examples 63 and

64. In the final part of the move, instead, we find Step 2C (example 65), where the authors explain the structure of the talk and specify the aspects of the topic that will be covered in the video, and Step 2D (66), in which authors acknowledge the various institutions or online platforms that sponsored the video.

> (63) **2A:** *Organic chemistry is really about how chemical reactions can make compounds that make human lives better - from medicines to materials. We're trying to build on the building blocks that nature provides! So, with that as motivation, let's learn about alkyne reactions.* (CC_2020-12-17)

> (64) **2B:** *Today I am going to introduce you to some amazing plants I've been studying since high school: parasitic plants!* (BIO_2018-05-02)

> (65) **2C:** *We'll focus on three learning objectives. The first is to explore parasitic plants within the broader context of parasitism. Next, we'll identify common adaptations within different groups of plants. And finally, we'll discuss the range of host dependence that we can observe in these groups.* (BIO_2021-02-03)

> (66) **2D:** *I'm here, visiting the Land Institute, the sponsor of this video.* (MIN_2017-09-27)

The *Presentation of the necessary background information* move (M3) is an obligatory move composed of four steps. This segment serves as a gradual introduction to the topic that will be elaborated in detail within the subsequent move. Here, authors begin by referring to shared pieces of information that allow the public to contextualise the topic within their existing knowledge (Step 3A, ex. 67). Within this move, authors also resort to anecdotes (Step 3B, ex. 68) or thought experiments (Step 3C, ex. 69) to grab the attention of their viewers and stimulate their interest: given their role, these sequences can either be used at the beginning of the segment or inserted after step 3A.

> (67) **3A:** *It is well-known that with the term menstrual cycle we refer to the regular changes in the activity f the ovaries and the endometrium that make reproduction possible.* (OSM_2019-01-28)

> (68) **3B:** *When our vegetarian ancestors started eating meat around two million years ago, it wasn't just because animals taste great, it was pure necessity: climate change made many of the plants our ancestors relied on less available, and meat bridged that gap.* (KUR_2019-06-09)

> (69) **3C:** *Imagine a bacterium as a very complex machine with thousands of complex processes going on that keep it alive and active. Antibiotics disrupt this complex machinery, for example, by interfering with its metabolism, slowing down their growth significantly, so they are less of a threat.* (KUR_2016-03-16)

The *Topic development* move (M4), located in the central part of the script, represents the most significant part of the video. It is an obligatory move within the general framework, as it focuses on providing a detailed explanation, description and classification of the issues being analysed. It is accomplished through four obligatory and two optional steps: it begins with Step 4A (example 70), devoted to the presentation of the topic of discussion, and it gradually transitions to steps 4B (71) and 4C (72), which respectively delve into the description, classification, and review of necessary grounding concepts. Subsequently, it displays Step 4D (73), which describes several problems associated with the issue at hand and presents research projects linked to it. In the end, the exposition of research materials and methods (Step 4E, example 74) and a detailed description of the main results of the study (Step 4F, example 75) may be included, although these steps are not compulsory.

> (70) **4A:** *Kawasaki disease isn't at all related to the motorcycle and engine company.* (OSM_2018-06-26)

> (71) **4B:** *Kawasaki disease is a vasculitis, or an inflammation of the blood vessels, that mostly affects the coronary arteries but can also affect any large- or medium-sised arteries as well.* (OSM_2018-06-26)

> (72) **4C:** *Remember that, with Kawasaki disease, the immune system attacks the arteries. Whatever the case, when the endothelial cells in the blood vessels are attacked, they become damaged which exposes the underlying collagen and tissue factor found in the middle layer of the blood vessel, or the tunica media.* (OSM_2018-06-26)

> (73) **4D:** *Studying viruses can be tricky detective work. Just when scientists think they've homed in on an exploitable weakness, a virus can shift its makeup through mutation.* (ACS_2020-08-20)

> (74) **4E:** *The team's method is based on surface enhanced Raman spectroscopy, or SERS. SERS enables researchers to detect interactions between individual molecules through changes in how they scatter light.* (ACS_2020-08-20)

> (75) **4F:** *In the presence of influenza A RNA, the beacon generated a strong SERS signal, whereas in the RNA's absence, it did not. More importantly, the beacon produced measurably weaker SERS signals as viral mutations accumulated. Ultimately, the researchers could detect RNA changes spanning as few as two nucleotides.* (ACS_2020-08-20)

Topic development - conclusion (M5) is positioned towards the end of the video and serves as a space for authors to conclude their argumentation and highlight the relevance of such issues for society. Within this segment, authors normally commence by reflecting on the importance of the research (Step 5A, example 76), then move on to answering to the initial question (Step 5B, example 77) or to providing a summary of the main points (Step 5C, example 78), and conclude with an encouragement for further reflection by considering potential future scenarios (Step 5D, example 79).

(76) **5A:** *Done properly, regenerative farming could play a vital role in helping our oceans, our climate, and ourselves.* (TED_2019-06-13)

(77) **5B:** *So, in the end, is the weather becoming more extreme?* **5C:** *The answers say that, above all, while weather will always be a chaotic system, shifts in our climate do increase the likelihood of extreme weather events.* (TED_2020-08-25)

(78) **5C:** *One big thing they've helped us learn is that the interactions between fault segments are really important: for example, when this particular segment slips, it increases the chances its neighbour will slip, letting us predict where the next quake will happen.* (MIN_2019-02-13)

(79) **5D:** *So, odds are out soot will still be here 66 million years from now. And if we choose to do differently, there might be some kind of human civilisation thousands or even millions of years from now.* (TED_2017-12-04)

Video conclusion (M6) is the final move of the videos. In this segment, authors normally start by expressing their gratitude to their colleagues (Step 6A, ex. 80) or audience (Step 6B, ex. 81), then proceed to announce the topic of potential upcoming videos (Step 6C, ex. 82), and even suggest resources for viewers to expand their knowledge on such topics (Step 6D, ex. 83). Additionally, they typically request support from their audience by prompting them to subscribe to the channel (Step 6E, example 84) and allocate some time to encourage viewers to act for the improvement of society (Step 6F, example 85).

(80) **6A:** *Thanks to Professor Klass for her kind help. And thanks, University of Minnesota!* (MIN_2017-07-27)

(81) **6B:** *Thanks for watching this episode of CrashCourse Organic Chemistry! Stay curious.* (CC_2020-05-06)

(82) **6C:** *Next episode we'll get into thermodynamics and how to use free energy and kinetics to help us predict reactions.* (CC_2020-10-14)

(83) **6D:** *If you want to know more about plant science, check out this awesome collaboration from our friends at Braincraft and Gross science, all about carnivorous stuff.* (OTBS_2016-08-23)

(84) **6E:** *If you want to help keep all CrashCourse free for everybody, join our community on Patreon.* (CC_2020-05-06)

(85) **6F:** *The most important thing is right away to solve this global warming problem. We don't have much time left. We have to put aside all of our political differences. The health and wellbeing of the planet is so much more important than everything else. You can do this, we can do this. I know we can. We can.* (OTBS_2019-10-07)

4.3.5 Comparison with existing literature

As stated at the beginning of the present chapter (paragraph 4.3), two studies were taken as preliminary reference models for the development of this framework, with the intention of obtaining an overall view on the typical textual organisation of this specific genre.

Evidence stemming from the present study shows both similarities and differences with the models developed by Chang and Huang (2015) and by Li and Li (2021). Above all, in line with the above-mentioned works, this study identified a surface-level textual pattern composed of three macro segments – introduction, body and closure – and six moves. Similarly, this model also shows that the moves which can be considered as obligatory are the ones that are located in the central part of the script and that are devoted to the presentation and explanation of the concepts. However, in contrast to their findings, the segments dedicated to the orientation of the listeners (e.g., M1) are labelled as obligatory.

In this context, the investigation on a higher number of YouTube channels allowed for the retrieval of a number of aspects which were not evidenced in the two aforementioned models. Above all, as far as the internal organisation of the frameworks is concerned, the integration of the model elaborated by Nwogu (1991) with these data made it possible to outline a more detailed framework of moves and steps. For instance, this is evident in the moves labelled as 'Presentation of the necessary background information' and 'Topic development – conclusion' in the current study. These segments are composed of four steps, which were not included in the models proposed by Chang and Huang (2015) and in Li and Li (2021). Additionally, a higher number of steps was retrieved within each move: this is particularly notable in Move 6, which comprises six steps in our analysis compared to only two steps in the previous models.

A few differences with the previous models were also retrieved when looking at the frequency of occurrence of the steps. For instance, Step 1A was found in all the instances under analysis, whereas it constituted an optional step in the abovementioned frameworks. Similarly, 1C was retrieved in 73% of the cases in this corpus, whereas its frequency was attested at 24 and 25% in the previous studies. Another notable difference is observed in 6F, which had a frequency of 73% in this analysis, compared to 46% and 50% in the 2015 and 2021 models respectively. Conversely, 6A turned out to be present in 42% of the videos in this corpus, while it appeared in over 53% of the TED talks included in the previous studies.

Finally, one last difference concerns the issue of move and steps patterns. In this regard, both studies by Chang and Huang (2015) and by Li and Li (2021) proved that there is a high degree of flexibility and variation in the structure and association of moves and steps: according to them, this is linked to “the many impromptu decisions speakers make to cater to each specific presentation context” (Chang & Huang 2015: 30). In the context of the present analysis, on the contrary, various moves and steps patterns could be identified. This may be because these videos are often based on prepared scripts that allow authors to structure their argumentation beforehand. Unlike live presentations in front of an audience, scripted videos offer more control over the argumentation structure. These patterns include, for example, the initial moves functioning as a ‘lead’ to provide the necessary background information, followed by the presentation of the main topic, research conducted in the field, major outcomes and concluding segments that highlight the importance of the content and elicit further reflections and studies on the topics.

4.3.6 Overall discussion of the results

In conclusion, evidence from the textual analysis discussed in previous sections made it possible to draw a series of observations about the discursive configuration of popular science in YouTube educational videos.

Above all, these findings demonstrate that YouTube products, similarly to blogs, are in line with the so-called ‘contemporary view’ of science popularisation, since they work towards the blurring of the boundaries between Academia and the general public through the focus on two main elements – education and engagement (Erviti & Stengler 2016: 6): this aspect is achieved by offering an audience-oriented presentation of the specialised concepts, as well as establishing with them a dialogical and interactional relationship.

As far as the dissemination of specialised knowledge is concerned – the so-called *docere* function (Załęska 2016: 35) – YouTube videos display a series of strategies that help remove a number of barriers, both linguistic and content-related, that hinder the comprehension of the message (Loffler-Laurian 1984: 124).

First of all, video scripts present a clear explanatory structure, composed of a well-identified combination of moves and step patterns (see paragraph 4.3.3) that allow for a linear – and therefore reader-friendly – presentation of the concepts. In line with what Martins Flores and Munis De Medeiros (2018) call 'didactic scenography', videos are narrated by a speaker, who can be either visible or invisible, that occupies a teacher position and acts as an informed person who has knowledge and dominance over the subject matters: in order to convey such contents, speakers display each knowledge segment in a peculiar way that demonstrates that scientific popularisation is not devoid of rhetoric, but is instead characterised by a well-defined discursive configuration that gives citizens the opportunity to learn about a wide range of high-profile science-based issues. These topics, in turn, both play an important role in their everyday lives and may as well influence their decision-making processes. To be more specific, speakers adopt a deductive rhetorical pattern, which provides the necessary background information first, then moves on to the explanation of the main issues and finally ends by summarising the results and highlighting their relevance (see pattern M3>M4>M5 in the central section of the videos).

This deductive pattern can also be found within Move 4 (Topic development), where the explanation of the concepts unfolds in six steps, starting from the statement of the issue – with its definition and classification – then moving on to the explication of some necessary background notions and ending with the description of some research projects and related results. Within this context, references to the detailed account of materials and methods employed for research are often omitted to leave more space to the emphasis on the relevance of research and its outcomes. However, the fact that these videos last around 10 to 20 minutes – as opposed, for instance, to the 3-minutes thesis presentations (Hu & Liu 2018) or 60-seconds science podcasts (Ye 2020) – gives the speakers the possibility to devote more time to some 'didactic' strategies, such as the accurate depiction of the settings, the revision of some grounding concepts, the final summary and answering to the initial questions, as well as to the stimulation of critical thinking and reflection.

Furthermore, as evidenced by Allgaier (2016, 2019), given that the use of online videos for science has started to replace scientific journalism, and that media coverage on specialised contents deeply influences discourses and actions, speakers pay particular attention to three elements in the building of their argumentations: the explanation of the relevance of this research for society (5A), the depiction of possible future scenarios (5D) and the call for action (6F). Finally, intertextuality plays a significant role in the transmission of content: mainly found in Step 6D, which is classified as an 'obligatory' step, this segments provides an opportunity to suggest additional resources and to include links to external websites, scientific papers and other videos from various YouTube channels. By including these references, speakers enrich the learning experience for the audience, allowing them to delve deeper into the subject matter and explore related materials for a more comprehensive understanding.

Turning now to the aforementioned element of 'entertainment', speakers employ a number of different strategies in their educational videos to grab and maintain their audience's attention and interest and, most importantly, to create online communities and establish dialogues.

As far as the first aspect is concerned, one of the most effective ways for speakers to catch the eye of their public is through the employment of two moves that are not present in other web-mediated genres: Move 1 (Listener orientation) and Move 2 (Content orientation). In the former, speakers open by greeting the audience, which is something that immediately makes the viewers feel involved in the situation, and then move on to their personal presentation, with the intention of showing viewers their background and the connection between the topic and their role. Within this context, Step 1C (Speaker presentation – position and role) plays an important role in establishing the credibility of the talk. Move 2 also helps raising interest in the public through the accurate depiction of the setting, the announcement of the topic and, when present, through the outline of the points that will be covered during the talk. What is more, alongside the discursive strategies mentioned *supra*, speakers grab and maintain the audience's attention also through the employment of visuals and imageries, well-known slogans, easily recognisable jingles and catchy titles. Finally, one last strategy that can be employed in this context is the addition of Step 6C in the concluding segment of the video: devoting time to announcing future videos ensures that the public remains interested in both the channel and the topics under discussion.

In the end, one last aspect to be considered is the process of interaction and community building (Holliman 2008; Welbourne & Grant 2016; Allgaier 2019). With the emergence of the Web 2.0, platforms such as YouTube have provided an alternative to the traditional content distribution, enabling the public to become, rather than passive consumers, active participants in the process of knowledge production. For this reason, speakers try to establish and sustain a dialogue with their audience and to create online communities of users around their videos. Additionally, in order to make viewers feel part of a community with shared values and knowledge, when introducing the topic, speakers devote some time to recalling some generally known facts of the world and beliefs (Step ‘Reference to shared knowledge’) or to sharing personal experiences (Step ‘Reference to an anecdote’).

Finally, interaction is obtained especially through the initial and final moves in the videos. Opening greetings and final acknowledgements are of particular importance in this context because they give the idea of real-life conversations. Additionally, subscription and comment requests inserted in the final move (Step 6E) encourage the development of conversations around that topic, while the integration of links that bring to other social networks sustain the development of discussions and virtual communities even further.

4.4 Structural move analysis in comic books about science

When it comes to comic books, the existing literature lacks a previous model that analyses the moves and steps within this specific genre. As a result, a self-designed data-driven taxonomy based on the close reading and manual tagging of the corpus was essential for the development of the frameworks presented in paragraph 4.4.1.

4.4.1 Moves and steps prototypes

As regards the surface-level textual structure of science-themed comics, all the samples included in the corpus were found to be composed of three macro-segments: Introduction, employed to grab the attention of the readers, as well as to welcome and inform them about the contents under analysis; Body, aimed at carefully explaining the contents and their implications; and Closure, in which authors summarise the main points covered in the book and draw their public’s attention on both the importance of such issues and the necessity of acting responsibly.

Within this context, the study of these texts in light of the *Structural Move Analysis* approach (Swales 1981, 1990) made it possible to identify a number of sub-genres within the broader category of science comics.

The first sub-genre encompasses a number of books that can be categorised as ‘didactic’, which are aimed at instructing the public on the subject matter by gradually moving from the most basic to the most difficult concepts within a specific discipline.

Notable examples include the comics belonging to the *Cartoon Guides, Monster Science* and *Adventures in Science* series. In these contexts, writers do not create a story that unfolds along the book, instead, they present scientific concepts in a sequential manner, starting with the fundamentals in the initial chapters and progressing to more advanced topics towards the end of the book. In line with this idea, the various graphic elements serve to help the understanding of the concepts and do not tell a sequenced story along the frames. Additionally, speech balloons are sparingly used in these comics, often serving as spaces for brief comments or humorous elements, while the rectangles positioned above each frame work to provide the various domain-specific explanations. See Fig. 22 below.

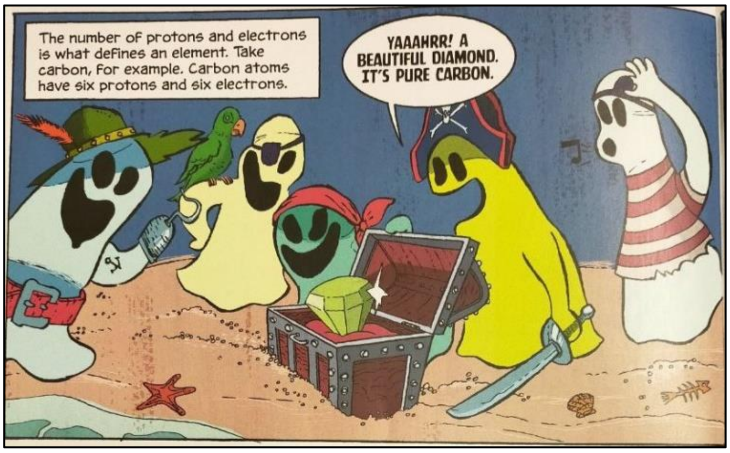

Figure 22. Example of 'didactic' science comic book frame.

This is the case, for instance, of the book *The Cartoon Guide to the Environment*, which starts with the description of the ecosystems and the communities of living beings in the world and ends with the detailed explanation of thermodynamic reactions and energy consumption.

As far as their discursive configuration is concerned, their three main constitutive parts – Introduction, Body and Closure – are composed of a total of 4 moves: M1 and M4 work, respectively, as opening and closing segments of the comic, while M2 and M3 are located in the central part of the book. Moreover, most of them were found to be composed of multiple steps: the present analysis retrieved 15 of them. Three belong to Move 1, three to Move 2, three to Move 3 and six to Move 4. The complete framework for this type of comic books can be found in the following table 21, while the detailed analysis of each segment is provided in section 4.4.4.

INTRODUCTION	
1. Move 1 • Step 1A • Step 1B • Step 1C	**Content orientation** Context setting Topic announcement Outline of the contents
BODY	
2. Move 2 • Step 2A • Step 2B • Step 2C	**Presentation of the necessary background information** Reference to shared knowledge Attention-grabbing devices Reference to an anecdote
3. Move 3 • Step 3A • Step 3B • Step 3C	**Topic development** Statement of the topic Definition and/or classification of the topic Description of the processes/ explanation of the issues
CLOSURE	
4. Move 4 • Step 4A • Step 4B • Step 4C • Step 4D • Step 4E • Step 4F	**Conclusion** Main points summary Explanation of the relevance of the topic Anticipation of the ensuing contents Description of future scenarios Explanation of the unresolved problems Call for action

Table 21. Move and step structure prototype for ‘didactic’ science comic books.

The second sub-genre features comic books that have the dual purpose of educating and entertaining readers, by narrating the adventures of the protagonist in relation to the subject matter. A prime example of this sub-genre is the *Max Axiom Super Scientist* series.

In this context, the voice and perspective of Max Axiom, a scientist, are utilized to explain scientific concepts through his personal experiences. As a result, the story and educational elements progress in tandem throughout the book. In this research, these types of comics are referred to as ‘didactic-narrative’ texts. As to the graphic elements, they develop sequentially within the frames, following the narration and the explanation of the concepts. What is more, in this specific context, the speech balloons represent the designated space devoted to the transmission of the specialised notions, as in the following example, taken from *Understanding Global Warming with Max Axiom Super Scientist*.

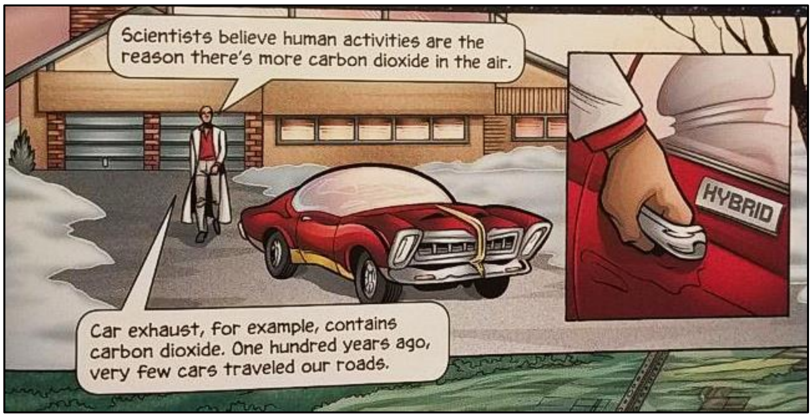

Figure 23. Example of 'didactic-narrative' science comic book frame.

As far as their discursive configuration is concerned, these comic books consist of three main components that together comprise a total of four moves: M1 is situated in the Introduction, M2 and M3 in the Body, and M4 in the Closure. Moreover, each move is found to consist of multiple steps, with a total of 13 segments identified in the present analysis. Specifically, M1 encompasses four steps, M2 comprises one step, M3 comprises four steps, and M4 comprises four steps. The complete framework for this type of comic books can be found in the following table (Tab. 22), while the detailed analysis of each segment is provided in section 4.4.4.

INTRODUCTION	
1. Move 1	**Reader and content orientation**
• Step 1A	Speaker presentation
• Step 1B	Scene setting
• Step 1C	Topic announcement
• Step 1D	Secondary characters presentation
BODY	
2. Move 2	**Presentation of the necessary background information**
• Step 2A	Reference to the historical background
3. Move 3	**Topic development**
• Step 3A	Statement of the topic
• Step 3B	Definition and/or classification of the topic
• Step 3C	Description of the processes/ explanation of the issues
• Step 3D	Expert interview

CLOSURE	
4. Move 4	**Conclusion**
• Step 4A • Step 4B • Step 4C • Step 4D	Main points summary Explanation of the relevance of the topic Explanation of the unresolved problems Call for action

Table 22. Move and step structure prototype for ‘didactic-narrative’ science comic books.

Finally, the last sub-genre retrieved in this corpus is categorised as ‘narrative-didactic’, exemplified by the comic books from Macmillan’s *Science Comics: Get to Know Your Universe!* series. Like the previous category, these texts are aimed at instructing and entertaining the public by blending specialised explanations with a fictional storyline, often narrated by non-human characters. For instance, this is the case of Dr. Cerebrum, the main character of the comic book *The Brain: The Ultimate Thinking Machine*, which personifies the brain and guides the readers through a journey inside the human mind. Nevertheless, what sets this sub-genre apart from the two previous categories is that the storyline opens and closes the comic, framing the scene for the explanation of the topics. On the contrary, the specialised contents are enclosed in the central part of the text, indicated as ‘Body’ in the present framework. The graphic elements, instead, follow the narrative and explanation of the concepts: in the initial and final segments of the comics, the images depict the characters and setting of the story, while, in the ‘Body’ section, the graphic elements represent specific scientific referents (e.g. neurons, dendrites, brain cortex). Here, the speech balloons thus serve dual purposes. They act as spaces for transmitting specialised notions and as platforms for genuine dialogues between the characters. As a consequence, technical explanations are both found in the rectangles positioned above each frame and in the white balloons that portray the conversations between the characters, as illustrated in Fig. 24.

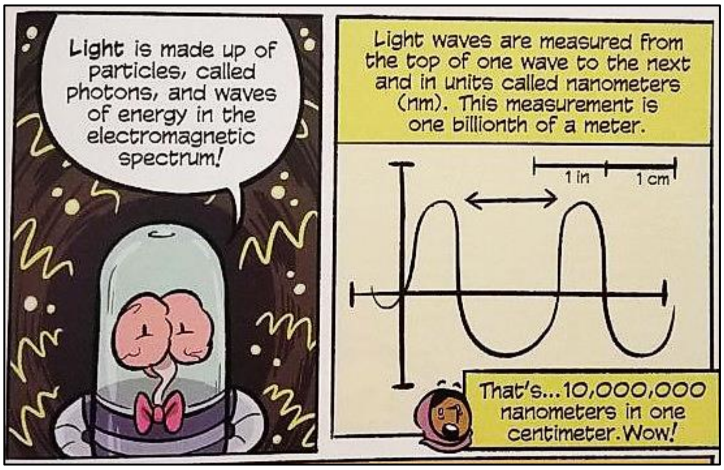

Figure 24. Example of 'narrative-didactic' science comic book frame.

In this context, their three main parts consist of 4 moves: M1 in the Introduction, M2 and M3 in the Body and M4 in the Closure. Furthermore, the analysis revealed a total of 13 steps across these moves. Five belong to M1, one to M2, four to M3 and three to M4. For a detailed overview of this type of comic books, see Tab. 23.

INTRODUCTION	
1. Move 1	**Story opening**
• Step 1A	Greetings
• Step 1B	Speaker presentation
• Step 1C	Secondary characters presentation
• Step 1D	Scene setting
• Step 1E	Topic announcement
BODY	
2. Move 2	**Presentation of the necessary background information**
• Step 2A	Reference to the historical background
3. Move 3	**Topic development**
• Step 3A	Statement of the topic
• Step 3B	Definition and/or classification of the topic
• Step 3C	Description of the processes/explanation of the issues
• Step 3D	Storyline intrusion
CLOSURE	
4. Move 4	**Story ending**
• Step 4A	Return to the storyline: story ending
• Step 4B	Call for action

• Step 4C	Final recommendations and links to external resources

Table 23. Move and step structure prototype for 'narrative-didactic' science comic books.

4.4.2 Moves and steps frequency and distribution

As far as 'didactic' comic books are concerned, the frequency counts for moves and steps are presented in tables 24 and 25. As readers can observe, all the identified moves can be labelled as 'obligatory', since their frequency of occurrence is attested at 100%. Figure 25 provides a visual representation of such results.

Move type	Number of observations	Percentage of frequency (out of 8)
Move 1	8	100%
Move 2	8	100%
Move 3	8	100%
Move 4	8	100%

Table 24. Overall distribution of the 4 move types in 'didactic' comic books.

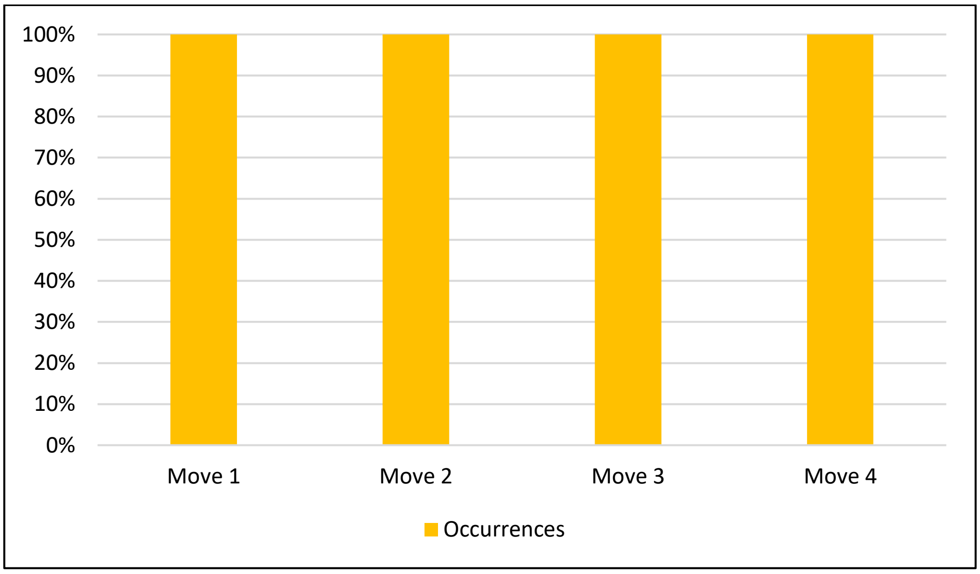

Figure 25. Visual representation of the move distribution in 'didactic' comic books.

As far as the steps are concerned, then, a greater variability in the frequencies can be observed. As displayed in table 26, among the most frequent 'obligatory' steps we find 1A (Context setting), 1B (Topic announcement), 3A (Statement of the topic), 3B (Definition and/or classification of the topic), 3C (Description of the processes/explanation of the issues), 4A (Main points summary) and 4B (Explanation of the relevance of the topic), which were retrieved in all the texts under analysis. Step 4C (Anticipation of the ensuing contents),85%, 1C (Outline of the contents), 75%, 2A (Reference to shared knowledge), 62.5%, 2B (Attention-grabbing devices), 62.5%, 4D (Description of future scenarios), 62.5%, 4E (Explanation of the unresolved problems) 62.5%, and 4F (Call for action) also fall into this category. On the contrary, Step 2C (Reference to an anecdote), can be ascribed to the 'optional' segments, since its frequency of occurrence is below the cut-off point of 60%. Refer to Figure 26 for a visual representation of these results.

Step type	Number of observations	Percentage of frequency (out of 8)
Step 1A	8	100%
Step 1B	8	100%
Step 1C	6	75%
Step 2A	5	62.5%
Step 2B	5	62.5%
Step 2C	2	25%
Step 3A	8	100%
Step 3B	8	100%
Step 3C	8	100%
Step 4A	8	100%
Step 4B	8	100%
Step 4C	7	87%
Step 4D	5	62.5%
Step 4E	5	62.5%
Step 4F	5	62.5%

Table 25. Overall distribution of the step types in 'didactic' comic books.

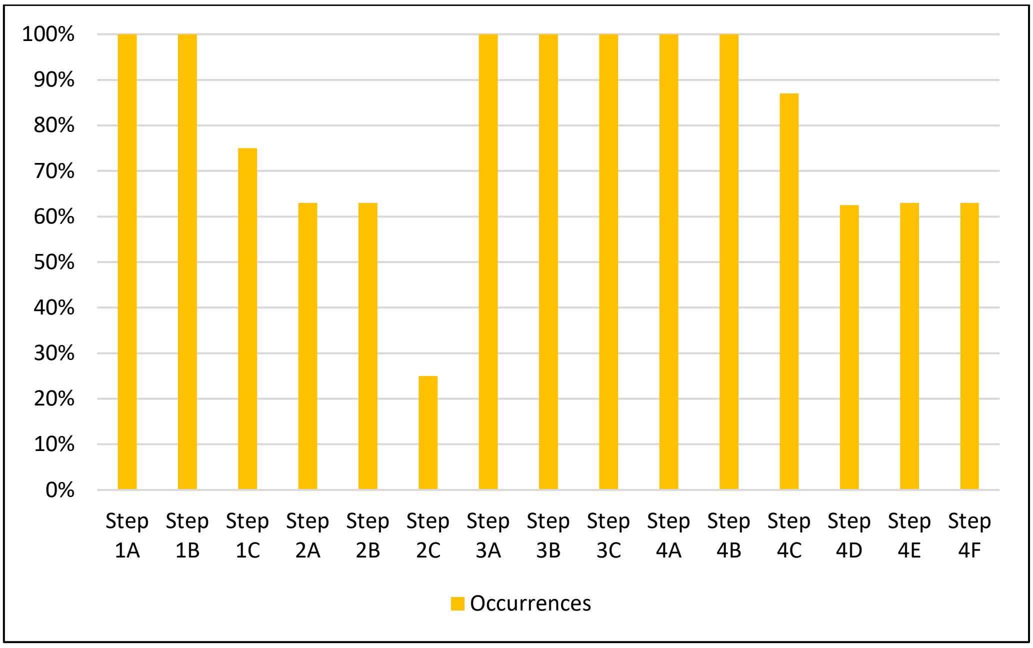

Figure 26. Visual representation of the distribution of the steps in ‘didactic’ comic books.

In light of these results, Move 1 (Content orientation) turns out to be composed of three steps, Move 2 (Presentation of the necessary background information) of two, Move 3 (Topic development) of three and Move 4 (Conclusion) of six.

In relation to the so-called ‘didactic-narrative’ texts, the moves retrieved in the *Max Axiom Super Scientist* series turned out to be present in all the books under analysis. See Table 26 and Fig. 27 below.

Move type	Number of observations	Percentage of frequency (out of 5)
Move 1	5	100%
Move 2	5	100%
Move 3	5	100%
Move 4	5	100%

Table 26. Overall distribution of the move types in ‘didactic-narrative’ comic books.

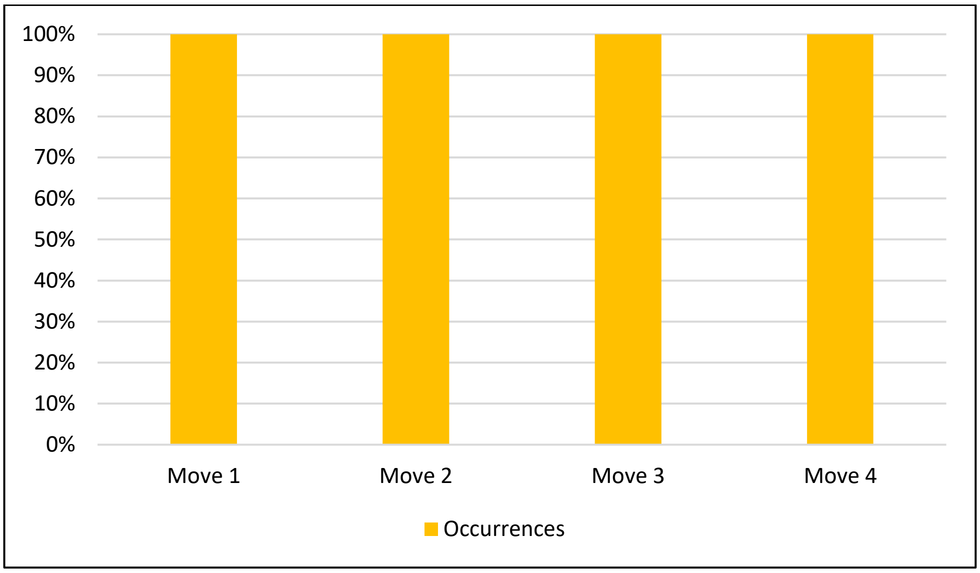

Figure 27. Visual representation of the move distribution in ‘didactic-narrative’ comic books.

As for the steps, however, all the segments retrieved in the analysis turned out to be ‘obligatory’, apart from Step 1D (Secondary characters presentation), which was found in one instance only. It thus appears that this sub-genre of science comic books is normally composed of four moves: Move 1 (Reader and content orientation) comprises three steps, Move 2 (Presentation of the necessary background information) one, while Move 3 (Topic development) and Move 4 (Conclusion) four. See Tab. 27 and Fig. 28 for the data concerning the distribution of the steps in this type of texts.

Step type	Number of observations	Percentage of frequency (out of 5)
Step 1A	5	100%
Step 1B	5	100%
Step 1C	5	20%
Step 1D	1	100%
Step 2A	5	100%
Step 3A	5	100%
Step 3B	5	100%
Step 3C	5	100%
Step 3D	5	100%
Step 4A	5	100%
Step 4B	5	100%
Step 4C	5	100%
Step 4D	5	100%

Table 27. Overall distribution of the step types in ‘didactic-narrative’ comic books.

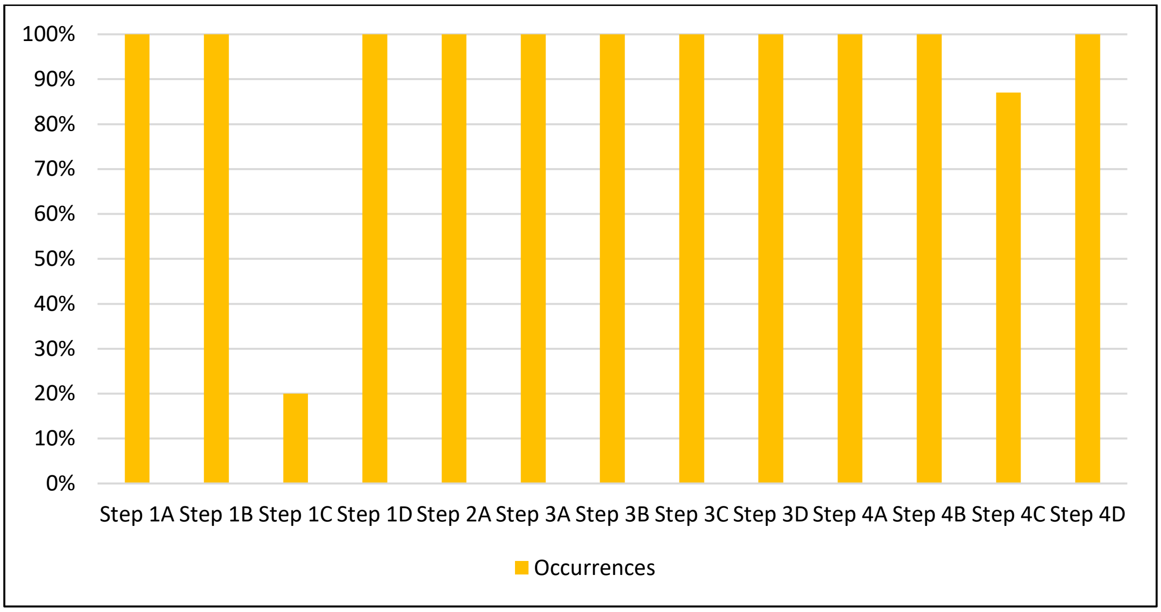

Figure 28. Visual representation of the distribution of the steps in ‘didactic-narrative’ comic books.

Finally, in ‘narrative-didactic’ comics, the moves and steps retrieved in the *Science Comics: Get to Know Your Universe!* series turned out to be present in all the books under analysis, as shown in tables 28 and 29, and in Fig. 29 and 30 below. It thus appears that this specific sub-genre is normally composed of four moves: Move 1 (Story opening) is made up of five steps, Move 2 (Presentation of the necessary background information) of one, Move 3 (Topic development) of four, and Move 4 (Story ending) of three.

Move type	Number of observations	Percentage of frequency (out of 2)
Move 1	2	100%
Move 2	2	100%
Move 3	2	100%
Move 4	2	100%

Table 28. Overall distribution of the move types in ‘didactic-narrative’ comic books.

Step type	Number of observations	Percentage of frequency (out of 2)
Step 1A	2	100%
Step 1B	2	100%
Step 1C	2	100%
Step 1D	2	100%
Step 1E	2	100%
Step 2A	2	100%
Step 3A	2	100%

Step 3B	2	100%
Step 3C	2	100%
Step 3D	2	100%
Step 4A	2	100%
Step 4B	2	100%
Step 4C	2	100%

Table 29. Overall distribution of the step types in ‘narrative-didactic’ comic books.

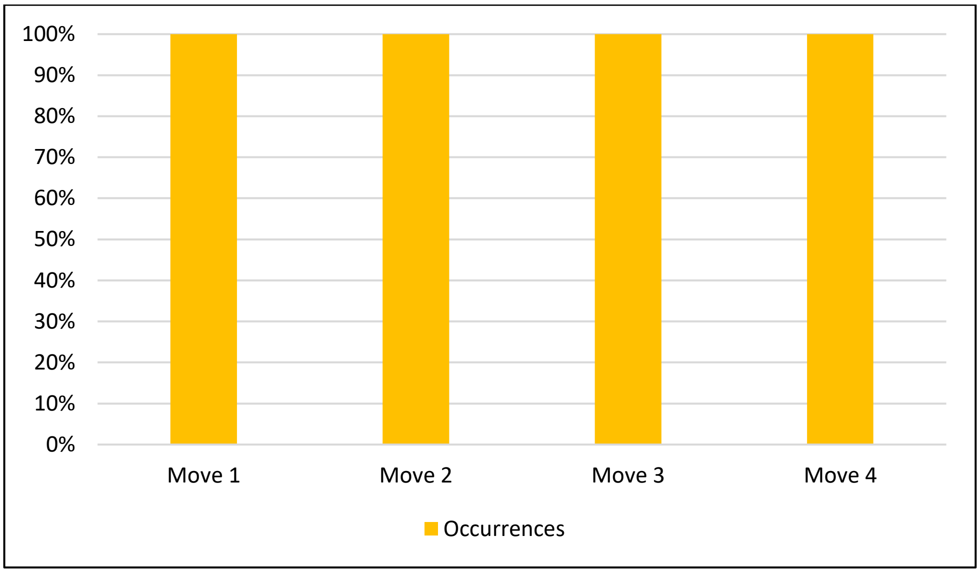

Figure 29. Visual representation of the move distribution in ‘narrative-didactic’ comic books.

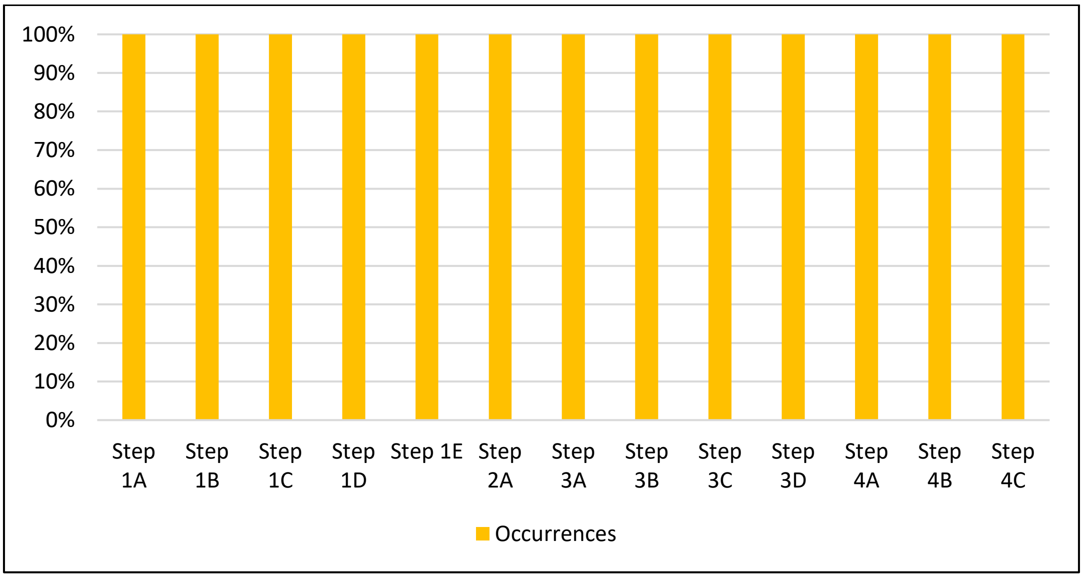

Figure 30. Visual representation of the distribution of the steps in ‘narrative-didactic’ comic books.

4.4.3 Moves and steps position and patterns

In accordance with Nwogu's approach (1991), the division into 'initial', 'medial' and 'final' segments was applied to comic book texts as well. What is more, to gain a more comprehensive understanding of the characteristics exhibited by each sub-genre, 'didactic', 'didactic-narrative' and 'narrative-didactic' comics were kept separate during this phase of analysis.

In 'didactic' comics, Move 1 (Content orientation), Move 2 (Presentation of the necessary background information) and Move 4 (Conclusion) are 'initial' moves, while Move 3 (Topic development) can be categorised as 'final'. Conversely, as far as the steps are concerned, 1A (Context setting), 2A (Reference to shared knowledge), 3A (Statement of the topic), 4A (Main points summary) and 4B (Explanation and relevance of the topic) are 'initial' steps, 1B (Topic announcement), 2B (Attention-grabbing devices), 3B (Definition and/or classification of the topic), 4C (Anticipation of the ensuing contents) and 4D (Description of future scenarios) are 'medial' steps, while 1C (Outline of the contents), 2C (Reference to an anecdote), 3C (Description of the processes/explanation of the issues), 4E (Explanation of the unresolved problems) and 4F (Call for action) are labelled as 'final' steps.

'Didactic-narrative' books are, on the contrary, organised as follows: Move 1 (Reader and content orientation), Move 2 (Presentation of the necessary background information) and Move 4 (Conclusion) are 'initial' moves, while Move 3 (Topic development) is labelled as 'final'. As far as the steps are concerned, 1A (Speaker presentation), 2A (Reference to the historical background), 3A (Statement of the topic) and 4A (Main points summary) can be ascribed to the 'initial' segments, 1B (Scene setting), 1C (Topic announcement), 3B (Definition and/or classification of the topic), 3C (Description of the processes/explanation of the issues), 4B (Explanation of the relevance of the topic) and 4C (Explanation of the unresolved problems) to the 'medial' segments, while 1D (Secondary characters presentation), 3D (Expert interview) and 4D (Call for action) to the 'final' ones.

Finally, as far as the 'narrative-didactic' comics are concerned, Move 1 (Story opening), Move 2 (Presentation of the necessary background information) and Move 4 (Story ending) are 'initial' moves, while Move 3 (Topic development) can be labelled as 'final'. The steps are organised as follow: 1A (Greetings), 2A (Reference to the historical background), 3A (Statement of the topic) and 5A (Return to the storyline: story ending) are labelled as 'initial', 1B (Speaker presentation), 1C (Secondary characters presentation), 3B

(Definition and/or classification of the topic), 3C (Description of the processes/explanation of the issues) and 5B (Call for action) can be defined as ‘medial’, while 1D (Scene setting), 1E (Topic announcement), 3D (Storyline intrusion) and 5C (Final recommendations and links to external resources) are tagged as ‘final’ steps.

Overall, the order and patterns of moves turned out to be stable in all the three sub-genres. Comic books open with one or two sections devoted to the depiction of the context and of the characters, such as *Reader and content orientation* or *Content orientation*, as shown in example 87. These sections are aimed at welcoming readers and providing them with the elements that are essential for the understanding of the whole book. Following this, specialised information is conveyed by initially referring to some background piece of knowledge and by delving into specific subject matters afterwards (see *Presentation of the necessary background information>Topic development*, example 88). Finally, the comic usually ends with a segment devoted to the summary of the main points and to the explanation of the relevance of the issues discussed. This section is placed immediately after the end of the *Topic development* move, as demonstrated in example 89 (*Topic development>Conclusion/Story ending*).

> (87) **Reader and content orientation:** [*While working in his greenhouse, Super Scientist Max Axiom starts thinking about global warming*.] *Hey, I love my greenhouse! Its glass panels help trap the heat of the sun and keep it from escaping. Because a greenhouse traps warmth, I can grow fruit even in a cold winter climate. But did you know that Earth’s atmosphere works something like a greenhouse too* (ES_GlobalWarming)

> (88) **Presentation of the necessary background information:** *10,000 years ago, in Neolithic Age, people practiced an early form of brain surgery known as trepanning. People would drill holes in other people’s skulls! Probably to relieve headaches or something. But if a person did have brain swelling, it might’ve actually helped! Maybe even saved their life! Ew, gross! They didn’t even have soap or painkillers back then! […] For most of history, people thought that the heart was the seat of knowledge, not the brain. Ancient Egyptians knew that if someone had a head injury, that person would behave strangely, but they didn’t know why. […]* **Topic development:** *Okay, but how does that relate to our brains? Cells and body have to work together, and that means being able to communicate. That’s where he brain comes in! When you have billions of cells working together to sustain a single organism, it’s important that they all get the right message. Neurons developed to make this communication possible! There are two possibilities for how neurons first appeared! Either they evolved within metazoa…or the neurons evolved as separate cells, and then joined forces. […] When neurons started working together, the nervous system began to develop!* (B_TheBrain)

(89) **Topic development:** *Another misconception is that ecosystems have a fairly stable equilibrium state, near which they remain. In fact, ecosystems are rarely, if ever, at equilibrium. Nature constantly fluctuates. Change and turmoil, rather than balance, is the rule. Population and communities tend to swing between limits but rarely remain constant. If disturbed, system may change and operate within new limits… and never return to some imagined ideal equilibrium state.* **Closure:** *Nevertheless, we do know a few things about how species interact… and in our next chapter we turn to one of the simplest interactions of all.* (ES_CartoonGuides)

The so-called 'didactic' comics like *The Cartoon Guides*, *Monster Science* and *Adventures in Science* series exhibit a distinct internal organization of moves. Above all, they commence directly with the *Content orientation* move, omitting any space dedicated to the presentation of the speaker, who remains unseen throughout the entire book and act as an external narrator of the issues. Additionally, given that each section of the book is dedicated to the explanation of a different topic, every chapter is characterised by a closed circular structure, which opens with a subsection devoted to contextual description and topic announcement and closes by presenting the most relevant conclusions. A similar structure can also be found in the 'didactic-narrative' comics like the *Max Axiom Super Scientist* series, with the only difference being that the narrator is visible: as a consequence, the opening section of these texts is dedicated to presenting the speakers to the audience, in order to establish a direct connection between the public and the narrating characters.

Looking at the internal arrangement of segments within each move, a diverse range of patterns has been identified. As far as the initial moves are concerned, 'didactic' comics commence by immersing the reader in the depicted context. This involves describing the environment from which the explanation originates (Step 1A), followed by the announcement of the topic under analysis (Step 1B), and concluding with a concise outline of the issues that will be dealt with throughout the chapter (Step 1C). See example 90.

(90) **1A:** *In times gone by, our ancestors saw little difference between living and non-living things. Edible and inedible, that's the thing. They saw volcanoes belch, rivers rush, the sunrise in the morning, the wind moan and sigh, and clouds drop water. So the ancients can be forgiven for seeing a world animated by spirits, can't they? Eventually, at some point, this notion mostly died out... And some people focused their attention on plants and animals alone. There's a name for these people. Weirdos? That, and biologists.* **1B:** *For many centuries, THIS was biology: search, collect, kill, cut, compare, classify. Biologists took on the world from the outside in. […]* **1C:** *Sorry! In our first few chapters, we discuss things you'll never see in everyday life. We start small, on the inside, and work our way out. We'll look at cell chemistry, how cells harness energy, how they regulate them-selves and co-operate through communication, how they store and process information and use it to reproduce, and how life*

evolves. In the end, I promise, everything will fit together in a beautiful structure—and yes, it even includes plants and animals! So what do you say? Let's get organised! (B_CartoonGuides)

'Didactic-narrative' comics are equally characterised by the pattern *Scene setting>Topic announcement*, but they are preceded by a number of steps that intend to familiarise the audience with the fictional characters who will guide them throughout the book. In this case, the order is normally 1A>1B>1C, with the presentation of the main speaker preceding the setting of the scene and the announcement of the topic under analysis, as exemplified in example 91. A comparable sequence of steps can also be observed in the initial segment of 'narrative-didactic' comic books.

(91) **1A:** *While working in his greenhouse, Super scientist Max Axiom starts thinking about global warming.* **1B:** *I love my greenhouse! Its glass panels help trap the heat of the sun and keep it from escaping. [...]* **1C:** *But did you know that Earth's atmosphere works something like a greenhouse too?* (ES_GlobalWarming)

Secondly, as far as the presentation of the background information is concerned, the three sub-genres under analysis display a similar pattern: 'didactic-narrative' and 'narrative-didactic' typically include one single step within this section, which involves referencing the historical background of the issues. On the contrary, 'didactic' comics show a more detailed internal structure: they usually commence by recalling shared knowledge (Step 2A) and subsequently employ attention-grabbing devices like thought experiments, rhetorical questions (2B) or anecdotes:

(92) **2A:** *Everything in the world is made of matter, but matter is made of something too. All matter is made up of tiny particles called atoms. [...]* **2B:** *Imagine a brick wall that is made of individual bricks. Like the bricks, atoms are the pieces that make up matter.* (CHEM_GhostsandAtoms)

Thirdly, as concerns the explanation of the specialised concepts, the order of the constituents turns out to be stable. As shown in the following example (93), authors normally begin by stating the main topic (A), they then proceed to define and/or classify it within the broader context of the discipline (B) and they conclude by explaining various processes and potential challenges associated with those concepts (C). To be precise, in 'didactic-narrative' comics, this type of explanation is often followed by Step 4D (Expert interview): here, the protagonist introduces another character, who represents an expert in the field who further elaborates on the notions (94). Finally, in 'narrative-didactic' comics, where the storyline holds particular significance, another step called *Storyline intrusion* can be observed (95). This specific segment can be inserted in various contexts, such as immediately after the statement of the topic – resulting in pattern 3A>3D>3B>3C – after its classification (3A>3B>3D>3C), or after the description of the challenges posed by the subject matter today (3A>3B>3C>3D).

> (93) **A:** *One can discuss certain properties of an ideal gas: Pressure? What's pressure? […]* **B:** *Pressure is defined as force per unit of area. A force applied to a small area can have more effect than a force spread over a large area. Pressure = force/ area […]* **C:** *Since doubling an area doubles the number of collisions and so doubles the force, force and area go up together, so the pressure is constant throughout the gas.* (CHEM_CartoonGuides)

> (94) **A:** *Scientists worry about what global warming will do to Earth's weather and climate.* **B:** *Weather describes the current state of the atmosphere, such as sunny and warm … or cold, rainy, and windy. Climate describes the average weather of a certain area over many years: dry climate, tropical climate, temperate climate, polar climate.* **C:** *Florida is normally warm and humid, for example. And Antarctica is cold and dry. Climates change over time, but global warming is changing them faster than normal.* **D:** *Let's visit a meteorologist who studies how global warming changes the earth's weather patterns. Hey, Jack. Is the world getting warmer?* (ES_GlobalWarming)

> (95) **3A:** *So then, what are the differences between Oligodendrocytes and Schwann cells?* **3B:** *The main difference is that Oligodendrocytes are found in the central nervous system and can support and protect up to 50 axons at time!* **3C:** *Oligodendrocytes send off branches from their cell body that wrap around different axons. On the other hand, Schwann cells are found in the peripheral nervous system and only wrap around one axon.* **3D:** *Hi! Would you like to purchase some homemade cookies to send kids like me to camp? Sure, give me two bags! Nice, we might win this thing! Stop right there, Troop 7 scum! What have you done with my sister? Trying to distract us, Nour? No dice! I'm going to win the "Junior Vice President of Marketing and Sales" patch …and there's nothing you can do to stop me!* (B_TheBrain)

Finally, as far as the closure of the book is concerned, 'didactic' and 'didactic-narrative' comics employ different approaches. One possibility, as illustrated in example 96, is to commence by explaining the relevance of the discussed topics (B), followed by summarising the main points (A) and eliciting actions or responses from the public (F). Another option is to begin by recalling the aspects covered in the preceding pages (A), and then anticipating what will come next (C), as in (97). Finally, as demonstrated in example 98, authors often also dedicate space to describing unsolved problems (E), envisioning possible future scenarios (D) and issuing a call to action (F).

> (96) **B:** *Global warming is a serious issue,* **A:** *but we can find solutions for our environmental problems. For example, today, scientists search for solutions to global warming by testing*

energy sources that don't release greenhouse gases. **F:** *And we can all do things to help reduce our impact on the atmosphere. For instance, reuse or recycle paper, plastic and metal. Whenever possible, walk, bike or use public transportation instead of riding somewhere in a car. Plant and protect trees, they will use the carbon dioxide we release. Turn of appliances and computers if you're not using them. And most important, learn more about the environment and tell people what you learn. Working together we can take positive steps toward solving the problem of global warming.* (ES_GlobalWarming)

(97) **A:** *Whew! We've covered a lot in the last 172 pages... We've talked about the basic ingredients of life, from electrons and protons up to macromolecules... We've shown how photo synthesisers build sugar from inorganic raw materials and how organisms get energy by oxidising that sugar. We've seen how organisms communicate, both within them-selves and with the outside world, to find food and maintain homeostasis.* **C:** *Let's see what we have left… Oh, right! I almost forgot life's most amazing feat of all: reproducing itself, generation after generation, for nearly four billion years and counting!* (B_CartoonGuides)

(98) **E:** *These efforts, while praiseworthy, are, uhm, a droplet in the ocean. Clearly, an enormous amount of work needs to be done. Equally clearly, it will take political effort, the engagement of governments and other organised groups. […]* **D:** *This much we can say for certain: biologists will be at the heart of all ecosystem management.* **F:** *And there's plenty left to discover. Today's scientists follow the trails blazed by Mendel, Darwin, Watson, Crick, Franklin, Woese, Washington, Margulis, Earle, and the rest — and we blaze new trails of our own! Who knows what's still out there, waiting to be found? Or where it will lead? Or who will find it? It just might be you!* (B_CartoonGuides)

'Narrative-didactic' comics, on the contrary, open the final section of the book by going back to the initial storyline (Step 5A), which had been temporarily set aside in the central part of the text to make room for the explanation of specialized concepts. Subsequently, they use the last pages of the book to directly address the public: this is done by encouraging them to act (Step 5B) and by providing suggestions regarding appropriate behaviours and additional useful resources (Step 5C). The pattern observed in this case is 5A > 5B < 5C, as exemplified in (98).

(99) **Topic development**: *The light bends when it passes through raindrops, and the spectrum of visible light can be seen broken up, from red to violet. There needs to be specific conditions for a rainbow to appear. You need to be facing away from a light source at a low angle, with liquid rain droplets in the air. […]* **5A:** *For those of you at home, Connie and I got our own private rainbow! Well! This has been the most informative Channel 6 news at ten we've ever had! It sure has, thanks Norman! Thank you, Connie! We'll be back in a minute with Randy Billows with sports!* **5B:** *Hey! Some of what wild weather stuff we just discussed can be pretty scary to think about! If you're nervous about any situation in this book it helps to make a plan about what to do in case of emergency. Talk to your family about what sort of emergency situations are likely where you live.* **5C:** *Ready.gov has guidelines for all kinds of disasters, like fires, droughts, tornadoes, tsunamis, hurricanes, and even super-rare stuff like space weather!* (ES_Wildweather)

4.4.4 Moves and steps description

Reader and content orientation, labelled as M1, serves as an obligatory move opening 'didactic-narrative' texts. It consists of four obligatory steps that are devoted, respectively, to introduce the speaker (1A, example 100), set the scene (1B, example 101), introduce the topic (1C, example 102) and to bring secondary characters into the spotlight (1D, example 103). The main aim of this move is twofold: to establish a connection with readers by grabbing their attention and to provide contextual orientation for the ensuing action.

(100) *Super scientist Max Axiom begins thinking about chemical reactions* (B_BasicsofCellLife)

(101) *While trekking through a vast canyon, Super Scientist Max Axiom finds himself on an exploration into Earth's ecosystems.* (ES_ExploringEcosystems)

(102) *It's amazing how many things we have around us. [...] But what's even more amazing is that it's all made of the same stuff. Everything you see – every chair, book, and speck of dust – is made of matter.* (CHEM_States of matter)

(103) *Hey Nick, help me lower the plankton net.* (B_BasicsofCellLife)

The move named *Content orientation*, retrieved in 'didactic' comics only, holds its place as an obligatory component within the introductory section of the book. Its primary rhetorical aim is to acquaint the audience with the topic at hand: authors thus start by providing contextual information on the topic (Step 1A, *Context setting*), as shown in example 104, then proceed to explicitly disclosing the subject matter of the book (Step 1B, *Topic announcement*), as in (105), and finally conclude with a step referred to as *Outline of the contents* (1C), in which authors provide a comprehensive list of the topics that will be covered in the book (106).

(104) *Our story begins in a place that's been called the most far-flung inhabited island in the world: Easter Island, a 64-square-mile speck in the Pacific Ocean, 2300 miles from anywhere.* (ES_CartoonGuides)

(105) *Suddenly, at some point, the wood bursts into flame. Where did THAT come from? How do beans turn into malodorous intestinal gas? CHEMISTRY is the science that answers that question, and chemical reactions are the strange transformations that reveal matter's hidden properties.* (CHEM_CartoonGuides)

(106) *In our first chapters we discuss things you'll never see in everyday life. We start small, on the inside, and work our way out.* (B_CartoonGuides)

Story opening, referred to as M1 in 'narrative-didactic' texts, constitutes an obligatory move retrieved in the initial sections of these texts. Through this segment, composed of five obligatory steps, authors provide the audience with all the pieces of information that are necessary for the understanding of the contents. Unlike other sub-genres, where the presentation of the speakers, the description of the setting and the announcement of the topic are presented separately, in these texts they become interconnected with the storyline. Consequently, five distinct steps can be identified within this move: 1A (Greetings), 1B (Speaker presentation), example 107, 1C (Secondary characters presentation), example 108, 1D (Scene setting), example 109, and 1E (Topic announcement), example 110.

> (107) *For more information, we turn to Channel 6's Stormy Norman Weatherby!* (ES_Wildweather)
> (108) *Tonight! It's the best darn news team in the tri-state area! Chase Mc Cloud! Connie Trales! Randi Billows with sports! And, Stormin' Norman Weatherby!* (ES_Wildweather)
>
> (109) *Tonight! Everybody's talking about just one thing, and that's… Snowpocalypse 20XX! That's right, tonight the tri-state area is about to get slammed with snow!* (ES_Wildweather)
>
> (110) *So much for GLOBAL WARMING! Ha-ha! […] Darn it, Chase! That's not how global warming works! […] You're a grown man – you ought to know this by now! I have a master's degree, I'll explain it to you!* (ES_Wildweather)

Presentation of the necessary background information turned out to be present in all the texts comprised in the corpus. Typically serving as an introductory segment within the main body of the text, it gradually presents the public with the topic discussed in the ensuing pages. In this segment, authors either start by referring to shared knowledge (111), as in 'didactic' texts, or mention the historical developments of such issues to show how far the studies on that topic have come (112). In 'didactic' comics, writers also employ attention-grabbing devices such as thought experiments, rhetorical questions (113) and engaging anecdotes (114) to titillate the public's attention and elicit their interest.

> (111) *We know that water is always made up of two hydrogen atoms and one oxygen atom.* (CHEM_GhostsandAtoms)
>
> (112) *In the past, biology focused on the structure and classification of individual organisms. Now, the subject embraces all levels of life, from tiny molecules to great ecosystems. In the past, biologists were inspired by the desire to improve food supplies, cure disease, and (of course!) Satisfy their own curiosity. Now we have a fourth motivation: to preserve our posterity.* (B_CartoonGuides)

(113) *Imagine a brick wall that is made of individual bricks. Like the bricks, atoms are the pieces that make up matter.* (CHEM_GhostsandAtoms)

(114) *Personally, I was first struck by decaying meat!* (CHEM_CartoonGuides)

Topic development, then, constitutes an obligatory move that is found in all the three sub-genres under analysis. This segment contains the detailed description and explanation of the specialised contents discussed in the book. It is usually accomplished through three main steps, namely *Statement of the topic*, in which authors introduce the issue (115), *Definition and/or classification of the topic*, in which they classify it within the broader context of the discipline (116), and *Description of the processes/ Explanation of the issues*, where they present the possible challenges and problems connected with such matters (117). What is more, in 'didactic-narrative' comics, an additional step contributes to the development of this move: *Expert interview* (118), in which the protagonist introduces another character who represents an expert in the field – this figure further explains such concepts, thereby reinforcing the validity of such arguments. Finally, in 'narrative-didactic' texts, given the significance of the storyline within this context, another step emerges: *Storyline intrusion* (119), in which the narration of the plot enters the explanation of the specialised contents, thus blending the narrative elements with the didactic aspects.

(115) *Now that we've covered the brain's evolution, we can get on to the good stuff! Braaaains!* (B_TheBrain)

(116) *There are two main types of brain cells: neurons and glial cells! Neurons are the cells that can send messages through chemical and electrical signals. They are capable of moving muscles, interpreting stimuli, learning-even creating thought itself!* (B_TheBrain)

(117) *When the neuron is stimulated, little channels open that let the positive and negative ions swap. The swapping of positive and negative ions is what triggers action potential! This conversion of chemical energy into electrical potential-the action potential- is what passes down the axon of the neuron to the axon terminal.* (B_TheBrain)

(118) *Let's visit an environmental scientist who can tell us more about carbon dioxide. Hey, Amy! What are you looking at?* (ES_GlobalWarming)

(119) *[…] Procedural memory is the memory of skills, or how to do something. FATHER! Nour, we've talked about you sneaking up on people. I cannot help I have the natural skills of a ninja. Well, I guess, I'm going to need more groceries now. Go to the shop and get me some more milk, eggs and sugar.* (B_TheBrain)

Moving on, the moves tagged as *Conclusion* and *Story ending* represent the concluding segments of the comics. The so-called *Conclusion* is present in both 'didactic' and 'didactic-narrative' comics and serves as the space in which authors summarise the main points covered during the explanation (120), clarify the relevance of such issues (121), mention a number of unresolved problems (122) and elicit actions from the public (123). In addition, in 'didactic' comics two other steps contribute to the development of this move: *Anticipation of the ensuing contents* (124), in which authors list the issues that will be covered in the following chapters, and *Description of future scenarios* (125) where they draw people's attention to possible future scenarios.

> (120) *We covered a lot in this chapter. We met acids and bases, measured their strength, and saw how that strength is related to their ionisation in water. We neutralized, titrated, and looked at the resulting salts. We saw how acids and bases affect a salt's solubility, and how buffers are made by combining weak acids and salts. Enough to give me a headache...* (CHEM_CartoonGuides)

> (121) *Plants hold a special place in the world. Their ability to turn sunlight into food places them at the base of most food chains. A food chain shows how energy moves from one living thing to another through food. A blade of grass starts a food chain. A grasshopper breakfasts on the grass. A mouse lunches on the grasshopper. The mouse then becomes dinner for a hawk.* (ES_Secretlivesofplants)

> (122) *Today, deer numbers have risen in the US. Overpopulation leads to lack of food. The hungry deers mow down plants and trees, which may never come back. Humans also change the face of Earth by cutting down forests, turning prairies to farmland and building on wetlands.* (ES_ExploringEcosystems)

> (123) *Remember, we're all members of an ecosystem, and everything in an ecosystem is connected. We must all do our parts to care for the plants, animals and environment around us.* (ES_ExploringEcosystems)

> (124) *In the next chapter, we'll explore some great uses of the concepts and the constant of equilibrium, and in the chapter after that, we'll dig deep and discover what equilibrium really means.* (CHEM_CartoonGuides)

> (125) *In the past, we always assumed that our ingenuity would create solutions to provide for future generations, but can this go on indefinitely? At some point, we have to face the fact that we are just a part of a limited biosphere. In the long run, this can mean only one thing: a no-growth economy, in which people enjoy a good quality of life but don't consume so much stuff. We'll grow environmental business! […] Population continues to grow, and nearly half the new mouths will be in China, India, Pakistan, Bangladesh, and Nigeria, all countries with water problems and degraded ecosystems.* (ES_CartoonGuides)

The so-called *Story ending*, instead, is unique to the 'narrative-didactic' sub-genre. It serves the purpose of concluding both the narrative and explanatory aspects of the comic, and therefore is realised by three different steps. *Return to the storyline: story ending*, in which authors revisit the plot that was interrupted in the central part of the text to make room for the explanation of specialized concepts. *Call for action*, used to encourage readers to apply the knowledge gained from the comic in their everyday lives, and *Final recommendations and links to external resources*, through which authors offer suggestions and provide links to external resources that can enhance people's understanding of the subject matter. These steps are exemplified, respectively, in examples 126, 127 and 128.

> (126) *Well, that was a great speech! Very inspiring! I'm going to use all this newfound knowledge to make myself a better person! See ya! Not so fast, my dear! There's still the matter of that precious, clever little brain of yours ... But...but...why do you even want my brain anyway?* (B_TheBrain)

> (127) *Remember, we're all members of an ecosystem, and everything in an ecosystem is connected. We must all do our parts to care for the plants, animals and environment around us. None of us can do it alone. Reduce your impact!* (ES_ExploringEcosystems)

> (128) *It's impossible to prevent a volcanic eruption. But knowing when one will happen can save lives. The U.S. Federal Emergency management Agency has tips for people giving near a volcano. Wear long-sleeved shirts, pants, and a dust mask. Follow evacuation orders by local officials. You should also have a disaster kit prepared. It should include a first-aid kit, a radio, flashlights, batteries, blankets, goggles, and breathing masks.* (ES_Whenvolcanoeserupt)

4.4.5 Discussion of the results

The results displayed in the preceding sections (4.4.1 to 4.4.4) allowed for the retrieval of a series of observations concerning the discursive configuration of scientific popularisation in comic books about chemistry, biology and Earth sciences.

First and foremost, finding a well-identified set of moves and steps, with recurrent patterns and specific locations, brought to light a series of discursive strategies for the transmission of the contents that testify that popular science in comics, like in blogs and educational videos, drastically deviates from the so-called 'canonical account' (Shapin 1990) or 'dominant view' (Hilgartner 1990; Lewenstein 1995) of science popularisation. On the contrary, people are seen as active participants in the process of knowledge transmission and, as a consequence, specialised notions are presented by employing a well-established *dispositio* (Załęska 2016) of the concepts and specific discursive strategies, which aim at removing the barriers that an average non-expert receiver normally encounters when dealing with such specialised information. At the same time, though, as part of the 'knowledge reconstruction' activity, authors also pay specific attention to stimulating their public's attention and to making them become emotionally engaged with the concepts, on the basis of the idea that "the more attractive the communication, the bigger the number of recipients" (Załęska 2016: 34).

To adequately educate the audience, authors adopt, above all, a well-identified explanatory structure for the presentation of the concepts. These matters are told by a narrator – either an external narrator or a character within the book representing a scientist or a non-human agent – who acts as an informed person with full knowledge on the subjects under analysis. To convey such contents, they usually start by inserting one or two moves devoted to the orientation of the readers, then turn to the presentation of some background pieces of information that are useful for the understanding of the main concepts, and end with a section dedicated to the conclusions, with some final comments on the subject matter.

To create appealing and easily comprehensible texts, authors present the domain-specific contents by employing a deductive rhetorical pattern and by selecting the pieces of information that are of particular importance for the non-specialist receiver. As far as the first aspect is concerned, a clear example of this type of pattern can be found in the moves situated in the central part of the texts, which normally unfold in several consecutive steps that are devoted, respectively, to the statement of the issue, its definition and classification, and the explanation of a number of related problems. As far as the second aspect is concerned, though, one of the most important features of comics (namely the presence of sequenced frames and balloons, as indicated by McCloud 1993) forces authors to break down the information into more digestible units, therefore omitting elements such as the in-depth description of materials and methods of research: this is done to allocate this space to the emphasis on the relevance of such topic, the summary of the main points covered in the book, or to the explanation of a number of unresolved problems and their relevance for people's everyday lives.

To emphasise the credibility of such explanations, authors also insert interviews with fictional professional scientists working in laboratories or research centres. This step is usually found within the *Topic development* move, which is normally placed after the introduction, definition and classification of the issue under analysis.

Finally, authors always make efforts to establish a link with people's everyday lives. This is accomplished, first of all, through the step labelled as *Call for action*, in which the speaker addresses the readers directly, inviting them to take action against a specific problem or to act responsively for the development of the society. At the same time, this is also achieved through the steps identified as *Final recommendations and links to external resources* in 'narrative-didactic' texts (in which the speaker provides links to real-life websites containing useful pieces of information on such matters) and through the so-called *Description of future scenarios* (in which the narrator depicts a number of different circumstances, with the specification of the impacts such aspects could have on people's everyday lives).

Turning to the *delectare* function (Załęska 2016: 35), comics reach this goal by relying mainly on visuals and images. However, since, as stated at the beginning, in comic art, graphics and words are intertwined and deeply influence each other, entertainment features can also be found in the textual parts of the books.

One of the most important strategies is the use of storytelling, which intertwines with the explanation of specialised contents. This is especially evident in 'narrative-didactic' comics, where the opening and closing segments of the books are devoted to the development of the plot, which, in its turn, constitutes the starting point for the transmission of the specialised pieces of knowledge. In 'didactic-narrative' texts, however, the explanation of the concepts is embedded in the development of the story and the reader gets informed on such specialised matters by following the evolution of the adventures of the main character. According to Farinella (2018: 6-7), employing such technique acquires a role of the utmost importance for engaging and amusing the public because it tackles people's emotional mechanisms, bringing them to identify themselves with both the story and the characters. This process, defined as 'emotionalisation' (Friesen, Van Stan & Elleuche 2018), 'identification' (Farinella 2018) or 'personification' (Jee & Anggoro 2012), enables readers to engage with subjects that would otherwise be perceived as too distant from the everyday lives, and that, as a consequence, could both trigger an individual information-seeking process and stimulate real-life discussions.

Nevertheless, in comics such as the *Cartoon Guides* or the *Adventures in Science* series, where storytelling techniques are not employed, the attention of the audience is grabbed through the employment of the *Reader and Content orientation* and the *Content orientation* moves, where the main characters are introduced, the setting is depicted, the topic is announced and the main points discussed are listed. What is more, in this specific type of comics, the quotation of hilarious anecdotes and the insertion of techniques such as thought experiments and rhetorical questions make the explanation of the contents more enjoyable.

Subsequently, once authors have attracted people's attention, it becomes crucial for them to maintain that interest by employing various strategies. Firstly, they utilize a step called *Anticipation of the ensuing contents*, which provides a glimpse into what will be covered in the upcoming chapters or sections. Another strategy is the incorporation of historical background in the narrative. This is Step 3A in 'didactic-narrative' books and Step 2A in 'narrative-didactic' comics. The inclusion of historical context plays a pivotal role in this context as it demonstrates the progress and advancements within the field being discussed.

Lastly, evidence from the textual analysis also allowed for the identification of three distinct sub-genres of the popular science comic book: as stated in paragraph 4.4.1, they are labelled as 'didactic', 'didactic-narrative' and 'narrative-didactic' texts, and they are characterised by various differences in terms of the internal discursive organisation.

The first category is represented by the so-called 'didactic' books, to which the *Cartoon Guides, Monster Science* and *Adventures in Science* comics belong. As stated by Farinella (2018: 7), these texts rely on the expository/argumentative structure of traditional scientific texts, with an external narrator acting as an omniscient instructed voice which assumes the position of a teacher and transmits the specialised contents. In these comics, writers do not create a story that unfolds along the book, but the scientific concepts are introduced sequentially, moving from the most basic ones at the beginning to the most complex ones at the end of the book: this is the case, for example of the comic book *The Cartoon Guides to Chemistry*, where the initial chapters deal with notions such as matter and ingredients, while the final ones talk about organic chemistry and logarithms. In an analogous fashion, graphic elements are employed, here, only to facilitate the understanding of each specific concept, and do not tell a story that develops sequentially within the frames: Farinella (2018: 9) defines this process as 'visual explanation'. What is more, the balloons are very rarely used in this context and usually serve as the place in which short comments or humoristic elements are introduced: on the contrary, all the specialised technical matters are explained within the rectangles on top of each frame. As far as their discursive configuration is concerned, their three main constitutive parts – introduction, body and closure – are composed of a total of 4 moves, with the opening one devoted to the depiction of the setting and to the announcement of the issues under analysis, the two central ones to the presentation of some background pieces of information and the explanation of the topics, and the concluding segment to the summary of the main points, the announcement of the ensuing contents and the stress on the importance of such topics for people's everyday lives. In these comics, though, each chapter works as an independent unit with a circular information structure: therefore, every time a new section begins, elements that orient the reader are placed before the main explanation of the contents and various concluding messages are located in the end. Furthermore, this type of explanation also employs mechanisms that are typical of didactic settings, such as the outline, the summary and the anticipation of the contents, which are aimed at facilitating people's understanding and connection of the different issues. Finally, to make the texts more appealing to the public, authors rely on the use of attention-grabbing mechanisms such as rhetorical questions and though experiment.

The second sub-genre within the science comics category is the one of the so-called 'didactic-narrative' texts: this is the case, for example, of the comics belonging to the *Max Axiom Super Scientist* series. Following the definitions by Farinella (2018), these texts both rely on the expository/argumentative structure of traditional scientific texts and insert a more character-driven narrative. In these comics, the explanation of the contents is entrusted to the voice of the main character, Max Axiom, a scientist with super powers and a white lab coat, who tells about the different scientific issues through the narration of his own adventures: as a consequence, the story and the didactic elements develop simultaneously along the book and the reader is informed on such specialised matters by following the evolution of his adventures: this is the case, for instance, of the book *Understanding Global Warming with Max Axiom Super Scientist*, where the explanation of global warming and related issues originate from the protagonist's observation of his own private greenhouse. In relation to the role and use of the graphic elements, they follow the development of the plot and the explanation of the concepts, thus evolving sequentially within the frames: in the words of Farinella (2018: 9) this is, again, an example of 'visual narrative'. More specifically, in this context, speech balloons represent the space dedicated to the transmission of the specialised concepts, while all the elements serving as orientation are described in the rectangles on top of the initial frame. As far as their discursive configuration is concerned, their three main constitutive parts are composed of a total of 4 moves, with the opening one devoted not only to the setting of the context and the announcement of the issues under analysis, but also to the presentation of the speaker and other relevant characters. The three remaining segments, then, are, as in the case of 'didactic' comics, dedicated to the presentation of some background pieces of information, the explanation of the topics and the summary of the main points. Similarly to the previously mentioned sub-genre, each chapter works as an independent unit with a circular information structure: consequently, every time a new section begins, elements that orient the reader are placed before the main explanation of the contents and various concluding messages are located in the end. Finally, when looking more closely at the internal disposition of the segments, it can be noted that 'didactic-narrative' comics employ elements that are typical of the 'didactic' sub-genre, such as the summary of the points covered in the chapter, the explanation of the relevance of the topic, the description of a number of unsolved problems and the invitation for readers to take action.

Ultimately, one last sub-genre retrieved in this corpus is the 'narrative-didactic' comic, which is represented, in this context, by the books belonging to Macmillan's *Science Comics: Get to Know Your Universe!* series. In this case, the narrative element is prominent, and authors detach themselves from the expository/argumentative structure of traditional scientific texts, opting for a more dynamic and character-driven narration. In these comics, the opening and closing segments of the books are devoted to the development of the plot, which, in turn, constitutes the starting point for the transmission of the specialised pieces of knowledge: this is the case, for example, of the book *Wild Weather: Storms, Meteorology and Climate*, where the TV announcement of the arrival of a massive snowfall in the city becomes the starting point for talking about weather phenomena and climate change. The explanation of the specialised contents is entrusted to the voice of a well-identified character, which can be both human – as Stormy Norman Weatherby in the book *Wild Weather: Storms, Meteorology and Climate* – or a personified non-human entity – as Dr. Cerebrum in *The Brain: The Ultimate Thinking Machine*. As concerns the role of the graphic elements, as in 'didactic-narrative' comics, they follow the development of the plot and the explanation of the concepts, therefore evolving sequentially within the frames: in the initial and final segments of the comic, the images thus portray the characters and the setting of the story, while in the 'Body' of the text, the graphic elements represent the scientific concepts under analysis (e.g. tornadoes, types of clouds, instruments for weather prediction). As a consequence, following the classification proposed by Farinella (2018: 9) this is, again, an example of ‘visual narrative’. Furthermore, the balloons thus indicate both the space devoted to the transmission of the specialised concepts and the place for real dialogues: consequently, technical explanations are found in both the rectangles on top of each frame and in the white balloons that portray the various conversations between the characters. In the end, as far as their discursive configuration is concerned, their three main constitutive parts – introduction, body and closure – are composed of a total of 4 moves, with the opening and closing segments devoted to the narration of the plot, while the two central ones to the explanation of the specialised contents. However, differently from the two sub-genres analysed above, there are no chapters in this book with a closed and circular informative structure, but the narration and explanation develop for the entire length of the comic. Lastly, when looking more closely at the internal disposition of the segments, it can be noted that ‘narrative-didactic’ comics employ several strategies that are specific to this type of comics, such as the presentation of the main speaker and the secondary characters, the setting of the scene and the intrusion of the storyline within the explanation of the specialised concepts.

All in all, it can therefore be said that analysing comics from the point of view of the Structural Move Analysis approach made it possible to retrieve a number of observations that confirm that this genre can successfully be applied to the transmission of specialised science-related contents, thus dismantling the idea advanced by scholars such as Vilchez-Gonzales and Perales Palacios (2006), who claim that this medium distorts not only specialised knowledge but also the view people have on the work of scientists and scientific matters.

Chapter 5

Exploring the rhetorical *elocutio*: a corpus-assisted investigation

The present chapter is devoted to the analysis of the data retrieved from the *Science Popularisation Corpus*. The aim is to examine the discursive and rhetorical configuration of the three media under analysis from a micro-textual point of view, namely at the level of their *elocutio*. This analysis is made possible thanks to the employment of corpus linguistics tools and methodology to the study of the texts, as specified in paragraph 5.1. On the one hand, sections 5.2 and 5.3 are devoted to the presentation of the results concerning the linguistic items rendering the rhetorical aim of *docere*, namely self-mentions and definitions. Sections 5.4 and 5.5, on the other hand, focus on the study of the *delectare* function and display the research conducted on questions and reader pronouns. These paragraphs are then further divided into smaller segments that report, respectively, the results that stem from blogs, YouTube video scripts and comic book texts: when presenting such outcomes, the chapter provides information on both their frequencies of occurrence and on the discursive functions associated with each item under analysis.

5.1 Popular science and the *elocutio* of the contents

As evidenced in the previous chapters, scientific popularisation is a communicational activity aimed at the democratisation of science-related knowledge, in which processes of content *re-contextualisation* and linguistic *re-formulation* (Gotti 2014) take place to enable the expert-public transfer of information. As a consequence, specific attention must not only be paid to the discursive *dispositio* of the contents, but also to the linguistic items employed for discourse framing and information tailoring purposes, since, as claimed by Hyland (2010: 117), language constitutes "a form of technology, or a resource for controlling an environment, by presenting interpretations and positioning participants in particular ways to establish knowledge". Additionally, language also plays a pivotal role in the decision-making processes: in the words of Corner and Hahn (2009: 199), "many of the most important decisions we make (as individuals or as a society) are rooted in our understanding and evaluation of scientific evidence, arguments, and claims". Against this backdrop, it thus becomes imperative to carefully analyse the texts at a micro-textual level of analysis, since the linguistic choices and the language items employed in these contexts have a profound impact on the way information is presented, interpreted and evaluated by both individuals and society as a whole.

This micro-textual level of analysis corresponds to the study of the *elocutio* (Załęska 2016: 39), which, according to the ancient model of text construction, constitutes the third stage of discourse organisation and concerns the correct deployment of words and phrases for effective writing and speech delivery (Lanham 1991: 144). Investigating the texts from this perspective allows for the retrieval of the techniques and strategies that lexicalise the rhetorical goals of *docere* – to educate (Załęska 2016: 34) – and *delectare* – to engage (Załęska 2016: 35) – which, in the specific context of popular science, represent the two core elements for effective knowledge transmission.

To this aim, the present analysis harnesses the methodology and tools of corpus linguistics, such as frequency lists, collocates and concordance lines, to quantitatively and qualitatively study the discursive strategies employed in blogs, YouTube video scripts and comic books about science. More specifically, for the study of the *docere* aim, under scrutiny are self-mentions and definitional patterns, while reader pronouns and interrogative utterances are taken into consideration for the study on the so-called *delectare* rhetorical goal. The outcomes of this study are presented in the following sections 5.2, 5.3, 5.4 and 5.5.

5.2 Reaching the *docere* aim: the role of self-mentions

First of all, self-mentions were taken as the starting point for the analysis on the techniques that lexicalise the *docere* rhetorical aim.

As stated by Hyland (2001b, 2005, 2008), self-mentions refer to the employment of 1st person personal and possessive pronouns to present propositional, affective and interpersonal information. Generally speaking, including or excluding authorial references in the texts is a writer's conscious choice, which affects both the conceptual meaning they are conveying and the impression they make on the readers. According to Ivanic (1998) self-mentions are central to the writing process since they project an impression of the writers and of how they stand in relation to the arguments. More specifically, they enable them to publicly show their level of authority, their personal commitment on the topic and provide also a clear indication of the perspective from which the statements should be interpreted (Kuo 1999; Hyland 2001; Fu & Hyland 2014). However, it is important to note that the frequencies and functions of such devices may vary across different media: the ensuing paragraphs will examine these variations, illustrating how blogs, YouTube educational videos and comics make use of these items to transmit specialised content to the lay audience.

5.2.1 Authorial presence in blog posts

5.2.1.1 Presentation of the results

The study of the results started with a quantitative analysis on 1st person personal and possessive pronouns in blog posts. On the whole, these specific linguistic items represent 3.5% of the entire population of the pronouns in the subcorpus, as showed in Fig. 31 below.

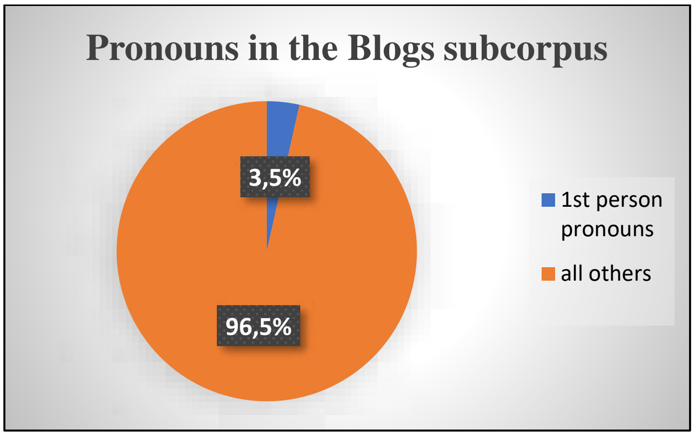

Figure 31. Distribution of 1st person pronouns *I* and *my* in the Blogs subcorpus (pie chart).

From a quantitative point of view, 80 instances of the pronoun *I* and 25 of *my* were retrieved in the corpus. The following table (Tab. 30) provides detailed information concerning their raw frequencies (RF) and also displays the number of occurrences normalised to 10,000 words, which, as stated by Freddi (2014: 81), contributes to a better understanding and interpretation of the data. For a visual representation of such data refer to Fig. 32.

SELF MENTIONS	BLOG POSTS	
	RF	NF (PTT)
I	80	4.7
My	25	1.5
TOTAL	**105**	**6.2**

Table 30. Frequency distribution of 1st person pronouns *I* and *my* in the Blogs subcorpus.

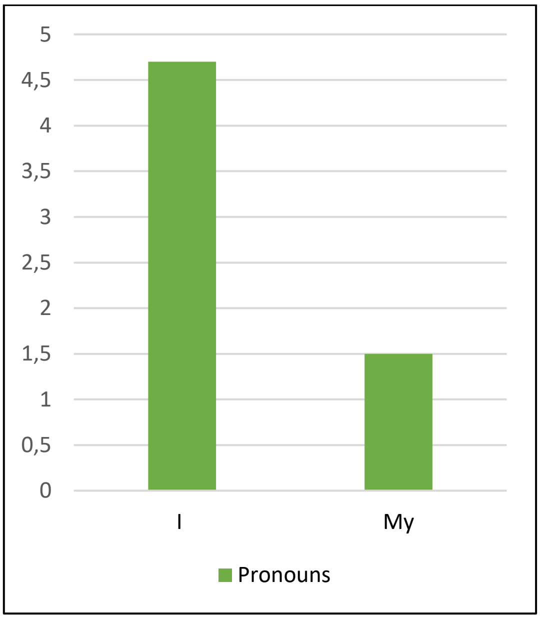

Figure 32. Frequency distribution of the pronouns *I* and *my* in the Blogs subcorpus (histogram).

To gain a more comprehensive understanding of the role played by these items in the construction of the argumentation, a Sinclairian analysis of the left and right co-texts was subsequently conducted (Sinclair 2004).

As far as the personal pronoun *I* is concerned, its right linguistic co-text was examined to retrieve the verbs normally associated with it. This analysis was inspired by the lesson by Tang and John (1999: 524), who state that the role of the speaker within a sentence is not a 'pre-fixed language entity' but is 'chosen' when writing: in this light, looking at the type of verb following the personal pronoun helped detect the type of identity the writer intends to establish within the text. In line with Halliday and Matthiessen's framework (2014), the retrieved verbs were then classified into three main categories: *mental*, *material* and *relational*. Detailed information about their distribution can be found in Table 31 and in the histogram displayed in Figure 33.

VERB TYPES	BLOG POSTS	
	RF	NF (PTT)
MENTAL	49	2.9
MATERIAL	26	1.6
RELATIONAL	5	0.3
TOTAL	**80**	**4.7**

Table 31. Frequency distribution of verb types following *I* in the Blogs subcorpus.

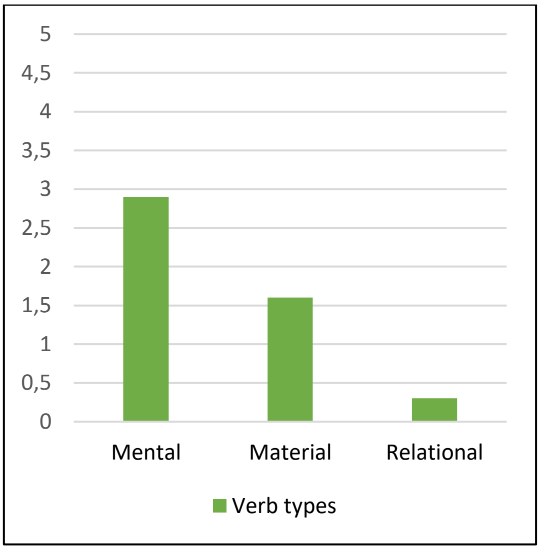

Figure 33. Frequency distribution of verb types in the Blogs subcorpus (histogram).

As we can observe, the most frequent category is that of the so-called *mental* verbs (Halliday & Matthiessen 2014: 197): expressing cognitive processes or states, these linguistic items are central for describing the intellectual and affective aspects of human experience. Within this category, the two predominant types of verbs are the ones belonging to the *cognitive* (31 occurrences) and *perceptive* (13 occurrences) categories, as shown in Tab. 32. In the specific context of science blogs, *cognitive* verbs play a role of the utmost importance because they allow the authors to interpret, analyse and comment on the displayed results critically and thoroughly. On the other hand, *perceptive* verbs serve to provide readers with concrete examples and empirical evidence of the reasonings and discoveries.

Types of mental verbs					
COGNITIVE	**Freq.**	**PERCEPTIVE**	**Freq.**	**DESIDERATIVE**	**Freq.**
Think	16	Notice	5	Hope	3
Realise	3	Observe	5	Want	1
Believe	3	Realise	2	Would like	1
Suppose	2	Suspect	1		
Expect	2				
Consider	2				
Wonder	1				
Consider	1				
Assume	1				
TOTAL	**31**	**TOTAL**	**13**	**TOTAL**	**5**
TOTAL: 49					

Table 32. Mental verb types following *I* in the Blogs subcorpus with raw frequencies.

The second most frequent category is the one of *material* verbs, which typically describe actions or events involving physical processes, material processes and communicative events. The table presented below (Tab. 33) demonstrates that the most frequently observed verbs are the so-called *material process* verbs. In this specific context, they enable bloggers to describe the actions performed during experimental procedures accurately, thereby helping readers better visualise the processes under discussion.

Types of material verbs			
MATERIAL PROCESS	**Freq.**	**VERBAL PROCESS**	**Freq.**
Do	5	Tell	2
Work	5	Say	1
Submit	3		
Join	3		
Develop	3		
Use	2		
Invest	1		
Make	1		
TOTAL	**23**	**TOTAL**	**3**
TOTAL: 26			

Table 33. Material verb types following *I* in the Blogs subcorpus with raw frequencies.

Finally, the least frequent category is represented by *relational* verbs, which are employed to describe a state or feature characterising the subject. As shown in Table 34, only the verb *to be*, labelled as *intensive relational* verb, was retrieved in this context. It was followed by various adjectives expressing the writer’s emotive response to the issues at hand. Through these items, not only are the opinions and viewpoints of the writers made evident, but they are also reinforced. This is because the choice of adjective following the verb adds depth and individuality to the sentence, conveying a strong sense of subjectivity and personal investment in the topics being discussed.

Types of constructs within relational clauses				
	EMOTIVE	**Freq.**	**DESIDERATIVE**	**Freq.**
I am +	Excited	2	Hopeful	1
	Fascinated	1		
	Surprised	1		
	TOTAL	**4**	**TOTAL**	**1**
TOTAL: 5				

Table 34. Intensive relational verb with adjectives following *I* in the Blogs subcorpus with raw frequencies.

Subsequently, an investigation was also conducted on the right collocates of the pronoun *my*, since, as claimed by Hyland (2001: 223) “possessive forms are also used to promote the writer’s contribution by associating them closely with their work”. Right-collocating nouns were therefore classified according to the semantic domain to which they referred and were later ascribes to one of the roles identified by Tang and John (1999). As shown in Table 35, the most frequent category is represented by nouns expressing an opinion (15 instances), which reinforce the expression of the writer’s point of view. Such category is followed by the ones related to the working environment (10 instances), which are used by bloggers to systematically inform the public about research and life in the realm of science.

Types of nouns following my			
OPINION	**Freq.**	**WORK**	**Freq.**
Opinion	7	Research	3
Guess	5	Study	2
Idea	2	Lab	2
Contention	1	Colleagues	1
		Data	1
		Equipment	1
TOTAL	**15**	**TOTAL**	**10**
TOTAL 25			

Table 35. Nouns following *my* in the Blogs subcorpus with raw frequencies.

All in all, the examination of the concordance lines and collocates of the collected data, coupled with the application of Tang and John's (1999) model, made it possible to observe that science bloggers take on several different authorial roles when transmitting specialised contents to the audience. More specifically, this context revealed the presence of four roles previously identified in the aforementioned model: *"I" as the guide through the essay*, *"I" as the recounter of research process*, *"I" as the architect of the essay* and *"I" as the opinion-holder*.

From a quantitative standpoint, the most frequent role turned out to be the so-called *"I" as the opinion-holder*, occurring in 55 cases. This was followed by *"I" as the recounter of research process* (39 occurrences), *"I" as the guide through the essay* (8 occurrences) and *"I" as the architect of the essay* (3 occurrences). For detailed distribution information, refer to Table 36 and the histogram displayed in Figure 34.

AUTHORIAL ROLE TYPE	**BLOG POSTS**	
	RF	NF (PTT)
"I" as the opinion-holder	55	3.1
"I" as the recounter of research process	39	2.4
"I" as the guide through the essay	8	0.4
"I" as the architect of the essay	3	0.3
TOTAL	**105**	**6.2**

Table 36. Frequency distribution of the authorial role types in the Blogs subcorpus.

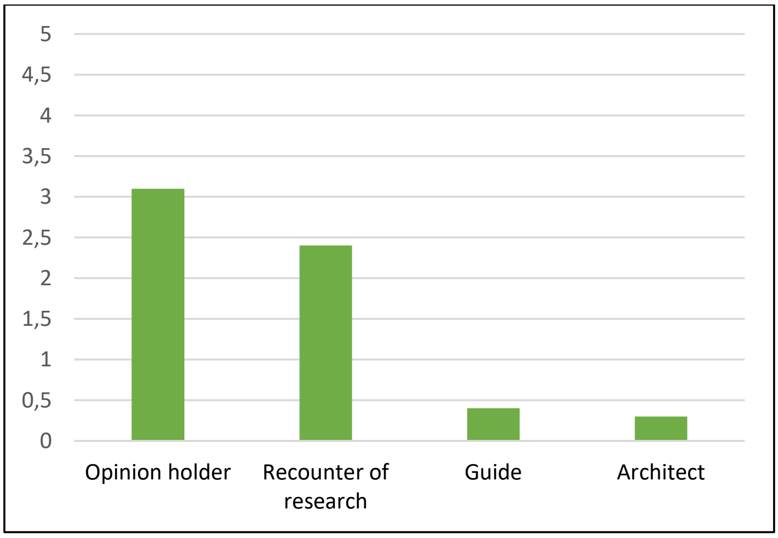

Figure 34. Frequency distribution of the authorial role types in the Blogs subcorpus (histogram).

As stated, *"I" as the opinion-holder* turned out to be the most frequent authorial role in science-themed blogs. This role – which is normally lexicalised through the employment of *cognitive, relational* or *desiderative mental* verbs, as in (129), or by using the pronoun *my* followed by a noun expressing opinion, like in (130) – enables writers to make their opinions and viewpoints visible. By intruding in such way into the text, authors critically interpret and analyse the results, make hypothesis and state their expectations and uncertainties towards the presented scientific evidence. This role thus serves the *docere* rhetorical function (Załęska 2016), since it allows bloggers to ensure that lay people properly understand the meaning and relevance of the issues under analysis, while simultaneously preventing any confusion or misinterpretation of the conveyed information.

> (129) *There's still a lot to figure out with this disease, but* ***I think*** *this new study gets us a long way to understanding how it comes about.* (SNE_2021-01-20)

> (130) ***My idea*** *is that nobody knows what will happen in the future. But for the sake of the future generation, we shall act now to prevent a bigger ecological disaster.* (SNE_2020-01-07)

"I" as the recounter of research process, which turned out to be the second most frequent authorial role in blog posts, is mostly lexicalised through *material process* verbs, as in (131), or by employing the possessive *my* followed by nouns related to the job sphere, such as *experiment*, *research* or *data* (132). This specific authorial role refers to the segments in which bloggers provide insights into methodology, data collection, study design, analysis and research procedures: these aspects collectively contribute to the transparency of science and research, fostering trust in the role and work of researchers and institutions. Additionally, instances employing *perceptive mental* verbs were also retrieved: as in (133), these are the cases in which scientists thoroughly explain the line of reasoning they have followed and the observations they have made during the research phase.

> (131) ***I have developed*** *synthetic biology based-tools for scalable regulation or activation of transcriptionally silent secondary metabolite (SM) gene clusters in filamentous fungi.* (ONB_2020-05-04)

> (132) *In our recent study, published in Genome Biology,* ***my colleagues*** *and I "dig" the databases and identify several new CRISPR-Cas12a loci, which have been harnessed to execute mammalian genome editing functionality.* (ONB_2019-02-08)

(133) ***I realised*** *that the knockout yeast strain I had generated could potentially act as an effective biocontainment platform for yeast.* (SCI_2021-01-10)

"I" as the guide through the essay refers to the author's role in leading and facilitating the reader's journey through the contents. As a guide, the author helps people navigate the information, understand the main points and make connections between different ideas (134). Scientific information can be complex, nuanced and difficult to understand for individuals who do not possess an in-depth scientific background and it can often lead to confusion, misinterpretation and potentially harmful decisions. Therefore, it is the responsibility of science communicators to help readers accurately interpret these domain-specific issues and provide them with the necessary tools to make informed decisions: this involves offering guidance and providing directions throughout the text, ensuring that readers are not only instructed, but also empowered to navigate the complex landscape of scientific information.

(134) ***I want to point out that*** *this molecule will be fundamental in the near future.* (SCI_2020-04-10)

Lastly, the role labelled as *"I" as the architect of the essay* emerged as the least frequent authorial role in the corpus. It pertains to passages where writers provide details regarding the schematic structure of the argument. Through the employment of *material* verbs expressing a *verbal process*, such as *tell* (135), bloggers structure, organise and outline the discourse, metadiscursively guiding non-expert readers through the development of the argumentation. In this specific context, these verbs are usually presented in the future tense, therefore expressing an anticipation of what is to follow.

(135) ***I will tell*** *you all about genetic structures in cells.* (BIOB_2019-02-08)

5.2.1.2 Discussion of the results

The joint analyses of the 1st person personal pronoun *I* and of the possessive pronoun *my* revealed that, in blog posts, authors take on different authorial roles to achieve the *docere* rhetorical goal. Their distribution is visually represented in Fig. 40 below.

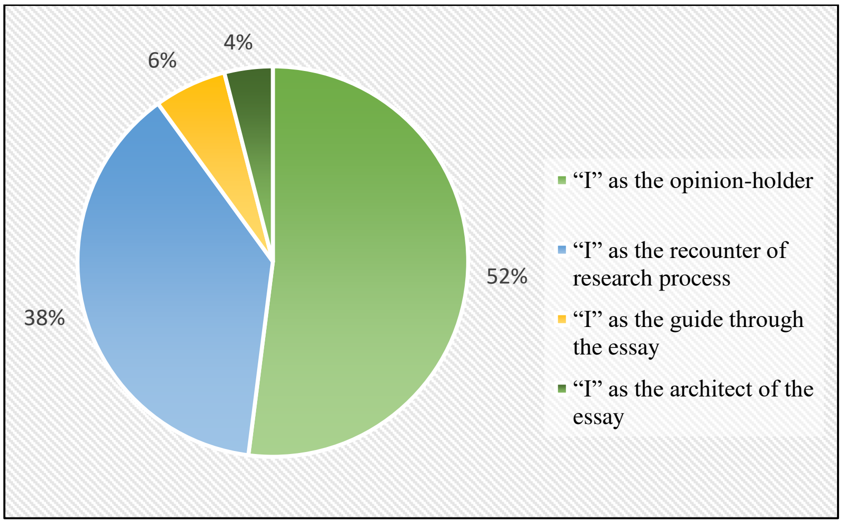

Figure 35. Distribution of the authorial role types in the Blogs subcorpus (pie chart).

As we can observe, when transmitting specialised contents, science bloggers predominantly act as opinion-holders and as recounters of research processes. The presence of these roles reflects the core objective of their mission: going beyond surface-level explanations and offering in-depth and precise insights into the realm of science. As shown, by assuming these roles, bloggers ensure that the public is not only exposed to the intricacies of the various domain-specific contents but is also provided with critical and exhaustive interpretations and evaluations on the topics under analysis.

By adopting the role of *I as the opinion-holder*, authors can express their unique critical viewpoints on the topics under discussion, which both help the public to understand the relevance of the issues under analysis and stimulate critical thinking: this, in turn, positively influences public opinion on science and the work of researchers, while simultaneously fostering informed decision-making processes. At the same time, making their opinion visible to the public also stimulates dialogue, encourages constructive debates and elicits people's active participation in the discussions on the topics.

By assuming the position of *I as recounter of research processes*, then, bloggers also contribute to the bridging of the gap between the Academia and the public. Through this role, authors effectively work as intermediaries, communicating scientific and technical knowledge in a manner that is both accessible and accurate. By offering accounts of research methodologies and experiments, the public not only gains insights into the practical steps of scientific investigation, but also obtains the opportunity to visualise and enhance their understanding of the topics being discussed.

5.2.2 Authorial presence in YouTube video scripts

5.2.2.1 Presentation of the results

In the specific context of YouTube video scripts, 1st person personal and possessive pronouns turned out to represent 6% of the entire population, as shown in the pie chart in Fig. 36.

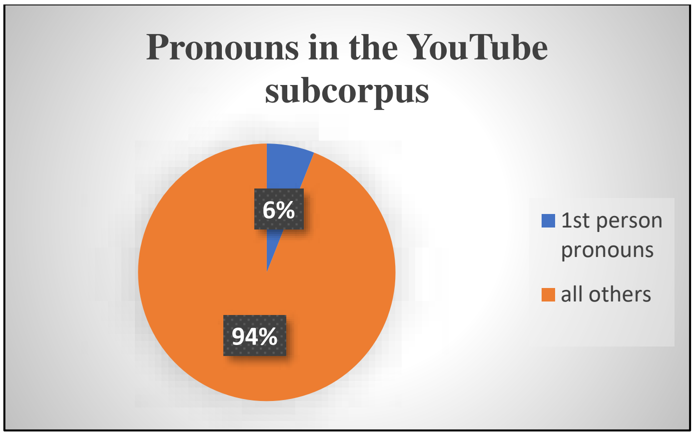

Figure 36. Distribution of 1st person pronouns *I* and *my* in the YouTube subcorpus (pie chart).

From a quantitative point of view, 352 instances of the pronouns *I* and 50 of *my* were retrieved. Detailed information regarding the raw and normalized frequencies can be found in Table 37 presented below, while a visual depiction of this data is provided in Fig. 37.

SELF MENTIONS	**YOUTUBE SCRIPTS**	
	RF	NF (PTT)
I	352	20.6
My	49	2.8
TOTAL	**401**	**23.4**

Table 37. Frequency distribution of 1st person pronouns *I* and *my* in the YouTube subcorpus.

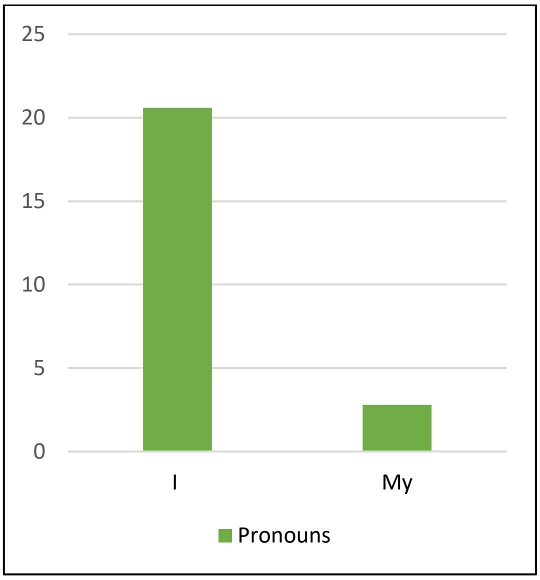

Figure 37. Frequency distribution of the pronouns *I* and *my* in the YouTube subcorpus (histogram).

In terms of qualitative analysis, a Sinclairian study of the left and right co-texts was conducted in this specific context as well, but due to the significant frequency of the pronoun *I*, this part of the study was undertaken on a randomly selected sample of 100 occurrences.

As far as the personal pronoun *I* is concerned, the present analysis made it possible to categorise the right-collocating verbs into *mental*, *material* and *relational* (Halliday and Matthiessen 2014). See Tab. 38 and the histogram presented in Fig. 38.

VERB TYPES	**YOUTUBE SCRIPTS**	
	RF	NF (PTT)
MENTAL	30	1.9
MATERIAL	52	3.1
RELATIONAL	18	1.1
TOTAL	**100**	**6.1**

Table 38. Frequency distribution of verb types following *I* in the YouTube subcorpus.

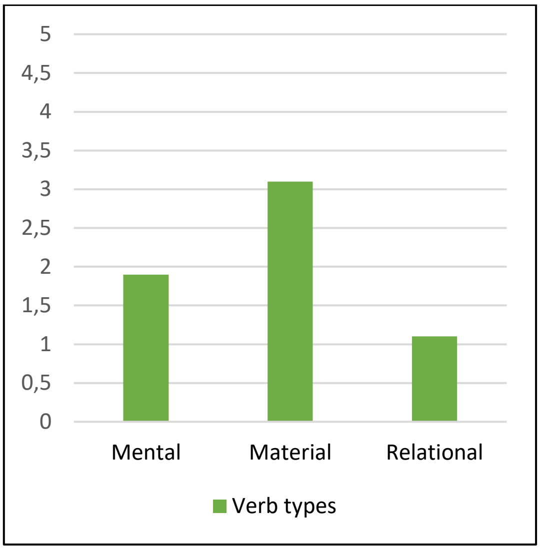

Figure 38. Frequency distribution of verb types in the YouTube subcorpus (histogram).

As we can notice, in the specific context of YouTube videos, the most frequent category is represented by the so-called *material* verbs. Within this macro-category, *verbal process* verbs emerged as the most frequent (35 occurrences). In the context of a spoken-based medium, these verbs allow creators to effectively introduce and convey information, ensuring a coherent structure of the video that is easily comprehensible to the audience. Following this category are *material process* verbs (17 occurrences), which are employed to vividly describe the actions undertaken by the speaker, guide the viewers on how to perform specific experiments and to provide concrete examples of the content under discussion. A comprehensive overview of these verbs and their frequencies can be found in Table 39.

Types of material verbs			
MATERIAL PROCESS	**Freq.**	**VERBAL PROCESS**	**Freq.**
Flip	2	Tell	8
Rotate	2	Say	7
Place	2	Talk	6
Cut	2	Speak	4
Put	2	Introduce	4
Spill	1	Describe	2
Throw	1	Quote	2
Make	1	Mention	1
Burn	1	Allude	1
Compress	1		
Form	1		
Shape	1		

TOTAL	**17**	**TOTAL**	**35**
TOTAL: 52			

Table 39. Material verb types following *I* in the YouTube subcorpus with raw frequencies.

Moving on, the second most frequent category resulted to be the one of *mental* verbs. According to the data presented in Table 40, *cognitive* verbs, utilized by creators to critically interpret, analyse and provide commentary on the discussed results, emerged as the most frequently employed category (26 occurrences). Following this, *desiderative* verbs – occurring 5 times – were found to serve the dual purpose of expressing the speaker's desire for feedback, suggestions or recommendations, as well as introducing forthcoming topics.

Types of mental verbs			
COGNITIVE	**Freq.**	**DESIDERATIVE**	**Freq.**
Think	10	Want	3
Believe	8	(Would) like	1
Remember	5		
Consider	3		
TOTAL	**26**	**TOTAL**	**4**
TOTAL: 30			

Table 40. Mental verb types following *I* in the YouTube subcorpus with raw frequencies.

Finally, the category with the lowest frequency is the one of *relational* verbs. Table 41 below shows that, in this specific context, the verbs *to be* and *to feel,* which are categorised as *intensive relational* verbs, are followed by adjectives that convey speakers' emotional responses towards the subject matter, as seen in blogs. What is remarkable of this medium, however, is that these verbs are very frequently followed by proper nouns (e.g., Abby Dernburg). These instances are connected to the interactive and conversational nature of this medium, where videos are structured as a communication between interlocutors. As such, speakers often assume the role of conversational partners, and therefore introduce themselves to establish a more personal and intimate connection with viewers.

Types of constructs within relational clauses				
I am/ I feel +	**NOUNS**	**Freq.**	**EMOTIVE**	**Freq.**
	Proper nouns	15	Excited	1
			Happy	1
			Worried	1
	TOTAL	**15**	**TOTAL**	**3**
TOTAL: 18				

Table 41. Relational verb with adjectives following *I* in the YouTube subcorpus with raw frequencies.

As far as the analysis on the pronoun *my* is concerned, right-collocating words were classified according to their semantic domain into 'work', 'personal life', 'opinion' and 'talk'-related nouns. As illustrated in Table 42, the most frequent category comprises the nouns linked to the author's personal life (19 instances), through which speakers introduce themselves and establish an intimate relationship with the public. Such category is followed by the words related to the talk (15 occurrences), which are used to structure the discourse, by the terms that concern the working environment (8 instances), which are used share information about the world of research and the work of scientists, and, lastly, by the nouns expressing an opinion (7 instances), employed to mark the writer's point of view.

Types of nouns following *my*							
OPINION	**Freq.**	**TALK**	**Freq.**	**PERSONAL LIFE**	**Freq.**	**WORK**	**Freq.**
Opinion	4	Video	6	Name	5	Research	2
Thought	3	Segment	4	Family	4	Lab	2
		Talk	3	Kids	3	Group	2
		Speech	2	Background	3	Interest	2
				PhD	1		
				Story	1		
				Health	1		
				Car	1		
				Internet	1		
TOTAL	**7**	**TOTAL**	**15**	**TOTAL**	**19**	**TOTAL**	**8**
TOTAL: 49							

Table 42. Nouns following *my* in the YouTube subcorpus with raw frequencies.

The analysis of the extracted concordance lines and collocates, coupled with the application of Tang and John's model, revealed the various authorial roles science communicators adopt when conveying specialized concepts to their YouTube audience. More specifically, three roles already identified in the 1999 model were retrieved in this context too, namely *"I" as the guide through the essay*, *"I" as the architect of the essay* and *"I" as the opinion-holder*. Additionally, a thorough examination of the corpus data led to the discovery of another authorial role referred to as *"I" as the individual*, and, considering the types of actions described in the sentences, to the adjustment of the label *"I" as the recounter of research process* to *"I" as the recounter of research process and experimenter*.

Quantitatively, *"I" as the architect of the essay* (50 occurrences) turned out to be the most frequently retrieved role. This was followed by *"I" as the individual* (37 occurrences), *"I" as the opinion-holder* (33 occurrences), *"I" as the recounter of research process and experimenter* (25 occurrences), and *"I" as the guide through the essay* (4 occurrences). Refer to Tab. 43 and Fig. 39

AUTHORIAL ROLE TYPE	**YOUTUBE SCRIPTS**	
	RF	NF (PTT)
"I" as the architect of the essay	50	3
"I" as the individual	37	2.2
"I" as the opinion-holder	33	2
"I" as the recounter of research process and experimenter	25	1.5
"I" as the guide through the essay	4	0.3
TOTAL	**149**	**9**

Table 43. Frequency distribution of the authorial role types in the YouTube subcorpus.

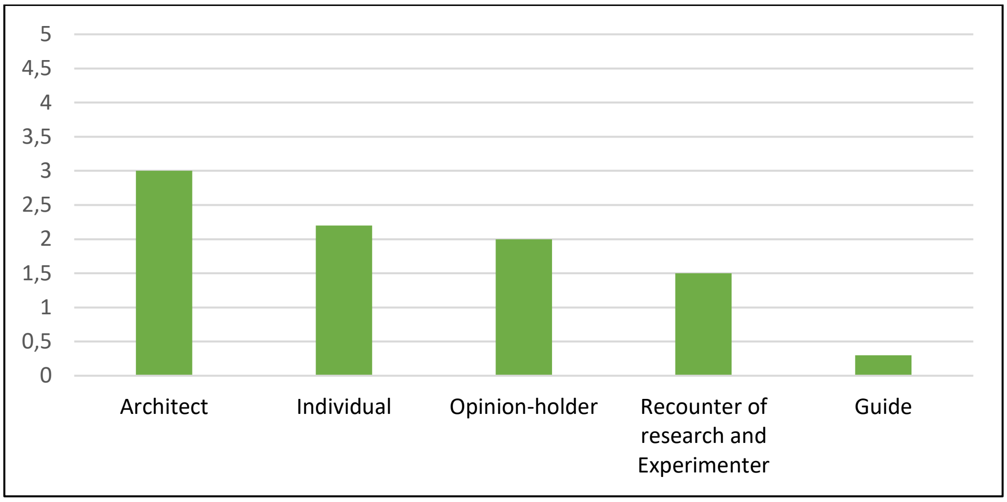

Figure 39. Frequency distribution of the authorial role types in the YouTube subcorpus (histogram).

Employing *material* verbs expressing a *verbal process* in the future form – such as *tell* and *describe* (136) – or using the pronoun *my* followed by a noun that refers to the act of discourse (137), the author effectively structures, organises and outlines the speech, therefore metadiscursively guiding non-expert readers in the flow of the argumentation. This authorial role, labelled as *"I" as the architect through the essay*, holds particular relevance in this specific medium because the target audience does not have a written text to refer to and relies solely on the progression of the video. By taking on this authorial role, creators thus help their audience navigate the discussed topics within the videos, thereby facilitating understanding and engagement.

(136) *Hi, I'm Abby Dernburg, and **I'm gonna tell** you in this segment about our characterization of special chromosome regions that play a critical role during meiosis to ensure proper chromosome segregation. So, **I'll remind** you that during meiosis the goal is to separate homologous chromosomes.* (BIO_2016-12-21)

(137) *And we wondered, of course, what is this apparent interaction with the nuclear envelope about? And in **my next segment**, I'll tell you more about that.* (BIO_2016-12-21)

"I" as the individual, rendered through *relational* verbs with attitudinal stance adjectives and proper nouns (138, 139), or through the pronoun *my* with words that refer to the author's personal everyday life (140), resulted to be the second most frequent in this corpus. By assuming this position, speakers establish a personal connection with their audience: voicing their own experiences, anecdotes and impressions builds a sense of trust and authenticity that brings listeners to engage with the speakers and the conveyed message on a deeper level.

(138) ***I'm super excited**, I've never been in a helicopter before and we're gonna take this thing up to the top of a glacier.* (OTBS_2017-07-25)

(139) *Hi, **I'm Dr. Caitlin Conn**, and I'm an assistant professor of biology at Berry College in Georgia.* (BIO_2021-02-03)

(140) *So, to give you a little bit of **my background** and how we became interested in this organelle, I did **my PhD** in the lab of Dr. Steve McKnight at the University of Texas Southwestern Medical Center.* (BIO_2020-01-20)

"I" as the opinion-holder refers to the role writers acquire when they want to visibly express their point of view, in the attempt to align the public with their perspectives and convincing them of the importance of the issues at hand. As already evidenced in blogs, this role is normally lexicalised using *cognitive mental* verbs (141), or by employing the pronoun *my* followed by a noun expressing opinion (142). In YouTube videos, this authorial role assumes paramount importance: it not only reinforces authenticity and transparency, but it also prompts viewers to critically examine the issues under discussion, urging them to participate in conversations and debates with others.

(141) *And so, **I think** one of the most interesting areas of future research for us is to understand how mitochondria communicate, through these and other mechanisms, to control the behaviours of cells.* (BIO_2020-01-20)

(142) ***My opinion** is that this research has big implications for how we think about cell biology.* (BIO_2020-01-20)

The authorial role labelled as *"I" as the recounter of research process* is, in this context, referred to as *"I" as the recounter of research process and experimenter*. Expressed with *material process* verbs (143) or with the possessive *my* in combination with nouns related to the job sphere (144), this role serves a dual purpose. On the one hand, it allows speakers to explain research procedures and methodologies. Conversely, and more commonly, it empowers them to vividly illustrate practical demonstrations and experiments. In videos, speakers frequently showcase how theoretical concepts are put into practice through their experiments: this aspect not only brings authenticity and credibility to the topics discussed, but also serves to enhance people's understanding of the subject matter.

(143) *So what **I do** here is: **I put** cocoa powder, and sugar, and scoby. This is without the scoby.* (REA_2020-12-15)

(144) *So, we decided in **my lab** to take a stab at understanding the functions of some of these uncharacterized, highly conserved mitochondrial proteins.* (BIO_2020-01-20)

Finally, *"I" as the guide through the essay* is the least frequent role retrieved in YouTube videos (145). As already emphasised in the previous sections, this is the role through which speakers guide the public in the interpretation of the contents. In this specific context, the infrequency of this role could be motivated by the presence of visual or auditory cues such as graphics, on-screen annotations and intentional variations in intonation which already serve the purpose of directing people's attention to specific elements within the discourse.

(145) *Now that we've seen acid-catalyzed and base-catalyzed tautomerization, **I want to** point out another pattern that we'll see throughout this series.* (CC_2020-12-17)

5.2.2.2 Discussion of the results

The joint analyses of the 1st person personal pronoun *I* and of the possessive pronoun *my* revealed that, in YouTube video scripts, the *docere* rhetorical goal is achieved through the employment of different authorial roles, whose distribution is portrayed in the pie chart displayed in Fig. 40.

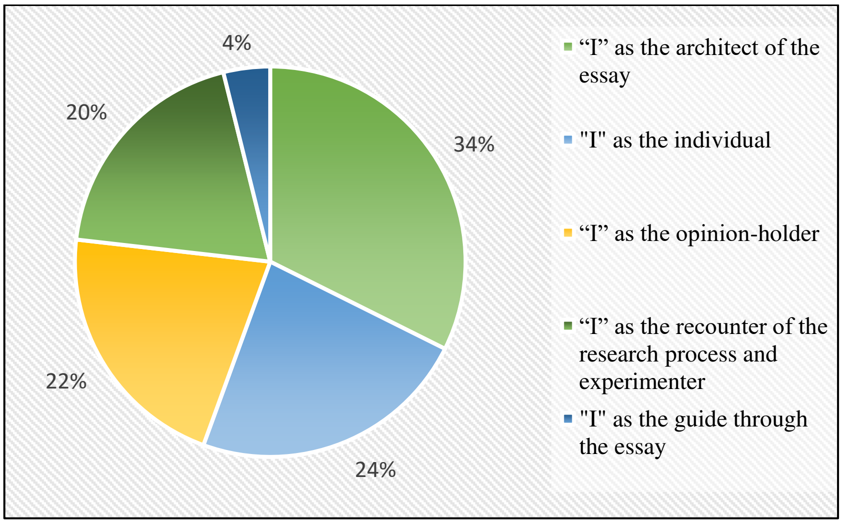

Figure 40. Distribution of the authorial role types in the YouTube subcorpus (pie chart).

As can be observed, in the specific context of YouTube videos, speakers educate their viewers by predominantly acting as architects through the essay, individuals, opinion-holders and recounters of research processes. The presence of these roles reflects the core objective of their mission: delivering informative high-quality information in an accessible and easy-to-understand way, as well as engaging the public while developing a closer and more intimate relationship with them. As shown, by assuming these roles, speakers not only ensure that the public is exposed to accurate domain-specific contents in a way that suits their understanding and memory retention, but they also foster the development of a more personal and intimate connection with the audience.

By adopting the role of *"I" as architect through the essay*, communicators attentively plan and construct their videos, shaping their contents in a way that effectively transmits specialised knowledge. In a context in which viewers are presented the specialised information without the complete text at hand, providing them with a roadmap of the contents gives them the possibility to follow the presentation more easily, and, as a consequence, to process and retain the presented knowledge effortlessly.

Then, by taking on the *"I" as an individual* role, thus showing the audience various details concerning their personal lives and previous experiences, allows speakers to create and nurture the author-viewer relationship, which, in turn, both fosters a sense of authenticity, relatability and personal engagement, and also contributes to the establishment of an informal and relaxed educational environment.

By adopting the role labelled as *"I" as opinion-holder*, speakers and communicators can express their perspectives and viewpoints on the topics, which serves two functions. On the one hand, it helps people gain a comprehensive understanding of the mechanisms and relevance of the specialised issues under analysis: this represents an essential foundation in the process of scientific enculturation, since it helps non experts to become acquainted with the specific knowledge and cultural aspects associated with those topics. On the other, it also stimulates critical thinking and serves as a starting point for constructive dialogues and debates: this, in turn, can both lead to a more interactive and engaging viewing experience, and can foster the creation of online discussion communities around those issues.

Lastly, by acting as *"I" as the recounter of research process and experimenter*, authors can not only accurately convey specialised and technical knowledge in an accessible way, but they can also provide viewers with practical demonstrations and experiments that showcase concepts or validate hypotheses. This, in turn, facilitates comprehension and memory retention of the concepts, while contributing to people's engagement through practical hands-on experiences.

5.2.3 Authorial presence in comic books about science

5.2.3.1 Presentation of the results

As portrayed in the graph below (Fig. 41), in comic books about science, 1st person personal and possessive pronouns constitute 10% of the entire population.

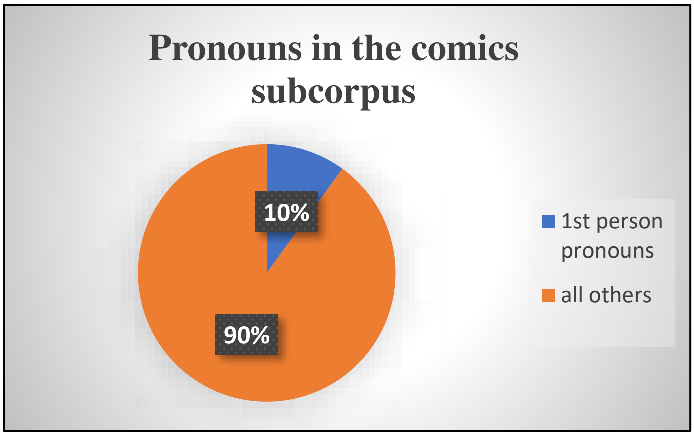

Figure 41. Distribution of 1st person pronouns *I* and *my* in the Comics subcorpus (pie chart).

More specifically, 446 instances of the pronoun *I* and 91 occurrences of *my* were identified, as displayed in Tab. 44 and Fig. 42.

SELF MENTIONS	**COMICS**	
	RF	NF (PTT)
I	446	26.7
My	91	5.5
TOTAL	**537**	**32.2**

Table 44. Frequency distribution of 1st person pronouns *I* and *my* in the Comics subcorpus.

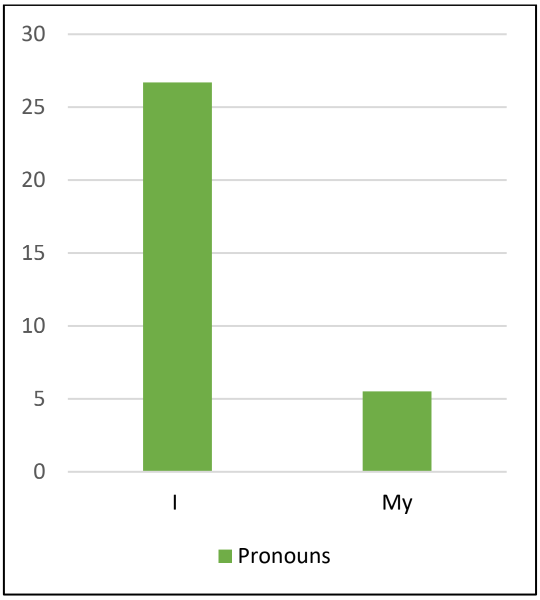

Figure 42. Frequency distribution of the pronouns *I* and *my* in the Comics subcorpus (histogram).

As far as the personal pronoun *I* is concerned, the Sinclairian analysis of its linguistic co-text revealed that it collocates with all three verb categories identified in Halliday and Matthiessen (2014), namely *mental*, *material*, and *relational* verbs. Table 45 and Fig. 43 provide detailed distribution information.

VERB TYPES	**COMICS**	
	RF	NF (PTT)
MENTAL	29	1.8
MATERIAL	39	2.4
RELATIONAL	32	2
TOTAL	**100**	**6.2**

Table 45. Frequency distribution of verb types following *I* in the Comics subcorpus.

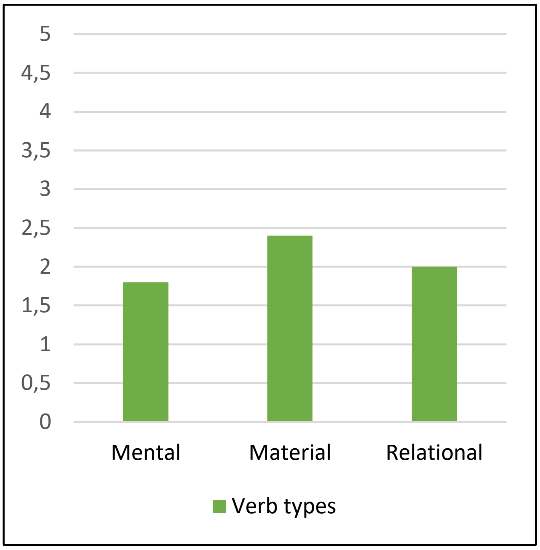

Figure 43. Frequency distribution of verb types in the Comics subcorpus (histogram).

As readers can observe, *material* verbs stand out as the most frequent category in comic books. Specifically, *material process* verbs (29 occurrences) are used to depict physical actions or movements performed by the characters interacting with their environment. Following these are *verbal process* verbs (10 occurrences), which serve the dual purpose of portraying character interactions and structuring the discourse by previewing the upcoming panels, thus effectively guiding the reader through the narrative progression. Table 46 provides a detailed view on the retrieved verbs and their frequencies.

Types of material verbs			
MATERIAL PROCESS	**Freq.**	**VERBAL PROCESS**	**Freq.**
Move	4	Tell	3
Use	3	Explain	3
Eat	2	Say	2
Enter	2	Describe	1
Lose	2	Mansplain	1
Reproduce	1		
Win	1		
Push	1		
Add	1		
Stir	1		
Make	1		
Give birth	1		
Open	1		
Start	1		
Destroy	1		

Harvest	1		
Remove	1		
Shut	1		
Grow	1		
Measure	1		
Borrow	1		
TOTAL	**29**	**TOTAL**	**10**
TOTAL: 39			

Table 46. Material verb types following *I* in the YouTube subcorpus with raw frequencies.

Differently from blogs and YouTube videos, comics exhibit a larger variety of *relational* verbs, as readers can see in Table 47. Most of them (29 out of 39) fall under the category of *intensive relational* verbs since they "express a property or state of the subject". On the contrary, three are labelled as *possessive relational* verbs and they express "a relationship of ownership between the subject and one or more objects" (Halliday & Matthiessen 2014: 250). Within the realm of comic books, these verbs play a role of the utmost importance: they complement the visual elements by providing additional context and characterisation in terms of appearances, actions and possessions.

Types of *relational* verbs			
INTENSIVE	**Freq.**	**POSSESSIVE**	**Freq.**
Be	18	Have	3
Serve	5		
Look	4		
Weigh	2		
TOTAL	**29**	**TOTAL**	**3**
TOTAL: 32			

Table 47. Relational verbs following *I* in the YouTube subcorpus with raw frequencies.

Finally, the category with the lowest frequency is that of *mental* verbs, which encompass speakers' cognitive processes and states. Within this category, *perceptive* verbs, providing information about their sensory perspectives, appeared most frequently (13 instances). Then, *cognitive* verbs, providing insights into the characters' thoughts, follow with 8 occurrences. *Emotive* verbs, representing their inner feelings and moods, were found in 5 instances, while desiderative verbs, expressing desires, wishes and intentions occurred 3 times.

Types of mental verbs							
COGNITIVE	**Freq.**	**PERCEPTIVE**	**Freq.**	**DESIDERATIVE**	**Freq.**	**EMOTIVE**	**Freq.**
Think	4	Taste	3	Hope	3	Like	3
Believe	1	Smell	3			Hate	2
Suspect	1	See	2				
Reckon	1	Find	2				
Guess	1	Hear	2				
		Glimpse	1				
TOTAL	**8**	**TOTAL**	**13**	**TOTAL**	**3**	**TOTAL**	**5**
TOTAL: 29							

Table 48. Mental verb types following *I* in the YouTube subcorpus with raw frequencies.

Nouns collocating on the right side of the pronoun *my* were classified according to their semantic domain into ‘discourse’, ‘domain-specific terminology’ and ‘personal life’. Table 49 illustrates these findings, revealing that the most frequent category comprises the nouns related to the speakers’ personal lives (41 instances), which are used to provide details on their personal backgrounds. Following this category are a number of domain-specific terms (38 instances), used when anthropomorphized figures describe their own features as part of the content transmission process. Ultimately are the nouns related to the talk (12 instances), that are employed to structure the discourse.

Types of nouns following *my*					
DISCOURSE	**Freq.**	**PERSONAL LIFE**	**Freq.**	**DOMAIN-SPECIFIC TERMINOLOGY**	**Freq.**
(Next) topic	5	Name	8	Homeostasis	4
Attention	4	Family	5	Microbiome	3
Opinion	3	Sister	5	Regulatory powers	3
		Body	4	Phosphorus	3
		Car	3	Acetate	2
		Dad	3	Catalitic convertor	2
		Friend	2	Cytosol	2
		Mom	2	Electron	2
		Body	1	Sunlight	2
		Neck	1	By-product	2
		Health	1	State of matter	2
		Brain	1	Conjugate	2
		Cookies	1	Proton	2

		Bone	1	Neutron	1
		Hand	1	Enzyme	1
		House	1	Nucleolus	1
		Mind	1	Solution	1
				Microscope	1
				Thermometer	1
				Matter	1
				Reduction	1
TOTAL	**12**	**TOTAL**	**41**	**TOTAL**	**38**
TOTAL: 91					

Table 49. Nouns following *my* in the YouTube subcorpus with raw frequencies.

The analysis of the concordance lines and collocates of the collected data, coupled with the application of Tang and John's (1999) model, made it evident that science comic books authors take on three of different authorial roles when transmitting domain-specific contents to the audience: *"I" as the individual*, *"I" as the architect of the essay* and *"I" as the opinion-holder*. As displayed in Tab. 50 and in Fig. 44, from a quantitative point of view, the most frequent is the role called *"I" as the individual* (158 occurrences), followed by *"I" as the architect of the essay* (22 occurrences) and *"I" as the opinion-holder* (11 occurrences).

AUTHORIAL ROLE TYPE	**BLOG POSTS**	
	RF	NF (PTT)
"I" as the individual	158	9.5
"I" as the architect of the essay	25	1.5
"I" as the opinion-holder	8	0.5
TOTAL	**191**	**11.5**

Table 50. Frequency distribution of the authorial role types in the YouTube subcorpus.

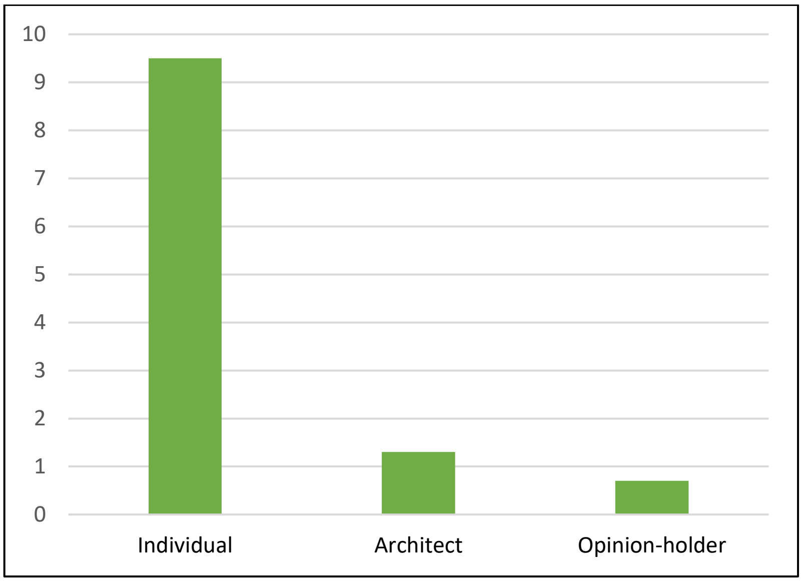

Figure 44. Frequency distribution of the authorial role types in the Comics subcorpus (histogram).

Readers can notice that the role labelled as *"I" as the individual* is the most frequent in this subcorpus. In the specific context of science comics, it is lexicalised through a variety of linguistic items. On the one hand, it is rendered using *intensive* and *possessive relational* verbs, often accompanied by attitudinal stance adjectives (146). On the other hand, it can also be conveyed by the pronoun *my* followed by nouns that refer to the speaker's individuality (147). By using this specific authorial role, speakers – who can be both individuals or personified non-human entities – provide the public with a direct window into their thoughts, feelings, history and experiences. In the context of comics, this constitutes a powerful tool for storytelling, because it allows authors to create characters that are easily relatable and whose stories and features resonate with a broad public.

(146) *Well, **I'm** a large herbivore, too!* (ES_CartoonGuides)

(147) *Should I have been celebrating Earth Day all this time? Would it help if I started now? Should I throw out **my car** and get an electric car?* (ES_Wildweather)

Additionally, this authorial role can also manifest in the form of *material process* verbs (148), *perceptive mental* verbs (149), or through the combination of the possessive *my* with a domain-specific noun (150). In these contexts, this specific authorial role enables the explanation of domain-specific notions through the verbal depiction of actions and processes, which are the result of the character's interaction with its surrounding environment.

(148) ***I reproduce** often in order to grow the body or replace damaged cells.* (B_TheBrain)

(149) ***I can** vaguely **sense** some electrons humming around, although they're awfully hard to pin down.* (CHEM_CartoonGuides)

(150) ***My microbiome** leans left, but I have big-tent genetics.* (B_CartoonGuides)

The second most frequent role in comics is the one labelled as *"I" as the architect through the essay*, retrieved in 22 instances out of 191. Through the employment of *material* verbs expressing a *verbal process* in the future form (151), the character, representing the voice of the author, structures and shapes the flow of information within the comic. Adopting this position holds particular significance in this specific context, because the information is presented in fragmented panels and readers are forced to piece together the informational puzzle on their own.

(151) ***I will mansplain** the meaning of metaphor now…* (B_CartoonGuides)

Finally, as far as the role tagged as *"I" as the opinion-holder* is concerned, linguistic evidence extracted from the corpus shows that, in comics, this role is lexicalised through *cognitive* or *desiderative mental* verbs (152), as well as through *emotive mental* verbs (153). By adopting this role, characters effectively act as conduits for expressing the viewpoints of the authors. This prompts readers to critically assess the concepts and actively engages them in the ensuing discussions.

(152) *Er… cough… the secrets of the universe aren't enough for you? Well, **I guess** not! Ah… well then… **I think** you may like the next chapter…* (CHEM_CartoonGuides)

(153) *Ecology is the study of environments, their biomes, and all the interactions within them, in short, the study of ecosystems. **I love** ecologists!* (B_CartoonGuides)

5.2.3.2 Discussion of the results

The joint analyses of the 1st person personal pronoun *I* and of the possessive pronoun *my* made it possible to observe that, in science-themed comic books, the *docere* rhetorical goal is achieved thanks to the adoption of various authorial roles. See the pie chart portrayed in Fig. 45 for a visual representation of such data.

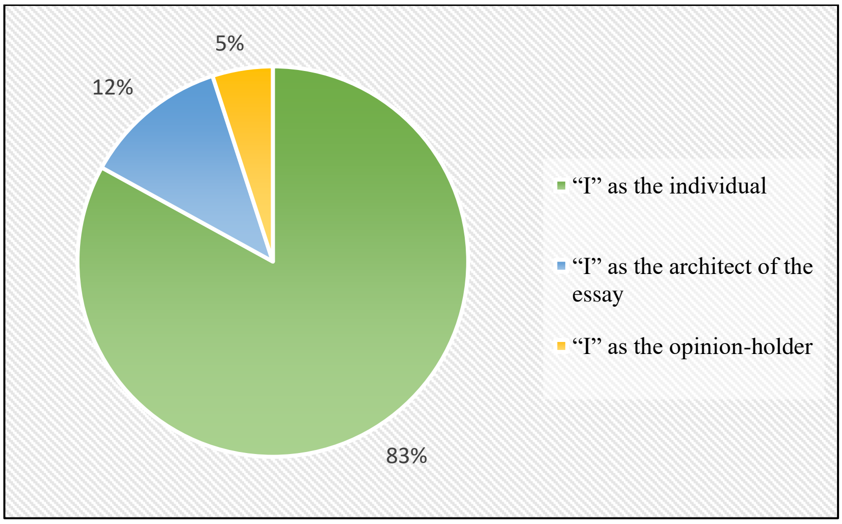

Figure 45. Distribution of the authorial role types in the Comics subcorpus (pie chart).

In popular science comics, authors educate their readers through the voice of their characters, which, in turn, assume two main roles: 'individual' and 'architect of the essay'. The presence of these roles reflects the core objective of their mission: delivering high-quality information in a way that is accessible and that facilitates clear visualisation, as well as engaging the public with relatable human-like characters and narratives that foster the development of a closer and more intimate connection with them.

By adopting the *"I" as the individual* authorial role, authors can both instruct and entertain their readers. On the one hand, the exploitation of *material process* verbs and *perceptive mental* verbs enables authors to introduce and explain domain-specific concepts and mechanisms that result from their characters' interactions with the environment. This, in turn, allows for a dynamic, engaging and easily comprehensible explanation that converts theoretical concepts into tangible events. On the other hand, explicit references to the protagonists' personal feelings, life experiences and emotions make them more relatable and closer to the real world, consequently encouraging readers to feel engaged, emotionally invested and interested in the story and the concepts they are reading about.

Furthermore, by taking on the *"I" as the architect of the essay* authorial role, authors provide context, insights and anticipation on the upcoming contents that guide their readers through the narrative. This, in turn, serves two purposes: on the one hand, it provides the public with a well-organised and coherent reading experience that aids the comprehension of both the storyline and the specialised contents; on the other, it fosters a sense of anticipation and suspense that keeps readers invested in the story.

5.3 Reaching the *docere* aim: the role of definitions

After the analysis described above, the examination of the rhetorical and discursive techniques exploited to achieve the *docere* rhetorical goal (Załęska 2016: 34) progressed with an investigation of the linguistic structures utilised to introduce and define domain-specific topics.

As claimed by Calsamiglia and Van Dijk (2014), in the specific context of scientific knowledge transmission, discipline-related terms represent the core of the communicative act of popularisation. Yet, they often tend to be omitted because they are generally considered as key obstacles for the public understanding of science. However, for a precise and effective dissemination of contents, Pilkington (2018: 122) claims that authors "cannot deny nor avoid the linguistic legacy of science" because this would lead to "shifting the focus away from science and its processes into specific actants and their actions" (Pilkington 2019: 581).

As a consequence, a number of linguistic and discursive strategies must be implemented, so as to both preserve the domain specificity of the original and accommodate it to a public composed of people with different backgrounds and degrees of knowledge. Within this context, definitions are key discursive segments through which the popularisation process takes place, and analysing their linguistic structures in a cross-medial perspective enables to gain thorough insights into both the activity of knowledge recontextualisation in its entirety, and into the way messages are framed in different communication contexts.

5.3.1 Definitions in blog posts

5.3.1.1 Presentation of the results

To gain thorough insights into their linguistic configuration and discursive role, 100 instances of definitions were manually extracted from the corpus and investigated from both a quantitative and qualitative point of view. In line with the model proposed by Pilkington (2018, 2019), the study focused on their macro-structure first and on their micro-structure at a later stage. On the one hand, from a surface-level point of view, definitions were analysed in terms of their composition, type and position of the constituents. On the other hand, they were classified, on a micro-structural level, according to elements such as the order of their constituents, their rhetorical function and type of hinge.

Above all, in line with the models by Pilkington (2018, 2019), three different types of definitions were highlighted: *prototypical, procedural* and *figurative*. As readers can observe in Tab. 51 and Fig. 46, the category with the highest frequency is the *prototypical*, retrieved in all the instances under analysis. This was followed by the *procedural* (91 occurrences) and, lastly, by the *figurative* type (10 cases).

DEFINITION TYPES	**Frequency**
PROTOTYPICAL	100/100
PROCEDURAL	91/100
FIGURATIVE	10/100
TOTAL	**201**

Table 51. Frequency distribution of definition types in the Blogs subcorpus.

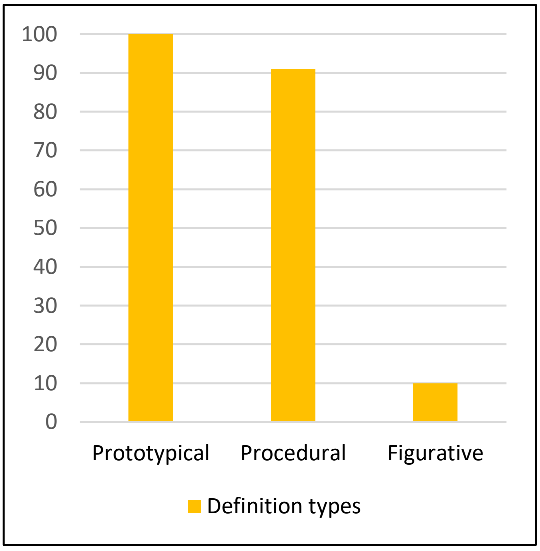

Figure 46. Frequency distribution of definition types in the Blogs subcorpus (histogram).

Most of the analysed sentences (nearly 90% of the cases) can be classified as *definitional strings* (Pilkington 2018: 123) or *chains* (Pilkington 2019: 588). These expressions refer to segments composed of multiple types of definitions joined together, aiming to approach the concept from diverse perspectives and to provide readers with more comprehensive accounts of the issues under analysis.

In the specific context of science-themed blogs, the analysis emphasised that the most frequent type of chain is the *prototypical* + *procedural* (154), which enables writers to effectively consolidate and present both the theoretical foundations and the practical applications of a concept. The *prototypical* element, on the one hand, serves to display the core essence, defining features and the constituting elements of a concept, while the *procedural* segment outlines methodologies, processes and research protocols. The order of these constituents is not fixed, and they can be arranged either preceding or following one another, as demonstrated in examples 154 and 155. Additionally, in this context, a small number of instances were found to adopt a different structure: *figurative* + *prototypical* + *procedural* (155). In these specific cases, authors employ the figurative segment as means to engage readers and activate their imagination, while utilise the other parts to instruct them on the specialised contents. In this pattern, the *figurative* segment typically precedes the others because it works as an attention-grabbing device for the reader.

> (154) [**prototypical**] *The nucleolus, located inside the nucleus, is probably the largest of the membrane-less organelles.* [**procedural**] *It acts as a factory to assemble ribosomes, the giant molecular machines that "translate" messenger RNAs to make all cellular proteins.* (BIOB_2018-01-03)

> (155) [**figurative**] *Imagine a lava lamp with its slowly flowing colored globules.* [**procedural**] *Those drops of color can maintain clear separation from the surrounding liquid because they contain molecules that are electrostatically attracted to each other, like the static electricity that causes two socks just taken out of a dryer to weakly cling to each other. They condense to form a separate droplet, or phase.* [**prototypical**] *This is known as phase separation, and membrane-less organelles follow the same principle.* (BIOB_2018-01-03)

Moving on, the chains were then subjected to a micro-structural analysis. Each segment was investigated on its own to retrieve in-depth insights into their linguistic internal structure and discursive function.

As shown in Tab. 51, the most frequent type of segment is the *prototypical* (156), which, in the words of Pilkington (2019: 590), constitutes "the most straight-forward of all chain components". Consisting of two internal sub-segments, namely the *definiens* and the *definiendum*, the primary purpose of this definition is to provide readers with a foundational understanding of the basic concepts, before delving into more detailed discussions. From a discursive perspective, *prototypical* segments are closely associated with the *docere* rhetorical goal, as they incorporate domain-specific information that are utilised to instruct the public about unknown or lesser-known notions.

> (156) *Alzheimer's and Parkinson's disease are members of a larger class of conditions characterised by the misfolding and aggregation of specific disease-related proteins. Other*

notable representatives include type II diabetes, Huntington's disease and the motor neuron disease ALS. (ONB_2017-07-04)

Prototypical definitions in science-themed weblogs exhibit two different structural patterns, which demonstrate the authors' high degree of flexibility in the presentation of new concepts. The first involves the *definiendum* preceding the *definiens* (157), while the second entails the *definiens* following the *definiendum* (158).

(157) *The nucleolus, located inside the nucleus,* [**definiendum**] *is probably the largest of the membrane-less organelles* [**definiens**]. (BIOB_2018-01-03)

(158) [**definiens**] *They're harnessing a microbe capable of controlling insects' reproductive processes. The microbe, called Wolbachia* […] [**definiendum**]. (BIOB_2017-06-27)

In this context, *definiens* and *definiendum* are joined together by various types of hinges, which can be explicit – namely expressed by verbs such as 'to be', 'to call', 'to represent' – or implicit, that is, rendered through punctuation marks. As shown in Tab. 52, authors of popular science blogs utilize both types of junctions, although a preference for the implicit form is observed. See also Fig. 47 for a graphic representation of such data.

HINGE TYPES	**Frequency**
EXPLICIT	32
IMPLICIT	68
TOTAL	**100**

Table 52. Frequency distribution of hinge types in the Blogs subcorpus.

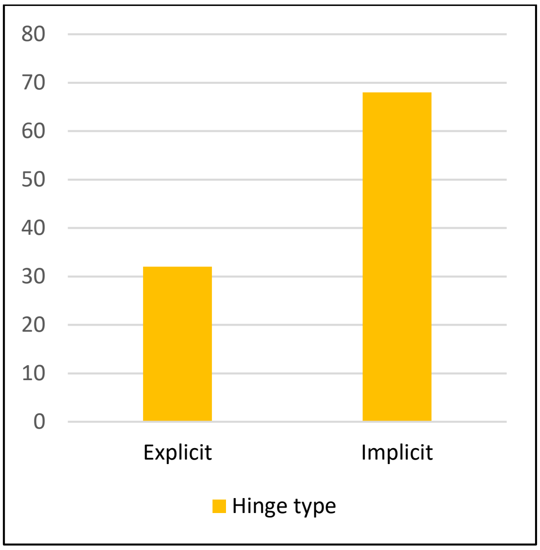

Figure 47. Frequency distribution of hinge types in the Blogs subcorpus (histogram).

As far as the implicit hinges are concerned, authors of popular science blog typically rely on five devices: brackets, hyphens, commas or double commas and colon:

(159) *Although it looks like a bursting firework from a Fourth of July celebration, this image actually was created from pictures of spermatids - one stage in the formation of sperm—in the fruit fly* (*Drosophila*). (BIOB_2017-06-30)

(160) *Researchers captured this image while investigating the promise of gene therapy for glaucoma, a progressive eye disease.* (BIOB_2016-11-02)

As indicated in Tab. 53, a diverse range of explicit hinges are employed. See also examples 161 and 162 below.

EXPLICIT HINGES	**Freq.**
is + noun	6
known as	5
refers to	5
is + direct quote	4
represents	2
constitutes	2
is named/nicknamed	2
called	2
which means	2
or	2
TOTAL	**32**

Table 53. Types of explicit hinge types retrieved in the Blogs subcorpus.

(161) *Cnidaria* ***is*** *one of the earliest branching metazoan lineages, and the group had undergone significant diversification some 500 million years ago.* (ONB_2019-03-29)

(162) *A biomarker* ***is "a characteristic that is objectively measured and evaluated as an indicator of normal biological processes, pathogenic processes, or pharmacological responses to therapeutic intervention".*** (ONB_2018-07-30)

The so-called *procedural* definition (163), serves, as claimed by Pilkington (2019: 590) to "identify the *definiens* not by genus and difference, but by the process in which the definiendum is a participant". In other words, this segment is utilised to instruct people on the techniques, methods and steps involved in understanding or applying a research protocol, as well as on the processes and mechanisms underlying a specific topic. In the context of popular science blogs, this definition was found to always appear in conjunction with either a *prototypical* or a *figurative* segment, and, from a discursive perspective, it turned out to be closely connected to the rhetorical goal of *docere*, as it provides clear and precise explanations on highly specialised matters.

(163) […] *Unlike traditional light microscopy, EM uses electrons, not light, to create an image. To do so, EM accelerates electrons in a vacuum, shoots them out of an electron gun and focuses them with doughnut-shaped magnets onto a sample.* (BIOB_2017-01-24)

Usually appearing in second position within the definitional chain, *procedural* segments are normally linked to the other elements via a variety of hinges. In this specific case, these hinges include domain-specific verbs, causative-verbs and relational verbs (Halliday & Matthiessen 2014). Table 54 provides a list of these elements with their frequencies and Fig. 48 displays a graphic representation of such data.

HINGE TYPES	**Frequency**
(Modal verb of possibility +) domain-specific verb	47
Causative verb + domain-specific noun phrase	29
Identifying relational verb+ domain-specific noun phrase	15
TOTAL	**91**

Table 54. Types of verbal clauses serving as hinge in procedural definitions within the Blogs subcorpus.

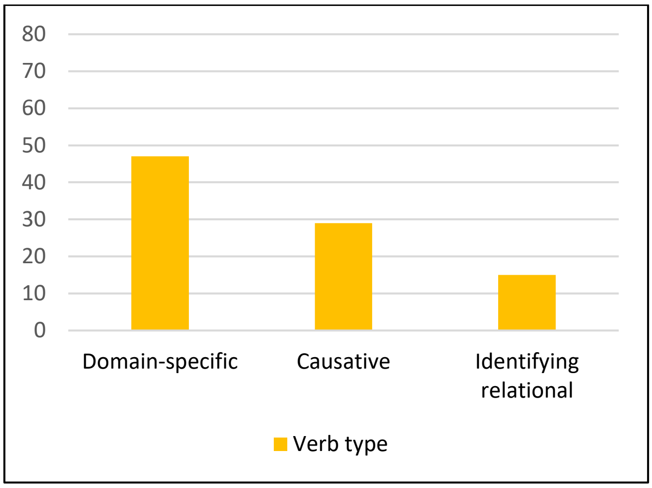

Figure 48. Frequency distribution of verbal clauses serving as hinge in procedural definitions in the Blogs subcorpus (histogram).

As readers can see, the structure with the highest frequency involves the use of a modal verb of possibility, such as *may* or *can*, in conjunction with a domain-specific verb (164). What follows is the *causative verb + noun phrase* structure, in which a verb such as *cause, help* and *allow* introduces a domain-specific noun phrase (165). Finally, one last structure sees relational verbs such as *act as*, *turn to be* and *prove to be* in combination with a specialised noun. Overall, the retrieval of these domain-specific linguistic structures reveals the necessity of possessing a certain degree of background knowledge to accurately process and understand the ideas presented. Using highly specialised technical verbs and complex nominalisations ensures, on the one hand, precision and accuracy in communication, but implies, at the same time, that readers are expected to have the ability to make connections and draw upon their existing knowledge.

(164) *The first-tier genetic test for individuals with neurodevelopmental delay is called chromosome microarray. This test* ***can detect*** *if part of a gene, an entire gene or multiple genes are missing or duplicated in an individual's genome.* (ONB_2018-02-26)

(165) *Perhaps some of the best understood regulatory RNAs are the microRNAs, short RNAs that bind to mRNA which mostly* ***causes downregulation*** *by either degrading the mRNA or preventing it from being translated.* (ONB_2017-11-30)

(166) *Coacervates* ***act as*** *a controlled genetic transfer system, in which shorter RNA pieces can shuttle between droplets while longer pieces are trapped in the hosting microdroplet.* (PHY_2018-10-09)

Finally, the least represented type of definition is the so-called *figurative.* This term encompasses the segments where analogies, metaphors, thought experiments and scenarios are exploited as tools to help people visualise concepts (167). In this context, they serve as a mean to effectively bridge the gap between experts and non-experts: by employing familiar and relatable imageries and by stimulating people's imagination through thought experiments, these definitions help readers navigate the essence of intricate domain-specific concepts in a more accessible and engaging way. In popular science blogs, *figurative* definitions work as introductory segments of the definitional chain, always appearing in conjunction with the *prototypical* and/or *procedural* chunks.

> (167) *Imagine an army of tiny soldiers stationed throughout your body, lining cells from your brain to every major organ system. Rather than standing at attention, this tiny force sweeps back and forth thousands of times a minute. Their synchronized action helps move debris along the ranks to the nearest opening. Other soldiers stand as sentries, detecting changes in your environment, relaying that information to your brain, and boosting your senses of taste, smell, sight, and hearing.* (BIOB_2019-07-03)

As anticipated, these segments can take many forms: scenarios, analogies and thought experiments. Tab. 55 lists all these functions together with their frequencies, while the histogram portrayed in Fig. 49 gives a graphic representation of such data.

FIGURATIVE DEFINITION TYPES	**Frequency**
Scenario	4
Analogy	4
Thought experiment	2
TOTAL	**10**

Table 55. Types of figurative definition within the Blogs subcorpus.

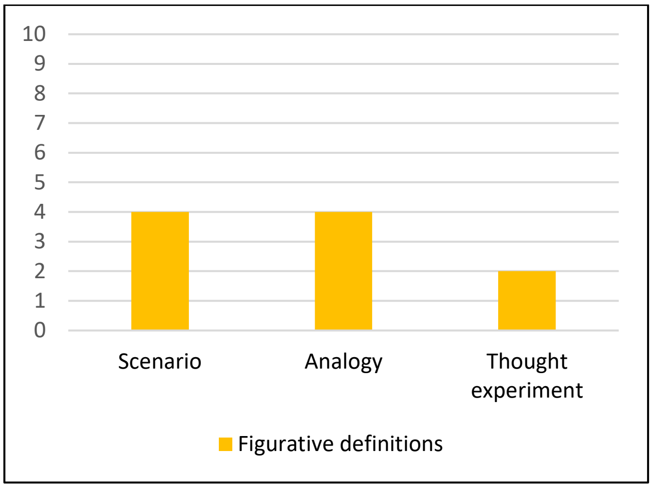

Figure 49. Frequency distribution of figurative definition types in the Blogs subcorpus (histogram).

As can be observed, scenarios stand out as the most common devices together with analogies, occurring in four instances (168). The role of scenarios is to present hypothetical situations or real-world examples that effectively illustrate the application of the topics being discussed. Analogies, on the other hand, enable the comparison between abstract concepts and everyday life situations, making domain-specific issues more accessible and comprehensible to readers (169). Lastly, thought experiments (2 occurrences) prompt readers to examine different perspectives, envision possible consequences of certain actions and reflect on the implications of the notions at hand (170).

(168) *If you've ever felt a slimy coating on your teeth, scrubbed grime from around a sink drain or noticed something growing between the tiles of a shower, you've encountered a biofilm.* (BIOB_2016-05-13)

(169) *Like a successful business networker, a cell's endoplasmic reticulum (ER) is the structure that reaches out—quite literally—to form connections with many different parts of a cell.* (BIOB_2017-05-04)

(170) *Imagine a lava lamp with its slowly flowing colored globules. Those drops of color can maintain clear separation from the surrounding liquid because they contain molecules that are electrostatically attracted to each other.* (BIOB_2018-01-03)

5.3.1.2 Discussion of the results

In conclusion, the analysis conducted at the level of the definitions made it possible to obtain a number of insights concerning the way in which these specialised contents are presented and explained in popular science blogs.

Overall, data indicate that the presentation of specialized concepts in popular science blogs necessitates a certain level of background knowledge to accurately comprehend and process the ideas being articulated. Several patterns and linguistic devices contribute to this complexity. First, the prevalence of *definitional chains* in presenting concepts enables bloggers to offer a more articulated, yet complex, explanation: the *prototypical* + *procedural* pattern, in particular, condenses the core notions and practical aspects of knowledge into a focused segment. Additionally, the absence of a fixed order of the constituents adds to this complexity, as readers need to decode various types of definition structures. Furthermore, the preference for implicit hinges in *prototypical* definitions makes it more difficult for readers to understand the connections between the concepts, and the adoption of various domain-specific verbs and noun phrases in *procedural* definitions implies that readers already understand these notions.

However, despite being mostly focused on transmitting highly specialised knowledge in an effective way, science bloggers also demonstrate attentiveness to their readers. This is demonstrated by the employment of analogies, scenarios and thought experiments that serve multiple purposes: they allow authors to capture and maintain their public's attention throughout the post, make the contents more relatable and create a more engaging experience.

5.3.2 Definitions in YouTube video scripts

5.3.2.1 Presentation of the results

In the specific context of YouTube video scripts, four types of definitions were retrieved: *prototypical, procedural*, *figurative* and *incomplete*. As Tab. 56 shows, the category with the highest frequency is the *prototypical* (100 occurrences), followed by the *procedural* (61 instances), *figurative* (27 cases), and *incomplete* (15 chunks).

DEFINITION TYPES	Frequency
PROTOTYPICAL	100/100
PROCEDURAL	61/100
FIGURATIVE	27/100
INCOMPLETE	15/100
TOTAL	**201**

Table 56. Frequency distribution of definition types in the YouTube subcorpus.

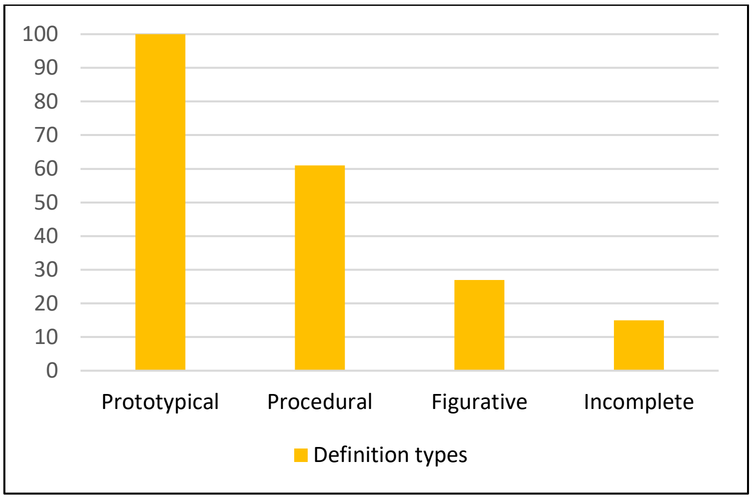

Figure 50. Frequency distribution of definition types in the YouTube subcorpus (histogram).

In YouTube videos, only 40% of the instances were identified as *definitional strings* (Pilkington 2018: 123). Conversely, most of them were rendered through *definitional patterns*, i.e., shorter segments composed of two informational elements (e.g., *prototypical* + *procedural*).

The most frequent type of chain resulted to be the *prototypical* + *procedural* (171), which provides readers with information on the core details about the topic and its functions. This is followed by the pattern *figurative* + *prototypical* + *procedural* (172), in which specialised information is accompanied or introduced by an analogy, metaphor or thought experiment. Finally, video scripts also display the *prototypical* + *incomplete* pattern (173), where authors introduce the topic under analysis and postpone the complete explanation to a later point within the talk, and the *procedural* + *incomplete* pattern (174), wherein they mention the functions and processes of the objects, deferring the in-depth explanation to a later time.

(171) [**prototypical**] *The attractions between the water molecules are called hydrogen bonds.* [**procedural**] *These hydrogen bonds give water a boiling point that is about 200 degrees higher than it should be when compared to other similar substances.* (ACS_2018-11-10)

(172) [**figurative**] *Imagine a bacterium as a very complex machine with thousands of complex processes going on that keep it alive and active.* [**prototypical**] *Antibiotics disrupt this complex machinery, for example, by interfering with its metabolism, slowing down their growth significantly, so they are less of a threat.* (KUR_2016-03-16)

(173) [**prototypical**] *And so that balance between anabolic and catabolic functions of mitochondria* [**incomplete**] *is one I'll come back to later, but it appears to be critically important.* (BIO_2020-01-20)

(174) [**procedural**] *And those 13 proteins... all of them co-assemble with other nuclear-encoded cytosolically synthesized proteins into large protein complexes, which creates very interesting and important challenges of coordination* [**incomplete**] *that we'll talk about later.* (BIO_2020-01-20)

Alongside these four types of definitional segments, YouTube video scripts also incorporate two additional elements within the structure of the definition: examples and questions. The formers are usually placed at the end of the segment, as in (175), and they are used as an audience-oriented device that helps viewers understand the concepts. Questions, on the contrary, are typically placed at the beginning of the definitional chain, as in (176), and are utilised to introduce the concept under analysis and stimulate receivers' critical thinking.

(175) *[...] that was based on a physical law called diffusion. Diffusion is the rule of the universe that molecules, especially in liquids or gases, are constantly moving around in all directions. And because they move around and bump into each other and other molecules, they tend to spread.* ***For example,*** *if you drop a sugar cube into water then there is a lot of sugar in one place and in another place there is none.* (KUR_2020-11-10)

(176) ***But what is a neutron star?*** *Think of a compact ball inside of which protons and electrons fuse into neutrons and form a frictionless liquid called a superfluid— surrounded by a crust. This material is incredibly dense – the equivalent of the mass of a fully-loaded container ship squeezed into a human hair, or the mass of Mount Everest in a space of a sugar cube.* (TED_2018-11-20)

From a quantitative and micro-structural point of view, Tab. 54 shows that the most frequently occurring type of definition is the *prototypical* (177), which is employed to present the essential features and attributes of the concepts under discussion.

(177) *Sucrose is a carbohydrate. As is glucose, fructose, etc. Carbohydrates are molecules that contain an awful lot of energy.* (ACS_2016-10-21)

Contrary to other media, prototypical definitions in YouTube videos typically adhere to a consistent internal structure, where the *definiens* follows the *definiendum* (178): this means that the unknown term is normally introduced before its corresponding explanatory sentence. In this specific context, displaying a consistent definitional order helps viewers become familiar with the format, thus making it easier for them to recognise, cognitively process and understand the key elements within the segment.

(178) *So, metabolism...*[**definiendum**] *metabolism is easily the most famous function of mitochondria. That's what we think about typically when we think about mitochondrial function* [**definiens**]. (BIO_2020-01-20)

Definiens and *definiendum* are joined together by a variety of hinge types. As shown in Tab. 57 and Fig. 51, authors of science-themed YouTube videos use both implicit and explicit hinges, with the explicit type being significantly prevalent.

HINGE TYPES	**Frequency**
EXPLICIT	87
IMPLICIT	13
TOTAL	**100**

Table 57. Frequency distribution of hinge types in the YouTube subcorpus.

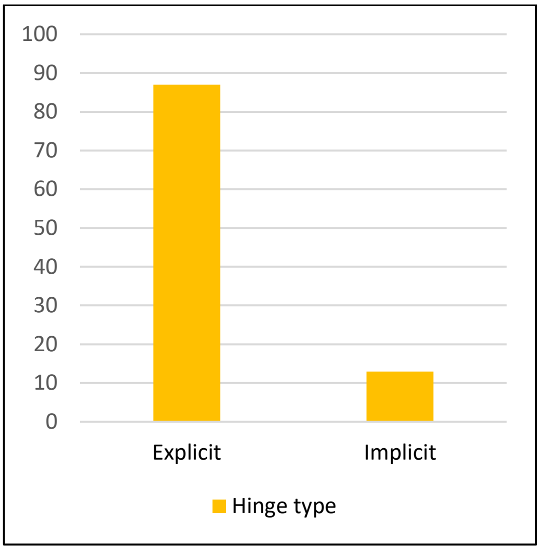

Figure 51. Frequency distribution of hinge types in the YouTube subcorpus (histogram).

As far as implicit hinges are concerned, authors typically rely on two devices: commas – or double commas – and dashes, as examples 179 and 180 display. In the specific context of YouTube videos, implicit hinges usually arise in conjunction with visual aids, such as written slides in the background, which are employed to clarify the connections between the presented notions.

(179) *Resistance against Colistin**,** a last-ditch antibiotic**,** had been discovered.* (KUR_2016-03-16)

(180) *But it wasn't until 1869 that legendary Russian scientist Dmitri Mendeleev developed an elegant and very useful method which would later evolve into one of science's most brilliant icons* — *the periodic table.* (ACS_2018-11-08)

However, as mentioned *supra*, speakers in science-themed YouTube videos display a preference for explicit hinges. The items retrieved during the present investigation are reported in Table 58 below.

EXPLICIT HINGES	**Freq.**
is + noun	18
is + adverb + noun	12
is + adjective + noun	9
called	8
defined as	7
known as	5
referred to as	5
that X call	5
X define it as	4
this is known as	4
otherwise known as	3
that we call	2
or	2
you may know it as	2
you've seen it marketed as	1
TOTAL	**87**

Table 58. Types of explicit hinge types retrieved in the YouTube subcorpus.

This preference may be connected to the challenges and difficulties of conveying specialised concepts to non-experts within the spoken medium: in videos, people are not presented with the entire text, but discover the concepts following the rhythm of the video. As a consequence, this aspect compels speakers to opt for structures and techniques that facilitate an easy understanding of the concepts and that streamline the cognitive processing of the information:

(181) ***You may know*** *the periodic table* ***as*** *a super organized collection, containing information about each element placed into rows and columns.* (ACS_2018-11-08)

(182) *Water* ***is an interesting substance*** *with a chemical makeup that gives it some unique physical properties.* (ACS_2018-11-08)

(183) *Deeper in the crust, the neutron superfluid forms different phases* ***that physicists call*** *"nuclear pasta", as it's squeezed from lasagna to spaghetti-like shapes.* (TED_2018-11-20)

Within this context, it is also important to highlight that, in YouTube videos, speakers frequently use hinges that include 1st and 2nd person pronouns (e.g., *that we call*, *you've seen it marketed as* and *you may know it as*). This may be motivated by the fact that, on the one hand, structures including the pronoun *we* (184) help reduce the physical and content-related distance between viewers and authors. On the other hand, patterns including the pronoun *you* (185) are audience-oriented tools that enable speakers to directly address their public, thus making them feel involved in the discussions.

(184) *There are 18 numbered columns on the table* ***that we call*** *groups.* (ACS_2018-11-08)

(185) *Aspartame,* ***you've seen it marketed as*** *"nutrasweet" or "equal" isn't even close to a sugar.* (ACS_2016-10-21)

Going back to the types of definitions, the second most frequent structure is the *procedural* (186), exploited to provide the public with details on the specific functions and processes connected to the object under analysis.

(186) *These hydrogen bonds give water a boiling point that is about 200 degrees higher than it should be when compared to other similar substances.* (ACS_2018-11-10)

Procedural segments are usually linked to the preceding elements via various explicit hinges: transformative material verbs (example 187), causative verbs (188) and domain-specific verbs (189), as indicated in table 59. See also Fig. 52 for a graphic representation of such data.

HINGE TYPES	**Frequency**
Transformative material verb	31
Causative verb + clause	23
Domain-specific verb	7
TOTAL	**61**

Table 59. Types of verbal clauses serving as hinge in procedural definitions within the YouTube subcorpus.

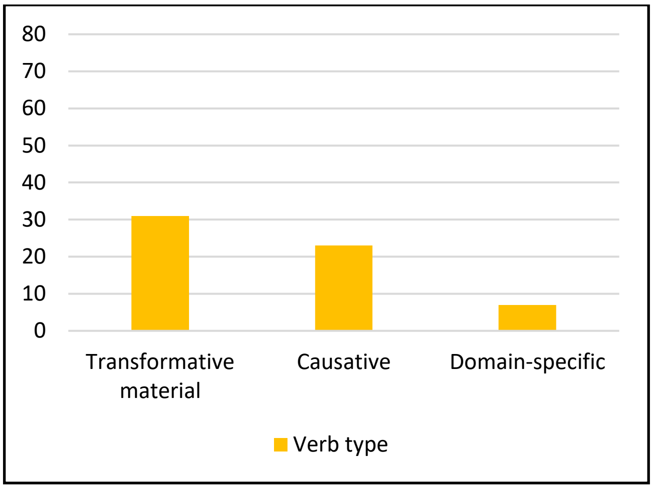

Figure 52. Frequency distribution of verbal clauses serving as hinge in procedural definitions in the YouTube subcorpus (histogram).

(187) *Immunotherapies* ***turn*** *immune cells into cancer hunters by training them on substances known as tumor-associated antigens.* (ACS_2020-08-08)

(188) *SERS* ***enables researchers to detect*** *interactions between individual molecules through changes in how they scatter light.* (ACS_2020-08-20)

(189) *Aspirin* ***inhibits*** *platelet cyclooxygenase, which prevents platelets from aggregating together.* (OSM_2018-06-26)

Resuming the exploration into the various types of definitions, in YouTube videos the *figurative* type resulted to be the third most frequent kind of definitional segment (190). As already stated, it consists in the use of analogies, metaphors, thought experiments and scenarios to make specialised content accessible and relevant to people's daily lives and experiences.

(190) *Imagine having trillions of little bombs inside your blood that could go off at any moment. So, our cells use numerous mechanisms to prevent complement from accidentally attacking them.* (KUR_2019-07-28)

In the specific context of science videos, *figurative* definitions turned out to serve both as introductory and concluding segments of the definitional chain, and always appeared in conjunction with the *prototypical* and/or *procedural* types. Tab. 60 displays the various forms employed for the creation of the *figurative* definitions. See also the histogram portrayed in Fig. 53.

FIGURATIVE DEFINITION TYPES	**Frequency**
Thought experiment	15
Analogy	7
Metaphor	5
TOTAL	**27**

Table 60. Types of figurative definition within the YouTube subcorpus.

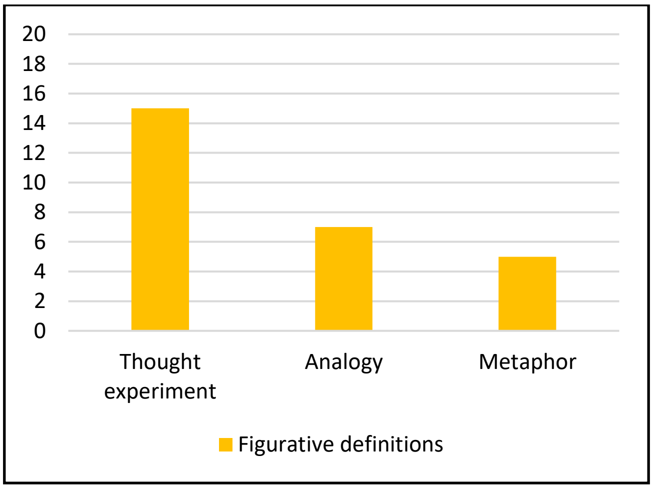

Figure 53. Frequency distribution of figurative definition types in the YouTube subcorpus (histogram).

As readers can observe, this analysis has revealed that the most frequent form of figurative definition in science-themed YouTube videos is the thought experiment, which occurs 15 times (191). Following that, analogies and metaphors are employed, respectively, 7 and 5 times. These devices engage viewers by actively drawing them into the discussions and by prompting them to link the presented topic with their previous knowledge. As a result, a deeper understanding with the information is fostered and the overall learning experience is enhanced.

(191) *Think of a compact ball inside of which protons and electrons fuse into neutrons and form a frictionless liquid called a superfluid— surrounded by a crust.* (TED_2018-11-20)

(192) *However, electron impact is sort of like a bullet hitting a glass bottle… so sometimes the sample molecule is broken apart into other ion fragments.* (CC_2020-06-09)

(193) *The exception to this is prolene, which is a tiny little golden ring.* (OSM_2019-12-27)

Finally, YouTube video scripts also incorporate examples of *incomplete* definitions. In this context, they work as interest-boosting mechanisms and cater to the *delectare* rhetorical aim. At the same time, they also provide the necessary information without overwhelming viewers with excessive details. Linguistically speaking, they are either signalled by phrases such as 'more on that later' (194) – which explicitly indicate that the information will be presented at a future point in time – or by clauses containing a verb in the future tense, as in (195).

> (194) *Oecophylla Weavers walk on long legs, have slender bodies and large eyes which make them look pretty cute, although their strong mandibles and the ability to shoot acids also make them pretty good at killing,* ***but more on that later****.* (KUR_2020-08-30)

> (195) *And so that balance between anabolic and catabolic functions of mitochondria is one* ***I'll come back to later****, but it appears to be critically important.* (BIO_2020-01-20)

5.3.2.2 Discussion of the results

In conclusion, this investigation has revealed that, in YouTube videos, specialised topics are presented in a way that strikes a balance between the accuracy of the presented information and the attention to the diverse needs of the audience.

On the one hand, definitions are mostly presented in the form of *definitional patterns*, which are shorter and less cognitively complex to decode compared to the longer definitional chains. Nevertheless, these chunks still manage to provide accurate and detailed descriptions of the concepts: this is evidenced by the widespread use of the *prototypical* + *procedural* pattern, which effectively conveys both theoretical and practical aspects within a well-defined segment.

On the other hand, various techniques are adopted specifically to ensure clarity, accessibility and people's intellectual involvement. Above all, authors employ *figurative* and *incomplete* definitions as key tools to engage the public, establish links between the specialised contents and people's lives, keep their interest alive and provide the correct amount of information without overloading. More specifically, by utilising devices such as analogies, scenarios and thought experiments, speakers make concepts more relatable and accessible. At the same time, the use of *incomplete* definitions enables a gradual unveiling of knowledge, which titillates people's interest and creates expectations. Furthermore, from a linguistic point of view, the exploitation of a fixed pattern of the constituents – with the object under analysis always preceding its definition (*definiendum*>*definiens*) and the presence, in most cases, of examples and questions embedded within the definition itself – helps viewers become familiar with the format, thus making it easier for them to recognise, cognitively process and understand the topics under discussion. Subsequently, the reliance on figurative definitions presenting analogies and scenarios that resemble the everyday-life environment helps people without scientific background to visualise concepts better. Ultimately, the reliance on explicit hinges within *procedural* and *prototypical* definitions makes it possible for speakers to structure the message clearly, without requiring viewers to infer meaning or make connections between the different parts on their own.

5.3.3 Definitions in comic books about science

5.3.3.1 Presentation of the results

In comic books, four types of definitions were retrieved: *prototypical, procedural*, *figurative* and *incomplete*. As shown in Tab. 61, the category with the highest frequency turned out to be the *prototypical*, which was retrieved in 88 cases. Following that, we find the *procedural* (43 instances), *figurative* (35 cases), and *incomplete* types (10 occurrences). See also the histogram displayed in Fig. 54 for a visual representation of such data.

DEFINITION TYPES	**Frequency**
PROTOTYPICAL	88/100
PROCEDURAL	43/100
FIGURATIVE	35/100
INCOMPLETE	5/100
TOTAL	**171**

Table 61. Frequency distribution of definition types in the comics subcorpus.

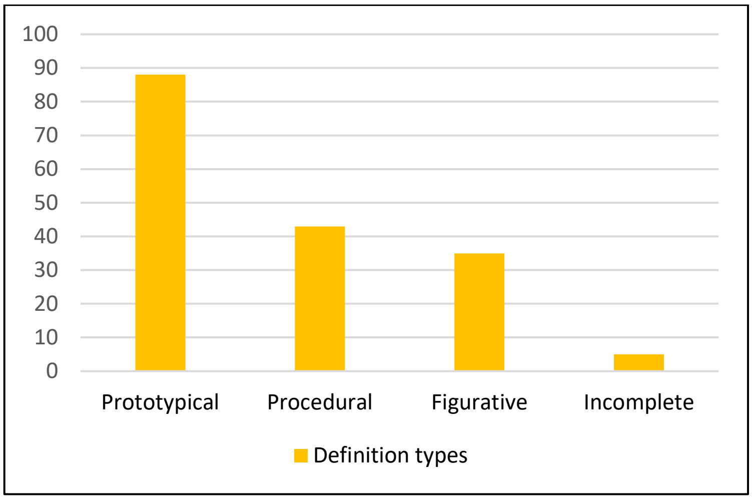

Figure 54. Frequency distribution of definition types in the comics subcorpus (histogram).

In science-themed comics books, a mere 20% of the instances turned out to be classified as *definitional strings*. Interestingly, in most cases authors decided to break down the information in different parts, therefore displaying the *prototypical, procedural* and *figurative* definitions as standalone elements. This may be connected to the nature of the medium itself, which calls for a more segmented presentation of the concepts, following both the visual representation of balloons and the main narrative line.

When present, the pattern emerging as the most frequent was *figurative* + *procedural* (196). In this pattern, specialized information was accompanied or introduced by analogies, metaphors, or thought experiments that sparked the readers' imagination and connected domain-specific concepts with their everyday experiences. Another prevalent pattern that emerged was the *prototypical/figurative* + *incomplete* pattern (197): here, authors introduced the topic being analysed and indicated that they would delve into it further in subsequent pages.

(196) [**figurative**] *The Sun is a gigantic nuclear furnace, heating up our entire solar system.* [**procedural**] *The Sun's rays travel 93 miles to Earth and enter the atmosphere.* (ES_Wildweather)

(197) [**figurative**] *Each organism contains a complete "instruction manual," encoded into "volumes" of molecules!* [**incomplete**] *Which brings us to our next chapter...* (B_CartoonGuides)

In numerical terms, the *prototypical* segment (198) stands out as the most frequently occurring in the corpus. Within this chunk, authors also normally include examples (199) and questions (200) to help readers orientate within the text.

(198) *Consumers that eat plants for energy are called herbivores. This group includes tiny insects and larger animals, such as with-tailed deer.* (ES_ExploringEcosystems)

(199) *Inertia is the ability of an ecosystem to resist change. A rain forest,* ***for example****, has high inertia.* (ES_CartoonGuides)

(200) ***What's the atmosphere?*** *The atmosphere is the layer of gases that surrounds the Earth, before you get to space. It's broken up into a few layers: exosphere, thermosphere, mesosphere, stratosphere, ozone layer, troposphere. But most of our weather happens in the troposphere, the layer closest to the Earth.* (ES_Wildweather)

Additionally, *definiens* and *definiendum*, which typically occur in the form of *definiens>definiendum*, are joined together by a variety of hinge types, both explicit and implicit. In the specific context of science comics, though, authors mostly employ implicit devices, as can be noted in Tab. 62 and Fig. 55.

HINGE TYPES	**Frequency**
IMPLICIT	62
EXPLICIT	38
TOTAL	**100**

Table 62. Frequency distribution of hinge types in the comics subcorpus.

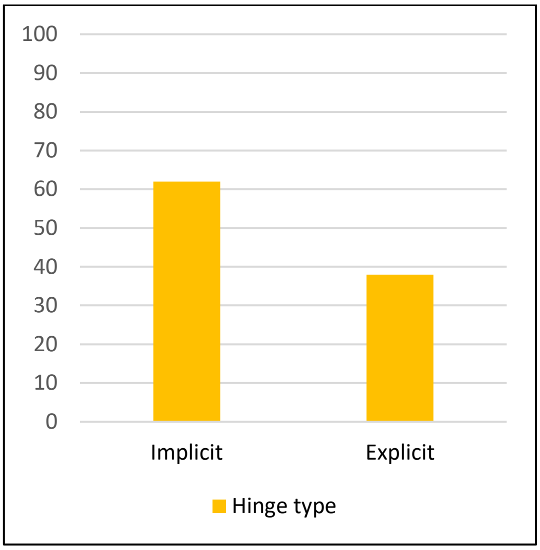

Figure 55. Frequency distribution of hinge types in the comics subcorpus (histogram).

As far as the implicit hinges are concerned, writers typically rely on devices such as colon, dashes, double commas and bullet points, as evident in examples 201 and 202. In addition to these elements, comic book texts also make use of visual cues, consistent colour schemes, different types of speech and thought balloons, and changes in character expressions that imply a logical/temporal progression.

> (201) *Cinder cone* — *a cinder cone forms from magma erupting from a single vent. The lava cools into cinders. The cinders fall around the volcano, forming a small circular cone.* (ES_Whenvolcanoeserupt)

> (202) *Stratovolcano*: *stratovolcanoes are the most destructive types of volcanoes. They form in layers of flowing lava, volcanic ash, cinders, and bombs of lava.* (ES_Whenvolcanoeserupt)

However, as shown in the table above, authors also exploit explicit hinges, which are listed in Tab. 63 below. In this specific medium, authors normally rely on a number of recurring and straightforward linguistic structures, such as the verb *to be* followed by a noun, or verbs like *to call, to define* and *to refer*. This choice may be motivated by the fact that through the establishment of a predictable definitional structure, readers can more easily become familiar with these aspects.

EXPLICIT HINGES	**Freq.**
is/are + noun	20
called	11
defined as	4
refers to	3
TOTAL	**38**

Table 63. Types of explicit hinge types retrieved in the comics subcorpus.

Returning to the study on the different types of definitions, the second structure identified was the *procedural* definition (203). Unlike *prototypical* or *figurative* definitions, which frequently appeared in conjunction with other segments, *procedural* chunks often appeared as standalone elements, typically accompanied by illustrations that visually reiterate the explanation of processes.

> (203) *In a Peleean eruption, thick magma locks the main vent, rising magma then pushes the blockage upward, forming a dome above ground.* (ES_Whenvolcanoeserupt)

Linguistically speaking, *procedural* definitions are typically characterised by the use of explicit hinges in the form *transformative material* verbs (203), which enable authors to depict dynamic actions and movements effectively. Furthermore, by using verbs that are not overly specialised, as in (204), authors ensure that the represented actions and movements are easily recognisable and relatable to the entire public of readers.

> (204) *A Strombolian eruption* ***produces*** *pasty and thick lava flows. The lava* ***spurts out*** *of the volcano in blobs. It* ***hardens*** *in the air and* ***falls*** *to the grounds in chunks.* (ES_Whenvolcanoeserupt)
>
> (205) *Blocks are hardened chunks of lava that* ***break off*** *from the volcano and* ***are hurled*** *skyward during an eruption.* (ES_Whenvolcanoeserupt)

Figurative definitions constituted the third most encountered type of segments (206).

> (206) […] *Yes, and the crust is… Like the crust of a sandwich!* (ES_Wildweather)

In this specific context, they were found to be used both as introductory and concluding segments within the definitional chain, and mostly appeared in conjunction with the *prototypical* and/or *procedural* chunks. As readers can observe in Tab. 64 and in Fig. 56 below, *figurative* definitions take many forms.

FIGURATIVE DEFINITION TYPES	**Frequency**
Analogy	20
Metaphor	10
Thought experiment	5
TOTAL	**35**

Table 64. Types of figurative definition within the comics subcorpus.

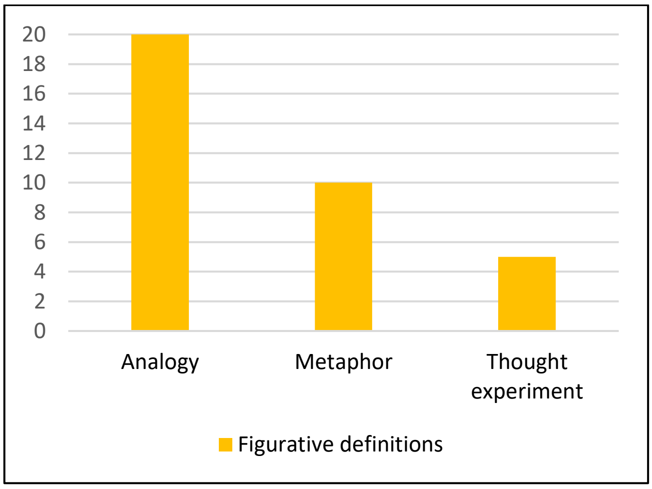

Figure 56. Frequency distribution of figurative definition types in the comics subcorpus (histogram).

Of the three types, analogies, introduced by linkers such as *like* (207), emerged as the most observed category (20 occurrences), followed by metaphors (10 occurrences), as in (208), and thought experiments (5 occurrences). In this specific medium, to better clarify and help readers visualise specialised contents and processes, authors use everyday life or well-known objects as referents for the metaphors and analogies (e.g., paper sheets, furnaces, walls).

(207) *Stratus clouds are* ***like*** *flat grey sheets that might bring some drizzle or light precipitation in the day.* (ES_Wildweather)

(208) *The Sun is a gigantic nuclear furnace, heating up our entire solar system.* (ES_Wildweather)

(209) *All matter is made up of tiny particles called atoms.* ***Imagine*** *a brick wall that is made of individual bricks. Like the bricks, atoms are the pieces that make up matter.* (CHEM_GhostsandAtoms)

Lastly, the category with the lowest frequency comprises the *incomplete* – or *delayed* – definitions. From a linguistic standpoint, they can be lexicalized through various means. They can be introduced by adjectives such as *next* or *ensuing* in combination with nouns that refer to specific locations within the book, as exemplified in (210). They can be lexicalised by fixed phrases like *more on that shortly* or *more on that later* (211), or, finally, by clauses containing future-tense verbs (212).

(210) *The committees that "regulate" fishing have usually been dominated by the fishing industry... and governments are increasingly dominated by non-farming city dwellers, as cities swell with industrialization.* ***In our next chapter****, we look at urban ecology…* (ES_CartoonGuides)

(211) *Some of them sublime, or go straight to the gas phase.* ***More on that shortly****.* (CHEM_CartoonGuides)

(212) *We also saw how a buildup of reaction products could start a reverse reaction that overtakes the forward reaction at equilibrium. In the next chapter,* ***we'll explore*** *some great uses of the concept—and the constant—of equilibrium, and in the chapter after that,* ***we'll dig*** *deep and discover what equilibrium really means.* (CHEM_CartoonGuides)

5.3.3.2 Discussion of the results

Overall, this investigation has revealed that, in comics, in addition to presenting specialised topics in an accurate and detailed way, significant emphasis is placed on ensuring the accessibility of this knowledge to a heterogeneous public of readers. This is demonstrated, above all, by the choice of the authors to avoid using dense definitional strings and to present the information contained in the *prototypical*, *procedural* and *figurative* segments as standalone elements. By conveying specialised contents in distinct parts, authors are thus able to help their public navigate across the contents, leaving them the necessary time to focus on each aspect individually: this, in turn, results in an easier processing of the information and in a better assimilation and retention of the domain-specific knowledge. Furthermore, considerable emphasis is placed on *figurative* and *incomplete* definitions, which are acknowledged as devices that engage the public and that enable them to establish links between the specialised contents and their everyday lives.

Ultimately, from a linguistic point of view, authors of science-themed comic books employ various strategies that make this medium suitable for a wide and heterogeneous public. These include, for instance, the use of examples and questions embedded within the definition, which allow for the breaking down of the information into smaller and more digestible segments. Likewise, the adoption of fixed definitional patterns – with the object under analysis always preceding its definition – and the reliance on a fixed and repeated number of explicit hinges enables a consistent and predictable structure in the process of information transmission: this, in turn, helps the audience navigate the contents and comprehend the issues more easily.

5.4 Reaching the *delectare* aim: the role of questions

Shifting the focus to the study on the *delectare* rhetorical aim, which encompasses the intricate process of captivating and engaging the public, interrogative sentences were investigated as part of the techniques for reader engagement.

Generally perceived as strategies to be avoided in academic writing (Hyland 2002b), thus often under-studied in scholarly literature, questions are defined as the strategy of dialogic involvement *par excellence*, since they "presuppose and mark the presence of the reader whose attention is captured and focused on the key points of the argumentation" (Hyland 2005: 374). More specifically, their aim is twofold: they work as a form of support for the structuring of the discourse – guiding the audience along the author's line of reasoning – and they serve as rhetorical tools that facilitate the transition from a monologue-style communication to an interactive dialogue. Indeed, through these tools, people are drawn into the topics and are seen as active participants into the discussions (Zou & Hyland 2019): as Webber (1994: 266) points out "questions create anticipation, arouse interest, challenge the reader into thinking about the topic of the text and have a direct appeal in bringing the second person into a kind of dialogue with the writer".

However, it is important to note that questions perform a wide range of functions, address different aspects of the text and can have different authoritative impacts on the discourse: the ensuing paragraph will therefore conduct a more in-depth investigation into these aspects, in order to examine how blogs, YouTube videos and comics make use of these devices to engage their audiences.

5.4.1 Questions in blog posts

5.4.1.1 Presentation of the results

On the basis of scholarly studies on this topic (see, *inter alia*, Webber, 1994; Hyland, 2002b; Zou & Hyland, 2020), a detailed examination was conducted to better understand the role and usage of interrogatives in blog posts. The corpus was queried and analysed by combining quantitative and qualitative approaches. In terms of their distribution, a total of 108 question instances were extracted from this subcorpus, as indicated by the data presented in Table 65.

QUESTIONS	**BLOG POSTS**	
	RF	NF (PTT)
TOTAL	**108**	**6.45**

Table 65. Frequency distribution of interrogatives in the Blogs subcorpus.

Upon closer examination, questions were classified according to their position into four sub-types: interrogatives occurring within the text, in headings or subheadings, in titles and in the concluding segments. Table 66 below reports this division and indicates the raw and normalised frequencies for each type. See also the histogram displayed in Fig. 57 for a graphic representation of such data.

POSITION OF THE QUESTION	**BLOG POSTS**	
	RF	NF (PTT)
IN THE TEXT	41	2.5
HEADING/ SUBHEADING	39	2.3
CONCLUSION	18	1
TITLE	10	0.6
TOTAL	**108**	**6.4**

Table 66. Frequency distribution of the different positions of the questions in the Blogs subcorpus.

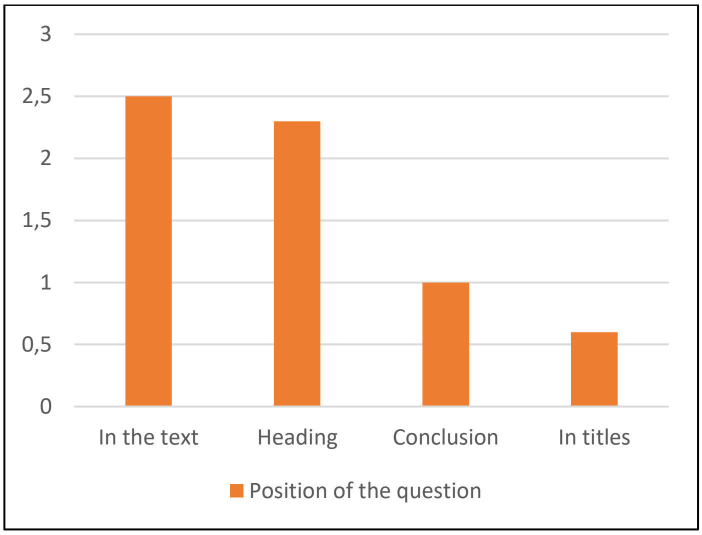

Fig. 57. Frequency distribution of the different positions of the questions in the Blogs subcorpus (histogram).

As readers can see, in the specific context of popular science blogs, questions are strategically placed throughout the texts, particularly within the body of the posts (41 occurrences) and in headings (39 occurrences). However, these devices can also be retrieved in the concluding segments of the post (18 occurrences) and, occasionally, in titles (10 occurrences).

Firstly, questions in headings (213) and within the body of the text (214) serve multiple functions. For instance, they can be employed as tools to introduce a new topic or to highlight research questions and overarching problems. By incorporating questions in these positions, bloggers provide the public with a clear focus for discussing the relevant issues. This aspect, in turn, not only helps them follow the presented information, but also facilitates their understanding of the most relevant points contained in the texts. Additionally, interrogatives can also be utilised to structure the discourse. The strategic inclusion of these items at regular intervals inside the body of the texts contributes to breaking down the information into more digestible units, consequently improving the readability and accessibility of the post.

(213) ***How Do Models Help Forecast the Spread of Infectious Diseases?*** *In a similar fashion, multiple models exist for forecasting the spread of infectious diseases. These models use existing data related to disease transmission, symptoms and health complications, and other factors to estimate the number of people who will become infected and, in some cases, die from the disease.* (BIOB_2020-04-29)

(214) ***How does the supplement folic acid get into our bodies?*** *I had assumed it was taken up in the same way as natural folates found in our diet, but our bodies take it up through different protein channels.* (ONB_2018-06-15)

Another type of interrogatives frequently occurring in blog posts is the use of questions within concluding segments, as in (215) and (216). From a discursive point of view, these are exploited to prompt readers to think critically about the implications and potential applications of the information presented. This introspective process, in turn, may even inspire the public to take individual actions, deepen their knowledge in the field and engage in dialogues and discussions beyond the post itself.

(215) *It's not possible to directly verify the forecasts of a forest model in future decades. So the researchers did the next best thing: They seeded their model with forest composition data collected at their site in Panama during the 1980s and then ran the model forward to show that it accurately represents the changes that occurred from then until now. Next, they plan to explore how a warming world might benefit trees with certain traits over others, shifting forest composition and the potential of forests to store carbon. "One of the biggest unknowns in climate forecasting is:* ***What are trees going to do****? Right now, they're absorbing some of the excess carbon we're producing and delaying climate change, but* ***will they keep doing it?*** (ECN_2020-04-20)

(216) *As rescue workers search for more than 100 people who are still missing, officials and scientists are trying to unravel the causes of the sudden flood.* ***What links might these events have to a changing climate?*** (SNE_2021-02-09)

Lastly, questions can also be found within the titles of the posts. In this specific context, they work as attention-grabbing devices: people are naturally drawn to find answers to questions, and inserting these devices in titles immediately tackles their interest, enticing them to click and read the post. In addition, they also contribute to the engagement and investment of readers by prompting them to reflect on their own experiences, opinions and previous knowledge on the issues. Furthermore, they also serve as preview of the contents that will be explored, thus instilling in the public several expectations that pique their curiosity. Ultimately, this type of questions helps bridge the gap between the realm of science and readers' everyday lives. Interrogatives placed in the title may reflect a concern or curiosity that the reader shares, fostering a connection that makes the presented content more accessible and relatable:

(217) ***Fluoride to the rescue?*** *A big leap forward in addressing antibiotic-resistant bacteria.* (SCI_2021-01-10)

(218) ***Why do aphids piggyback on each other after dropping off the plant?*** (ONB_2018-12-06)

To thoroughly examine the discursive function played by the extracted questions in this specific medium, a close reading of 100 randomly extracted occurrences was conducted. What is more, to understand the various functions and sub-functions performed, this phase was complemented by the insights provided by the model developed by Thompson (1998).

In line with this framework, the extracted questions were divided into two macro-categories, namely *audience-oriented* and *content-oriented*. According to him, the former category relates to the instances "in which something appears to be demanded by the presenter of the audience, and which at least symbolically allow the audience an opportunity to provide actual verbal or non-verbal response" (1998: 140). In other words, they are addressed to the needs, interests and expectations of the public, thus aiming to understand their perspective and tailor the information to their specific needs. *Content-oriented* questions are, on the contrary, the interrogatives that focus on the content of the message itself. They are generally rhetorical questions which do not expect audience response, but that are used to ensure that the framing of the message is accurate, well-supported and organised. The following Tab. 67 shows the frequencies retrieved in this specific subcorpus of each function. See also the histogram portrayed in Fig. 58 for a visual representation of such data.

QUESTION TYPE	**BLOG POSTS**	
	RF	NF (PTT)
CONTENT-ORIENTED	96	5.7
AUDIENCE-ORIENTED	12	0.7
TOTAL	**108**	**6.4**

Table 67. Frequency distribution of the different types of questions in the Blogs subcorpus.

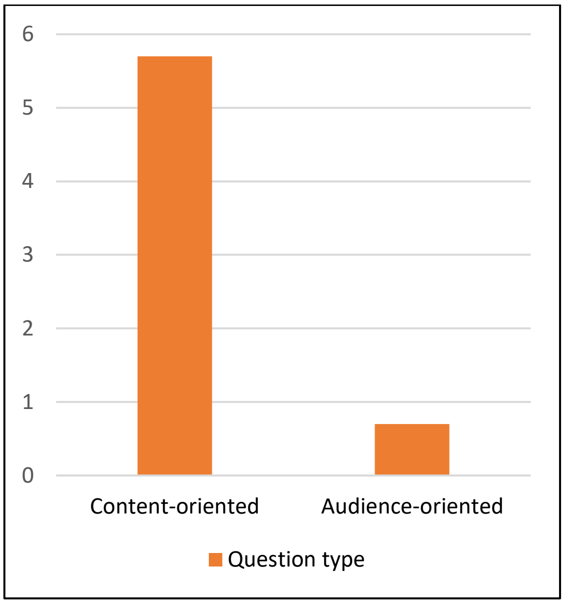

Figure 58. Frequency distribution of the different types of questions in the Blogs subcorpus (histogram).

As readers can observe, *content-oriented* questions stand out as the most frequent type of interrogatives in science blogs (96 instances). These items are aimed at engaging readers for knowledge transmission purposes: the intention behind their inclusion is to foster a sense of active participation that deepens people's understanding on the topics and helps them navigate across the various issues. *Audience-oriented* questions, on the other hand, were retrieved in only 12 instances. In this case, such interrogatives are aimed at engaging people on a more personal level. Upon closer investigation, both categories appear composed of different discursive sub-functions.

As far as the *content-oriented* category is concerned, six different discursive functions were identified and labelled as follows: 'framing discourse' (35 occurrences) was the most frequent, followed by 'organising texts' (27 occurrences), 'food for thought' (17 occurrences), 'getting attention' (10 occurrences), 'stressing the novelty or importance of an issue' (4 occurrences) and 'marking an attitude' (3 occurrences). See the following Table 68 and Fig. 59.

CONTENT-ORIENTED FUNCTIONS	BLOG POSTS	
	RF	NF (PTT)
Organising texts	48	2.7
Food for thought	17	1
Getting attention	10	0.7
Stressing the novelty or importance of an issue	10	0.7
Marking attitude	10	0.7
TOTAL	**96**	**5.8**

Table 68. Frequency distribution of the different content-oriented types of questions in the Blogs subcorpus.

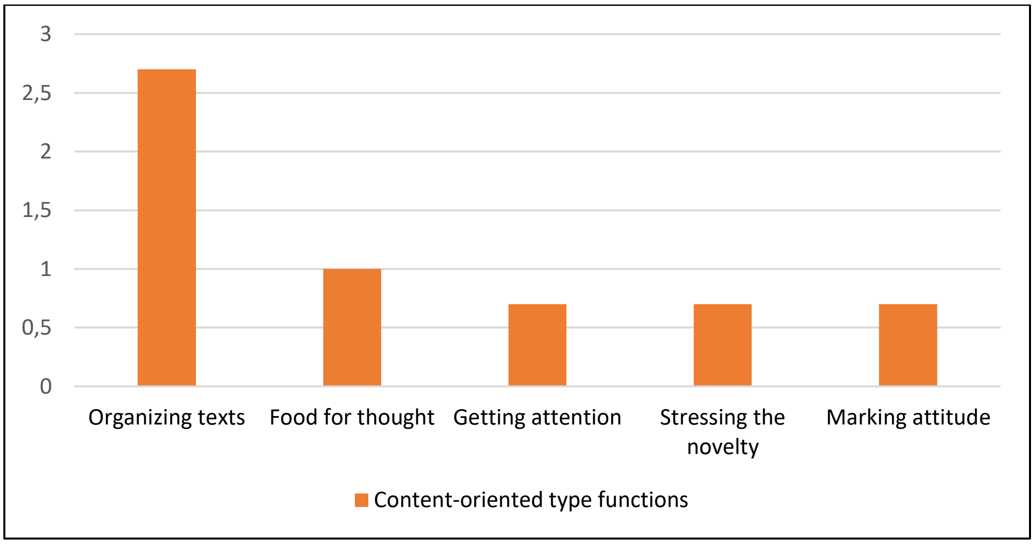

Fig. 59. Frequency distribution of the different content-oriented types of questions in the Blogs subcorpus (histogram).

The function labelled as ‘organising texts’, generally found within the text (219) or in headings and subheadings (220), is utilised in blogs to offer readers a coherent, well-structured text that is accessible and that avoids overwhelming them with excessive information. They can be used to establish context, introduce a specific topic and define the boundaries of the discussion. These devices enhance readability and facilitate information retrieval: with these questions acting as signposts, the public is guided through the presentation of the various concepts and can easily retrieve the main points of interest.

(219) ***How do swimming bacteria sense that they have found a potential surface to colonize?*** *Working with the bacterium Caulobacter crescentus, Indiana University Ph.D. student Courtney Ellison and her colleagues, under the direction of professor of biology and NIGMS grantee Yves Brun, recently showed that hair-like structures on the cell's surface, called pili, play a role here.* (BIOB_2018-02-05)

(220) *The Science of Infectious Disease Modeling.* ***What Is Computer Modeling and How Does It Work?*** (BIOB_2020-04-29)

Secondly, the category labelled as 'food for thought' (220) was specifically created for this context to indicate the interrogatives used to raise unresolved issues and emergent topics. In blogs, they can serve as thought-provoking devices that elicit reflections, spark curiosity and invite people to explore different possible scenarios. This, in turn, not only improves people's critical thinking abilities, but also motivates them to act.

(221) *How hot will it get? How high will the seas rise?* (SNE_2020-01-07)

Thirdly, 'getting attention' questions refer to the interrogatives found in titles. These items represent the first encounter readers have with the text and are therefore crucial in persuading them to continue reading. As illustrated in example 222, these questions are primarily designed to catch and hold people's attention. However, they also act as inputs for further discussion on the topic, both within and outside the blog itself.

(222) *Newly Identified Cell Wall Construction Workers:* ***A Novel Antibiotic Target?*** (BIOB_2016-10-12)

Fourthly, the discursive function labelled as 'stressing the novelty/importance of an issue' refers to the interrogatives utilised to emphasize the significance or novelty of the issues being discussed. As demonstrated in the following example, these utterances are typically placed before or after a claim, in order to strengthen its validity and credibility. Inserting these devices acquires a role of the utmost importance in this context, because it allows authors to render the presented notions more meaningful and impactful.

(223) *García-Garibay's research team has been working for 10 years on motion in crystals and designing molecular motors in crystals.* ***Why*** *is this* ***so important?*** (SCI_2016-09-22)

Finally, one last sub-type of *content-oriented* questions is the 'marking attitude' function. These utterances can be located at the beginning, end, or within the body of the texts, and bloggers use them to express their personal evaluation of the topics being discussed. As illustrated in the following example, these questions allow authors to demonstrate the significance of the debated issues and, at the same time, encourage the development of constructive debates and discussions.

(224) ***Why*** *does such a* ***complicated*** *system exist?* (BIOB_2018-03-28)

Transitioning now to the *audience-oriented* category of questions, a distinct discursive function emerged. This function, not present in the model developed by Thompson (1998), was labelled as 'summary', and was highlighted in 12 instances (225). Normally found in the concluding segments of the posts, these questions are employed by authors to prompt readers to reflect on what has been discussed in the post, and, consequently, to check whether they come away with a clear understanding of the specialised concepts. These tools thus act as guides, ensuring that readers understood the main idea without getting lost in the details. At the same time, they also serve as memory cues that aid in the cognitive process and retention of knowledge.

(225) ***What can we learn from these findings about the fundamentals of tree frog attachment?*** *From an evolutionary perspective, the similarity of the mucus gland morphology and mucus chemistry between species of different lifestyles disagrees with an adaptation of the mucus gland system in the toes of tree frogs towards attachment.* […] (ONB_2019-07-26)

5.4.1.2 Discussion of the results

The joint quantitative and qualitative analyses on the functions and frequencies of interrogatives made it possible to draw a number of conclusions concerning the role that these items play in the engagement and interaction with the public. As demonstrated, two types of questions are to be found in popular science blogs: *audience-oriented* and *content-oriented*. The pie chart represented in Fig. 60 portrays their distribution.

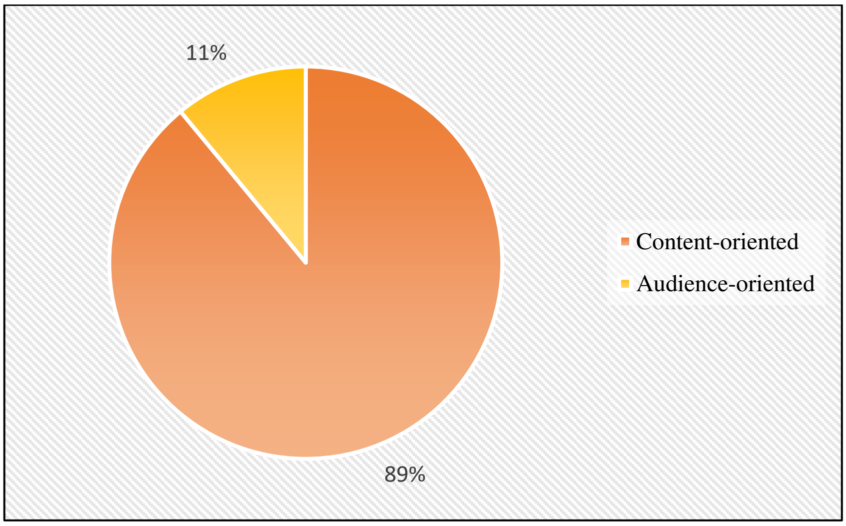

Figure 60. Distribution of the different question types in the Blogs subcorpus (pie chart).

As we can notice, in Institutional science-themed blogs, authors mainly employ questions with a *content-oriented* function, which points to the fact that these tools are not strategically used for mere entertainment purposes, but they are exploited to captivate the attention of the public to accurately transmit specialised contents. As a consequence, this figure suggests that, in this specific context, even when utilising linguistic devices normally tailored for the *delectare* rhetorical function, the *docere* aspect is predominant.

The emphasis on this type of questions clearly brings to the fore the intention of authors to provide the public with detailed information and thought-provoking contents. Indeed, by using interrogatives mostly located within the text and mainly associated with functions such as 'framing discourse', 'organising texts', 'marking attitude' and 'stressing the novelty or importance of an issue', authors provide their audience with an accessible text that is coherent and well-structured, whose information load is well-balanced, and in which the most salient points are effectively highlighted. These aspects, in turn, enhance the overall readability of the posts, facilitate their understanding, and ease people's cognitive processing and information retention. Additionally, by inserting questions performing the so-called 'food for thought' function in the conclusion, authors stimulate an introspective process of critical thinking, which brings people to explore different viewpoints, deepen their knowledge in the field and which may even push them to take action in their everyday lives.

Ultimately, the idea that Institutional science-themed blogs prioritise content transmission and the learning process over establishing a relationship with the audience is further reinforced by the type of *audience-oriented* questions found in this context. Indeed, most of these devices take the form of rhetorical questions, which are used to summarise the main points covered during the article and to ensure that people have well-understood and well-interpreted the issues under analysis. Normally inserted at the end of the posts, these questions are employed by authors to prompt the public to think about what has been discussed in the post and to check their understanding of the notions previously addressed: as a consequence, it becomes evident that, in blog posts, even when authors resort to *audience-oriented* devices, their primary focus is ensuring effective knowledge transmission, content comprehension and information absorption.

5.4.2 Questions in YouTube video scripts

5.4.2.1 Presentation of the results

As regards the distribution of questions across YouTube video scripts, the quantitative analysis highlighted the presence of 450 interrogative utterances, corresponding to a normalised frequency of 26.4 PTT, as indicated in Tab. 69.

QUESTIONS	**YOUTUBE VIDEOS**	
	RF	NF (PTT)
TOTAL	**450**	**26.4**

Table 69. Frequency distribution of interrogatives in the YouTube subcorpus.

As far as their intratextual distribution is concerned, Tab. 70 and the histogram in Fig. 61 show that, in YouTube video scripts, questions are strategically placed in four different positions: openings (46 occurrences), titles (29 occurrences), concluding segments (15 occurrences) and body of the talk (10 occurrences).

POSITION OF THE QUESTION	YOUTUBE VIDEOS	
	RF	NF (PTT)
OPENING	46	2.7
TITLE	29	1.7
CONCLUSION	15	0.9
BODY OF THE TALK	10	0.6
TOTAL	**100**	**5.9**

Table 70. Frequency distribution of the different positions of the questions in the YouTube subcorpus.

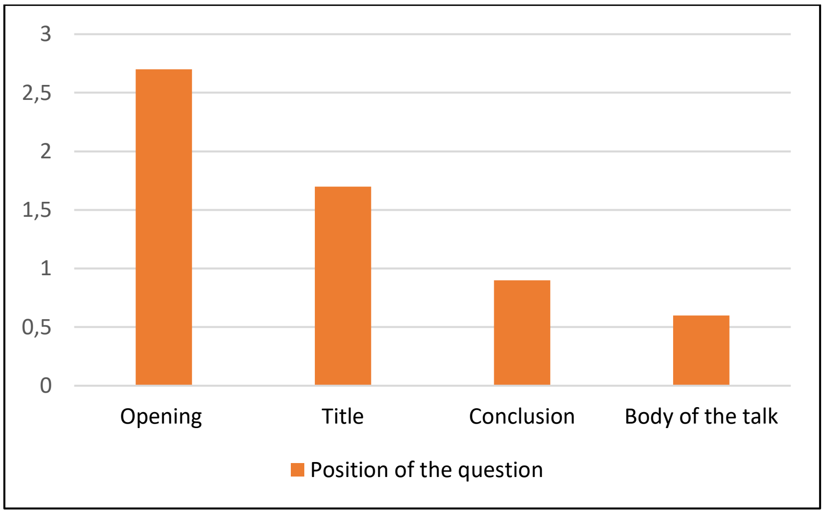

Figure 61. Frequency distribution of the different positions of the questions in the YouTube subcorpus (histogram).

In this specific medium, speakers mostly employ interrogatives in the opening sections of the talk (225) and in titles (226, 227). In these locations, these items serve a dual purpose: they work as attention-grabbing devices and as tools for setting expectations. The opening sections of videos represent the crucial moment for piquing people's curiosity and interest: therefore, starting with questions that resonate with their own individual doubts or concerns, significantly contributes to rendering the contents more relatable. At the same time, commencing with a question connected to the topic of the video, the speaker is thus able to set the tone and provide the public with an indication of what they can expect to learn. As a consequence, both these elements create a sense of anticipation and curiosity, enhancing people's overall viewing experience and motivating them to watch the content until the end.

(226) ***I love kombucha, but what is it?*** *Delicious. Delightful. Kombucha is a fermented tea. It's made by combining tea, sugar, and a symbiotic culture of bacteria and yeast, or a scoby.* (REA_2020-12-15)

(227) ***Can Coral Reefs Survive Climate Change?*** (OTBS_2016-11-23)

What is more, in the specific context of questions appearing in video titles, these items are of specific relevance because they improve the process of search engine optimisation. As observed by Bogatyrev and Smirnova (2020), titles act as the first informational elements of the audio-visual content unity and function as the decoding key for the video-message. Incorporating questions in these segments, authors are thus able to align the videos with frequently searched queries, therefore increasing visibility, engagement and reach of the video itself.

(228) ***Dangerous Marshmallows?!*** (MIN_2020-11-19)

Interrogatives also appear within the body of the talk (229). Their presence in this specific context plays a role of the utmost importance because, in a medium where viewers must learn the contents following the pace and rhythm of the video, these linguistic items allow speakers to emphasise key points, provide a clear and well-defined logical structure to the message and set the focus of the discussion. These elements thus crucially help people internalise the conveyed message, test knowledge comprehension, engage the audience and encourage participation:

(229) *Many other parts of the immune system are just tools to activate the compliment system. Imagine having trillions of little bombs inside your blood that could go off at any moment. So our cells use numerous mechanisms to prevent compliment from accidentally attacking them.* **What exactly does it do?** *And,* **what makes it so dangerous?** *In a nutshell, the complement system does three things. It cripples enemies. It activates the immune system. And it rips holes in things until they die.* (KUR_2019-07-28)

Lastly, interrogatives located at the end of the talks (230) are employed to speak to the viewers in a direct and un-mediated way. To be precise, they are used for a variety of purposes: as a way to prompt people to share their individual thoughts on the topics – thus contributing to the creation of a sense of community around the video – to elicit receivers to take further action (e.g., supporting or promoting institutions, charities or the channel itself) and as a way to encourage further exploration on the topics:

(230) *Chemists have since created or discovered other molecules like sucralose, and stevia, both of which are sweeter than aspartame, and hundreds of times sweeter than table sugar. So, that's why things taste sweet.* ***Hey, you know what else would be sweet?*** *If you click that subscribe button, because that way you get a weekly dose of chemistry awesomeness from Reactions*. (ACS_2016-10-21)

Transitioning now to the discursive analysis, interrogatives retrieved in YouTube educational videos were observed to belong to the two categories mentioned above: *audience-oriented* and *content-oriented* (Thompson 1998). The following Tab. 71 shows the frequencies of each function and the histogram portrayed in Fig. 62 gives a visual representation of such data.

QUESTION TYPE	**YOUTUBE VIDEOS**	
	RF	NF (PTT)
AUDIENCE-ORIENTED	67	4
CONTENT-ORIENTED	33	1.9
TOTAL	**100**	**5.9**

Table 71. Frequency distribution of the different types of questions in the YouTube subcorpus.

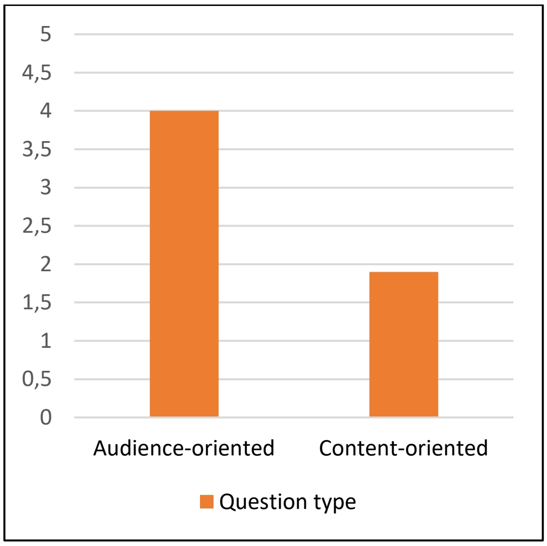

Fig. 62. Frequency distribution of the different types of questions in the Blogs subcorpus (histogram).

In the specific context of YouTube educational videos, *audience-oriented* questions (67 instances) stand out as the most represented category, followed by the *content-oriented* type (33 instances).

As far as *audience-oriented* utterances are concerned, five different discursive functions were retrieved. Such functions were labelled as 'evoking a response' (21 occurrences), 'checking understanding' (18 occurrences), 'seeking agreement' (15 occurrences), 'summary' (9 occurrences) and 'provocation' (4 occurrences). See Table 72 to get a detailed picture on these functions and their frequencies and Fig. 63 for a visual representation of such data.

AUDIENCE-ORIENTED FUNCTIONS	**YOUTUBE VIDEOS**	
	RF	NF (PTT)
Evoking a response	21	1.2
Checking understanding	18	1
Seeking agreement	15	0.8
Provocation	9	0,6
Summary	4	0.3
TOTAL	**67**	**3.9**

Table 72. Frequency distribution of the different audience-oriented types of questions in the YouTube subcorpus.

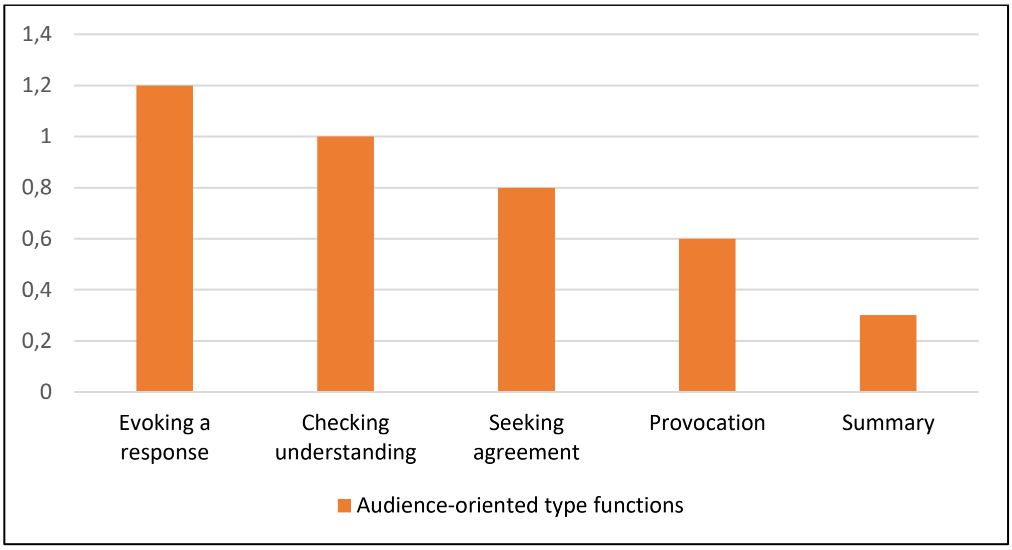

Fig. 63. Frequency distribution of the different audience-oriented types of questions in the YouTube subcorpus (histogram).

The function labelled as 'evoking a response' appeared to be the most frequent in this subcorpus. Such questions are intended to prompt viewers to engage with the content of the video and respond to it in an active and thoughtful way. On the one hand, they work as devices that encourage critical thinking. On the other hand, as stated by Zou and Hyland (2019: 7), they also "change the monologue into a dialogue", because viewers are encouraged to provide real answers, as in normal face-to-face conversations or as in real-life learning environments:

> (231) *One of these mushrooms will make you hallucinate, one could kill you, and one would be great in a stir fry.* ***Can you guess which is which?*** (REA_2019-12-24)

Secondly, 'checking understanding' questions are employed by authors to assess whether the public has correctly understood the presented information. Recalling real-life educational settings, these instances serve a dual purpose. On the one hand, they help viewers reinforce their knowledge and prompt them to become aware of their level of understanding. On the other hand, they indicate authors' sensitivity to possible difficulties that may arise due to knowledge gaps. This awareness thus reflects both their commitment to the creation of a more inclusive learning experience and their willingness to establish a more intimate and personal relationship with the public:

(232) *So, when the plant genome was sequenced in early 2000, first from Arabidopsis, people were interested to see how many R proteins are there in plants,* ***right?*** (BIO_2018-05-02)

(233) *So, the first question is this, besides these three examples of symbiosis that we just discussed,* ***what other examples can you think of mutualism, commensalism and parasitism?*** (BIO_2021-02-03)

Moving forward, the 'seeking agreement' type of interrogative is used to align viewers with the author's point of view. This fosters a sense of closeness between speaker and viewers, creating a perception of belonging to a community of like-minded people who share values, needs and daily challenges. Moreover, these interrogatives also encourage viewers to reflect on the issue being presented and relate them to their own personal values and beliefs.

(234) ***Can we all agree that climate change is a pressing issue that requires immediate action?*** (BIO_2018-05-02)

(235) ***That … no … that makes no sense, okay?*** (BIO_2018-05-02)

The function labelled as 'provocation' (Webber 1994: 265-266), on the contrary, serves as a tool to challenge viewers' assumptions, beliefs or values. Its purpose is to prompt them deeper thinking about a specific topic and its implications. Such instances instil a sense of tension and/or conflict in the audience, provoking a more profound sense of engagement and emotional investment towards the issues under discussion (236).

(236) *OK, you're about to see one of the cutest things ever, but first I want you to ask yourself a question:* ***could you find your way back here … without a phone?*** (OTBS_2016-10-17)

Finally, 'summary' questions (237) are aimed at summarising or recalling pieces of knowledge introduced earlier in the talk, therefore helping the audience to retain information and bridge possible areas of confusion. In the context of YouTube videos, these questions hold particular importance: given the nature of the platform, where viewers are presented with the information at the pace of the video, this specific function enables authors to emphasise key points and ensure that essential information is not lost amidst the overall information load.

(237) ***Remember that we saw how HIV replication can create mutation?*** (OSM_2016-04-18)

Content-oriented question, instead, resulted to perform four distinct functions: 'getting attention' (15 occurrences), 'framing discourse' (9 occurrences), 'food for thought' (7 occurrences) and 'marking attitude' (2 occurrences), as indicated in Table 73 and Fig. 64.

CONTENT-ORIENTED FUNCTIONS	**YOUTUBE VIDEOS**	
	RF	NF (PTT)
Getting attention	15	0.9
Framing discourse	9	0.6
Food for thought	7	0.5
Marking attitude	2	0.1
TOTAL	**33**	**1.9**

Table 73. Frequency distribution of the different content-oriented types of questions in the YouTube subcorpus.

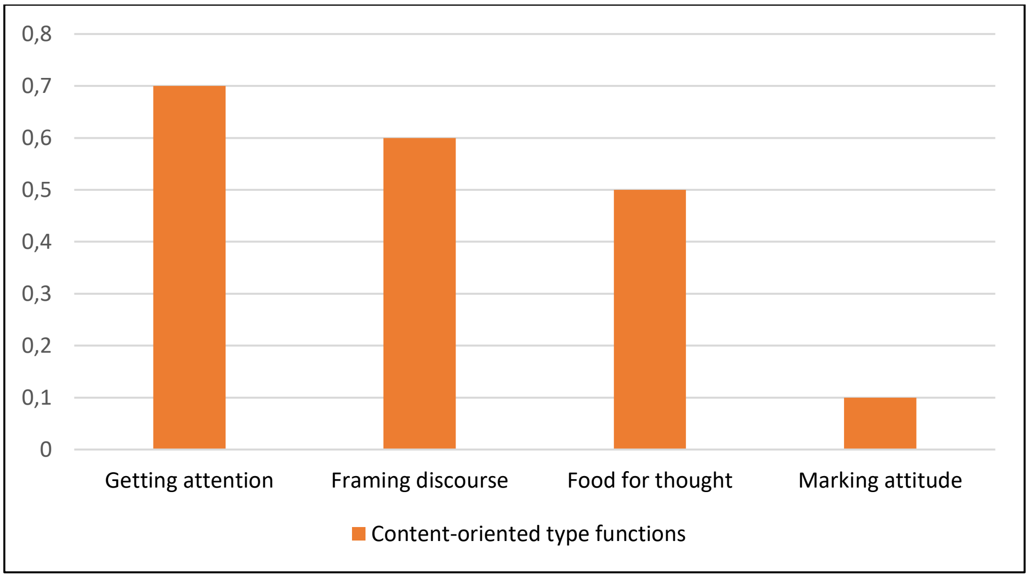

Fig. 64. Frequency distribution of the different content-oriented types of questions in the YouTube subcorpus (histogram).

The function labelled as 'getting attention' is performed by the questions found in video titles. In the specific context of YouTube channels, interrogatives located here are of specific relevance because they grab viewers' attention and raise their curiosity, prompting them to click and watch the video in its entirety. Furthermore, questions in titles also help content creators set the tone and topic of the video, allowing the public to get an idea of what to expect (238).

(238) ***What Exactly Happened at Chernobyl?*** (REA_2019-08-15)

'Framing discourse' questions, then, are designed to structure or guide the development of the talk towards a particular direction. Typically occurring in educational settings, these interrogatives help speakers organise the talk in a systematic and coherent way, bringing the audience to a deeper and more meaningful engagement with the material being presented. Providing a well-structured and easy to understand content, whose information load is accessible and not too overwhelming, this specific function acquires specific relevance in a digital landscape like YouTube that accessed by a public composed of people with different backgrounds, educational levels, interests and perspectives (239).

(239) ***So you've heard about isotopes, but what exactly are they?*** (ACS_2018-08-14)

Thirdly, 'food for thought' interrogatives (240) are usually located at the end of the talk and serve the purpose of stimulating intellectual curiosity, critical thinking and discussions among viewers. By raising unresolved issues and emergent matters, these questions work as catalysts for reflections. They motivate the public to reflect on what still needs to be done in a particular field, on the problems that may arise in the future and on the steps individuals can take to contribute towards societal improvement.

(240) ***What opalescent plays of light will one day radiate from the things we forget in the darkness?*** (TED_2020-12-03)

In the end, the least frequent type of *content-oriented* questions identified are those that fulfil the 'marking attitude' function. In the specific context of YouTube videos, these utterances are used to express the speaker's point of view, evaluation or emotional response towards the presented topics. Their objective is to establish a sense of closeness with the audience and create an informal and relaxing learning environment (241).

(241) *Proviral just means that it's ready to be integrated into the host's DNA, so it enters the T-helper cell's nucleus and pops itself into the cell's DNA, ready to be transcribed into new viruses,* ***pretty sneaky, huh?*** (OSM_2016-04-18)

5.4.2.2 Discussion of the results

As shown in the following pie chart (Fig. 65), two types of interrogatives are found in YouTube educational videos: *audience-oriented* and *content-oriented* questions.

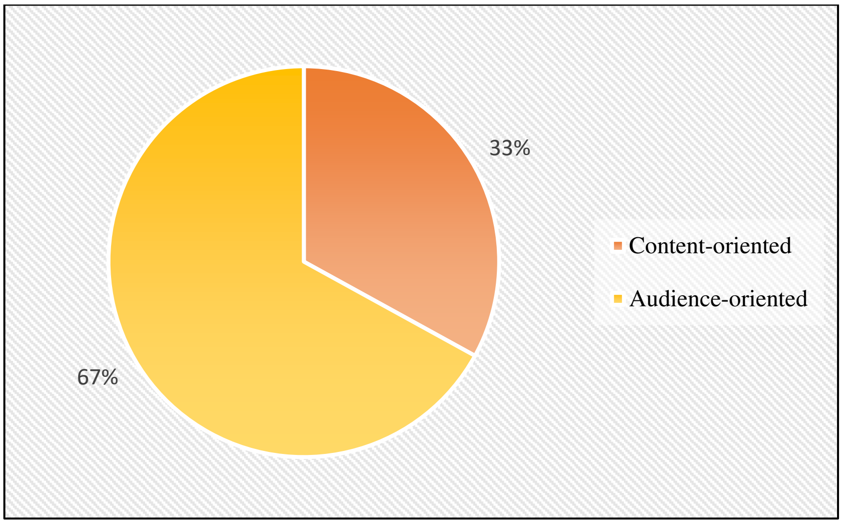

Figure 65. Distribution of the different question types in the YouTube subcorpus (pie chart)

Authors of science-themed YouTube educational videos mostly exploit questions with an *audience-oriented* function. This figure suggests that significant attention is dedicated to accommodating the concepts and interacting on a more personal level with the audience. Indeed, in the YouTube environment, authors attempt to engage and take care of the viewers in various ways. First of all, they try to recreate a real-life learning environment by asking questions that presuppose a real response from the audience and check their understanding (the so-called 'evoking a response', 'checking understanding' and 'summary functions'). They also prompt them to engage with the contents in an active and thoughtful way by eliciting critical reflections (the so-called 'food for thought' function). Furthermore, they strive to establish an emotional connection with people by openly showing their points of view and emotional responses: this is achieved, for instance, using provocative interrogatives that challenge shared assumptions and beliefs (the so-called 'seeking agreement' and 'provocation' functions).

Additionally, the idea that science-themed YouTube educational videos prioritise the development of a relationship and engagement with the public is further reinforced by the type of *content-oriented* questions retrieved in this subcorpus. Indeed, most of these questions are used to grab viewers' attention and stimulate their curiosity (the so-called 'getting attention' function). Simultaneously, the presence, among the top two functions retrieved in this subcorpus, of the 'framing discourse' question type demonstrates authors' attention and willingness to offer accessible and easily understandable knowledge to a wide range of audiences. By employing such devices, they are thus able to cater to individuals of all ages, educational backgrounds, and needs.

5.4.3 Questions in comic books about science

5.4.3.1. Presentation of the results

From a quantitative point of view, 812 instances of questions were retrieved in comics books about science, as the following Tab. 74 demonstrates.

QUESTIONS	COMICS	
	RF	NF (PTT)
TOTAL	**812**	**48.6**

Table 74. Frequency distribution of interrogatives in the Comics subcorpus.

As far as their intratextual distribution is concerned, questions were classified according to their position into three sub-types: those occurring within the text, in chapter headings and in concluding segments. Tab. 75 below reports this classification and indicates the raw and normalised frequencies for each type. The histogram displayed in Fig. 66, then, provides a graphic representation of such data.

POSITION OF THE QUESTION	COMICS	
	RF	NF (PTT)
IN THE TEXT	73	4.3
CONCLUSION	25	1.6
CHAPTER HEADING	2	0.1
TOTAL	**100**	**6**

Table 75. Frequency distribution of the different positions of the questions in the Comics subcorpus.

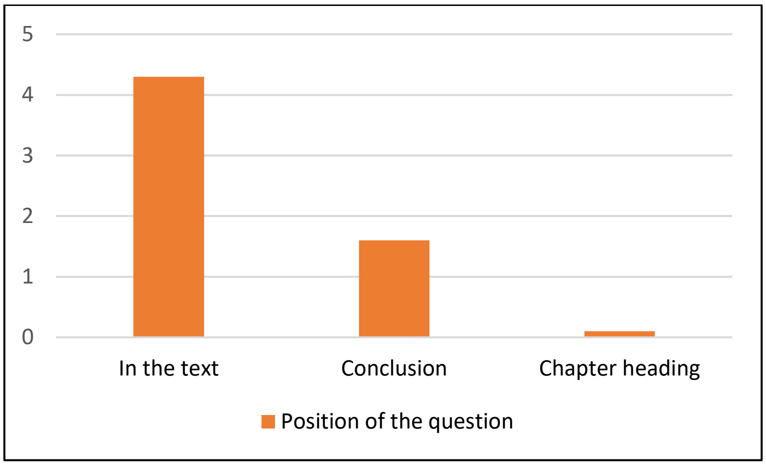

Figure 66. Frequency distribution of the different positions of the questions in the Comics subcorpus (histogram).

As readers can observe, questions are mainly placed within the texts (73 occurrences) and in conclusions (25 occurrences), while only two interrogatives are part of a chapter heading.

The ones that are posited inside the text contribute, at the same time, to the narrative progression of the story and to the process of specialised information delivery. On the one hand, they reveal and develop the personalities, actions and underlying thought processes of the characters, consequently enhancing the dialogic intrinsic nature of the medium. On the other hand, by breaking down the information load and emphasising specific aspects within the discussion, they are also capable of providing a well-defined and logical structure to the presentation of the concepts.

(242) *This brilliant observation is the start of collision theory.* ***How often do particles collide?*** *It depends on their concentration (or partial pressure). Imagine that a volume of gas or solution is divided into countless tiny compartments. If two particles share a compartment, we'll call that a collision.* (CHEM_CartoonGuides)

In comics, then, interrogatives can also be placed in the concluding sections, whether it is the end of a chapter or of the entire book. In the former case, they are aimed at anticipating what might come next, stimulating readers' interest and providing them with information concerning the upcoming content (243). Conversely, when positioned at the end of the entire book, their main objective is to spark reflections on the domain-specific issues presented (244). By including thought-provoking questions or leaving certain interrogatives unanswered, authors can cultivate readers' curiosity and encourage them to consider the issues from multiple perspectives.

(243) *Our lives literally depend on adequate supplies of chemical ingredients, from amino acids to zinc, and these are spread around the world by the action of countless living things.* ***Can there be a better reason for preserving the web of life?*** (ES_CartoonGuides)

(244) ***Who knows what's still out there, waiting to be found? Or where it will lead? Or who will find it?*** (B_CartoonGuides)

Finally, questions can sometimes be found in chapter headings (245). Interrogatives positioned here mostly help frame the topic of the chapter and set expectations for what will come next. Simultaneously, they also arouse curiosity, encourage continued reading and stimulate readers' thinking by prompting them to recall previous knowledge or personal experiences.

(245) *Chapter 8 -* ***What limiting factors?*** (ES_CartoonGuides)

As regards their discursive functions, questions in comic books about science were categorised into three classes: the above-mentioned *content-oriented* and *audience-oriented* types, and the *character-oriented* category. This label was created purposely for this work to refer to the interrogatives directed towards one of the characters in the books. The following Tab. 76 shows the retrieved frequencies of each function and the histogram portrayed in Fig. 67 provides a visual representation of such data.

QUESTION TYPE	**COMICS**	
	RF	NF (PTT)
CHARACTER-ORIENTED	35	2.1
CONTENT-ORIENTED	34	2.1
AUDIENCE-ORIENTED	31	1.8
TOTAL	**100**	**6**

Table 76. Frequency distribution of the different types of questions in the Comics subcorpus.

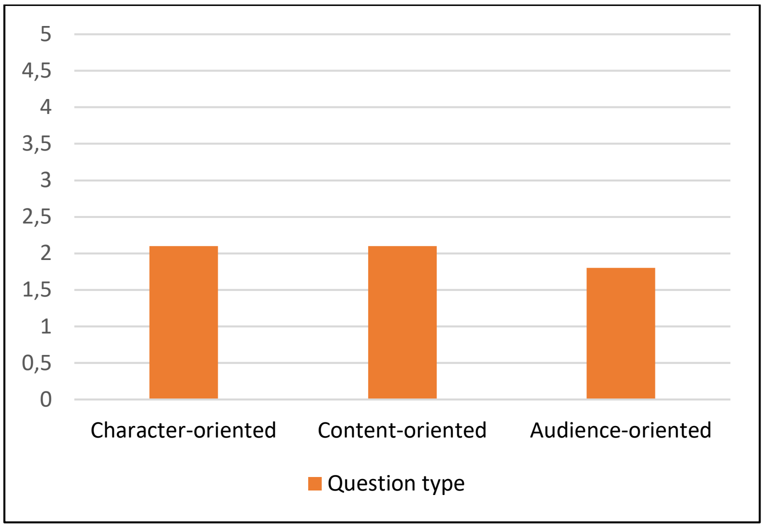

Fig. 67. Frequency distribution of the different types of questions in the Blogs subcorpus (histogram).

As far as their distribution across the corpus is concerned, the quantitative analysis brought to the fore that *character-oriented* questions occur most often (35 instances), followed by the *content-oriented* type (34 instances) and, lastly, by the *audience-oriented* interrogatives (31 instances).

As far as the *character-oriented* type is concerned, three functions were identified in the realm of science comic books: 'eliciting an action' (14 occurrences), 'direct address – from speaker to characters' (12 instances), 'direct address – from characters to speaker' (9 instances). See Table 77 and Fig. 68.

CHARACTER-ORIENTED FUNCTIONS	**COMICS**	
	RF	NF (PTT)
Eliciting an action	14	0.8
Direct address (from speaker to characters)	12	0.7
Direct address (from characters to speaker)	9	0.5
TOTAL	**35**	**2**

Table 77. Frequency distribution of the different character-oriented types of questions in the Comics subcorpus.

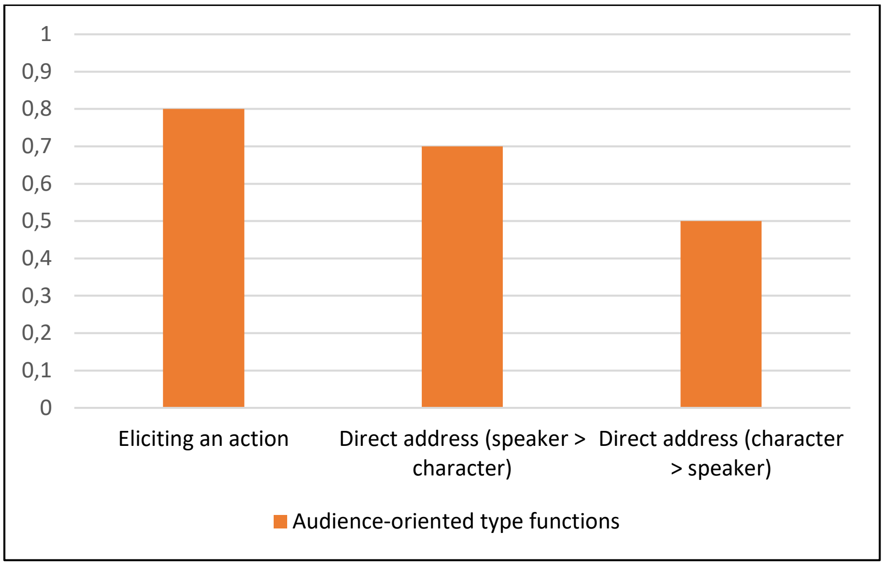

Fig. 68. Frequency distribution of the different character-oriented types of questions in the Comics subcorpus (histogram).

'Eliciting an action' is the prevailing function within 'character-oriented' questions. In these instances, the speaker, while addressing other characters within the book, utilizes questions to prompt specific behaviours. For instance, in (246), the main character addresses a molecule and requests it to move in order to demonstrate its appearance. These questions work as narrative devices that support the explanation and visualization of the concepts by verbally depicting characters engaging in specific actions. Science-themed comic books effectively combine storytelling and visual representation using *character-oriented* interrogatives: indeed, these actions serve as visual demonstrations that complement the narrative exposition, making scientific abstract concepts more accessible to readers.

(246) ***Could you turn a little to the left?*** (CHEM_GhostsandAtoms)

Direct addresses to characters (247) or to the main speaker (248), finally, play a crucial role in driving the plot and developing the informative parts of the comic. Through these tools, authors can recreate a real-life conversational environment that fosters a sense of involvement and engagement in readers.

(247) *Imagine pulling DNA apart like a zipper.* ***Ever get anything stuck in your claws?*** (B_CartoonGuides)

(248) *Wait, wait! You said that brain science has come a long way* – ***What did you mean?*** (B_TheBrain)

The *content-oriented* type of questions, instead, comprises four distinct discursive functions: ‘framing discourse’ (24 occurrences), ‘food for thought’ (6 instances), ‘getting attention’ (2 instances) and ‘marking attitude’ (2 instances), as shown in the following tables and figures.

CONTENT-ORIENTED FUNCTIONS	**COMICS**	
	RF	NF (PTT)
Framing discourse	24	1.5
Food for thought	6	0.4
Getting attention	2	0.1
Marking attitude	2	0.1
TOTAL	**34**	**2.1**

Table 78. Frequency distribution of the different content-oriented types of questions in the Comics subcorpus.

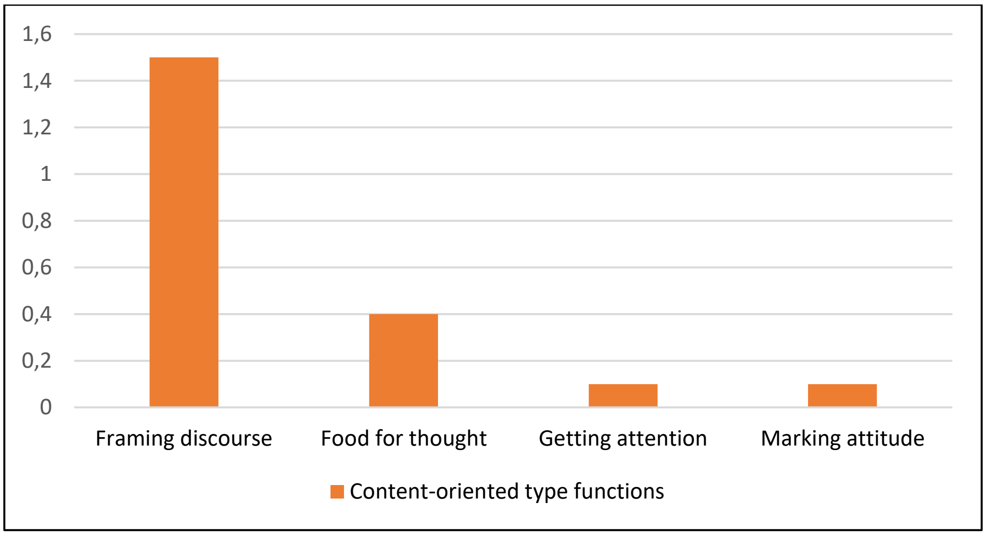

Figure 69. Frequency distribution of the different content-oriented types of questions in the Comics subcorpus (histogram).

In the realm of science comics, the most frequent category of *content-oriented* questions turned out to be ‘framing discourse’, which encompasses the interrogatives employed to structure the narrative and the explanation of the various specialised contents. These tools are extremely helpful not only to establish the context (249), but also to guide readers’ understanding and interpretation of the various passages (250).

(249) ***How do living systems overcome activation energy? How do they make reactions run?*** (B_CartoonGuides)

(250) ***Okay, but why is this important?*** (CHEM_CartoonGuides)

Secondly, 'food for thought' type of questions (251), normally located at the end of the book, emerged as the second most common category. In comics, they increase the educational value of the book by encouraging readers to actively engage with the material at hand. They work as cliff hangers, stimulating each reader's curiosity by hinting at future developments intriguing possibilities.

(251) *If all living things ate only organic matter, life would eat itself up and dwindle away. And yet it doesn't.* ***Why?*** (B_CartoonGuides)

Lastly, questions belonging to the 'getting attention' and 'marking attitude' functions are the categories that appeared with the lowest frequency. The former (249) comprises questions located in chapter headings to set the tone and topic of the chapter. The latter (252), instead, gives voice to the writer's own emotional response or point of view. Within this context, they are strategically utilized not only to elicit emotional responses from readers but also to direct their focus towards specific content.

(252) ***Isn't it evident that we all need to take action now to save our planet*?** (ES_CartoonGuides)

In the end, *audience-oriented* questions, which refer to the instances where the author directly addresses real-life readers, exhibit three distinct functions: 'checking understanding' (19 occurrences), 'evoking a response' (8 instances), 'seeking agreement' (4 instances). See Table 79 and Fig. 71.

AUDIENCE-ORIENTED FUNCTIONS	COMICS	
	RF	NF (PTT)
Checking understanding	19	1.1
Evoking a response	8	0.4
Seeking agreement	4	0.2
TOTAL	**31**	**1.8**

Table 79. Frequency distribution of the different audience-oriented types of questions in the Comics subcorpus

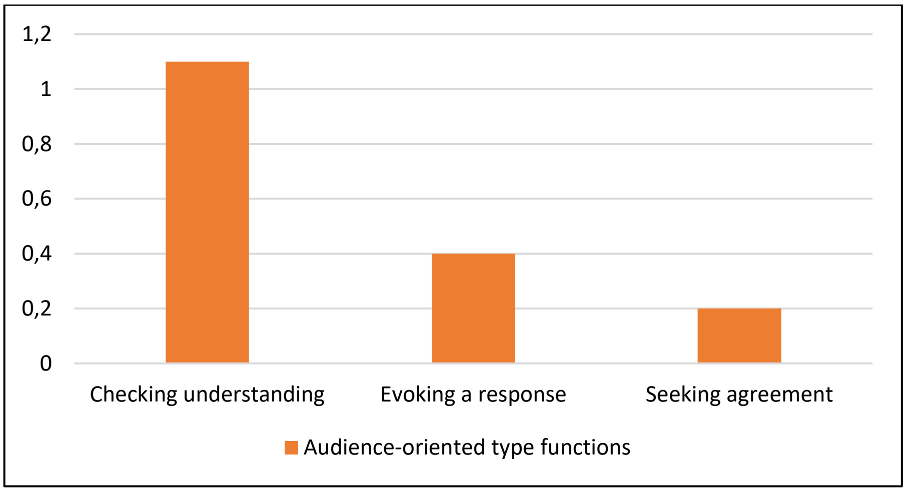

Figure 70. Frequency distribution of the different audience-oriented types of questions in the Comics subcorpus (histogram).

Questions performing the 'checking understanding' function (253) do not expect answers from a character inside the text but are addressed at the real-world audience reading the book. Their principal objective is to assess the audience's comprehension of the presented material, but they also serve as 'self-assessment' tools for readers, allowing them to detect areas requiring further clarification.

> (253) *As a particle, it has a definite mass, charge and spin, but it also has a wavelength. It's "smeared out" in some way. Its precise position is always a bit uncertain.* ***Make sense?*** (CHEM_CartoonGuides)

The second most frequent type of question is the 'evoking a response' category (254), which helps readers engage with the material on a deeper level. As for the previous category, such utterances target the real-world audience and therefore receive no answer from the characters within the book. Like the previous category, these structures enable readers to either individually process the information or to discuss the topics with other people, promoting both personal exploration and broader conversations.

(254) ***Would you call this an energy crisis?*** (ES_CartoonGuides)

Finally, the least frequent type of *audience-oriented* question is 'seeking agreement' function (255). These utterances express writers' opinions and emotional responses, in the attempt to align the readers with their own perspective.

(255) *You mean the mommy-murdering minx was really named Amber?* ***Shocking, isn't it?*** (CHEM_CartoonGuides)

5.4.3.2. Discussion of the results

As shown in the following pie chart (Fig. 71), three types of interrogatives are to be found in this medium: *character-oriented*, *audience-oriented* and *content-oriented* questions.

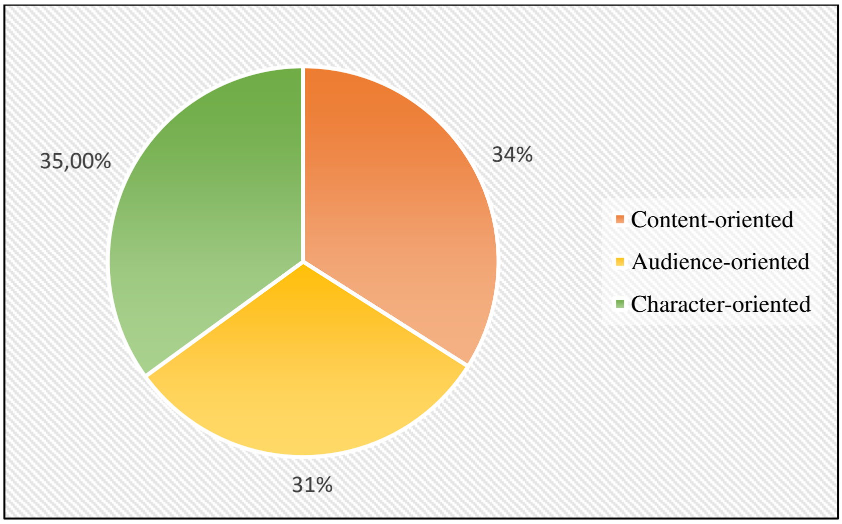

Figure 71. Distribution of the different question types in the Comics subcorpus (pie chart).

As indicated above, authors of science-related comic books skilfully balance their attention between an accurate transmission of the contents and the engagement of readers – a function which is performed through both the development of the narrative storyline and the direct addresses to the real-world reading public. This association creates a well-rounded educational experience for readers and leads to greater retention and application of the presented material.

As mentioned in the previous pages, the act of effectively accommodating the contents to the audience is accomplished through the exploitation of the so-called *audience-oriented* and *character-oriented* questions, which allow readers to be engaged with the materials on a deeper and more intimate level. The former category, representing the interrogatives addressed at the real-world audience, encourages people to critically reflect on the concepts, find answers and carefully think about their learning process. On the contrary, the latter category, which includes the interrogatives addressed at one or more characters within the narration, recreates a real-life conversational environment, thereby crafting a sort of 'immersive experience' where real-life readers of the comic become active participants in the story through a process of individual identification with the characters.

Conversely, the emphasis on the accurate transmission of domain-specific knowledge is demonstrated by the presence of interrogatives located inside the body of the text, which are mostly associated with functions such as 'framing discourse', 'food for thought', 'marking attitude' and 'eliciting actions'. Through these devices, authors provide the public with an accessible, coherent and well-structured text, which efficiently distributes the information load across the panels and helps readers navigate through it. At the same time, inserting *character-oriented* questions that verbally depict actions supports the explanation of the concepts and facilitates their visualisation.

5.5 Reaching the *delectare* aim: the role of reader pronouns

The analysis of the rhetorical and discursive techniques employed to achieve the *delectare* rhetorical goal (Załęska 2016) ended with an investigation into the distribution and discursive role of 2nd person pronouns *you* and *your*.

As claimed by Hyland (2005, 2008, 2010), 2nd person reader pronouns are the most explicit way authors have for achieving proximity and engaging the public. By directly addressing readers through these linguistic items, writers/speakers not only capture their audience's attention, but also promote a sense of inclusivity and involvement that goes beyond the simple transmission of specialised information. This address to the so-called 'reader-in-text' (Thompson & Thetela 1995), works as a bridge between authors and readers, bringing to the fore "the interpersonal dimension in the text" (Lafuente-Millán 2013: 206).

However, such devices can perform multiple discursive functions and their frequencies may result in a different impact on the discourse, especially across different media. For this reason, a more detailed analysis on these aspects was carried out, and its results are presented in the following paragraphs 5.5.1, 5.5.2 and 5.5.3.

5.5.1 Reader pronouns in blog posts

5.5.1.1. Presentation of the results

Overall, 2nd person personal and possessive pronouns represent 6.5% of the entire population of the pronouns in the subcorpus, as shown in the pie chart below (Fig. 72).

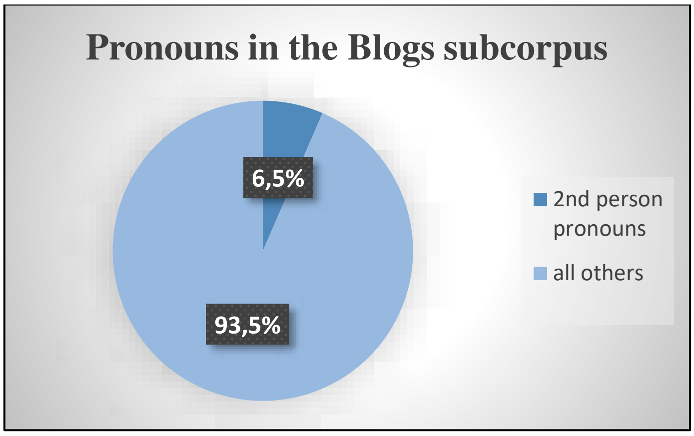

Figure 72. Distribution of 2nd person pronouns *you* and *your* in the Blogs subcorpus (pie chart).

More specifically, 146 instances of the pronoun *you* and 44 of *your* were retrieved in the corpus. The following table (Tab. 80) provides detailed information concerning their raw and normalised frequencies. See also Fig. 73 for a visual representation of such data.

READER PRONOUNS	**BLOGS**	
	RF	NF (PTT)
You	146	8.7
Your	44	2.6
TOTAL	**190**	**11.3**

Table 80. Frequency distribution of 1st person pronouns *you* and *your* in the Blogs subcorpus.

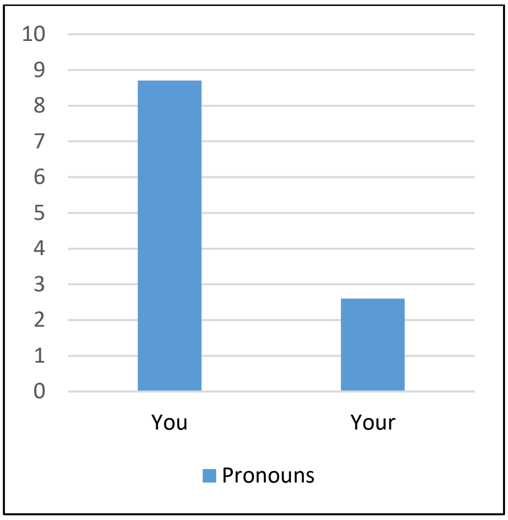

Figure 73. Frequency distribution of the pronouns *you* and *your* in the Blogs subcorpus (histogram).

Subsequently, to obtain more detailed insights into the discursive role played by these items in the construction of the argumentation, a Sinclairian analysis of the left and right co-texts turned out to be necessary. More specifically, as far as the pronoun *you* is concerned, the extraction of a random sample of 100 lines of concordance proved to be essential, since the high number of the retrieved instances did not allow for a thorough study of all the occurrences.

To this aim, the first aspect taken into consideration concerned the referents of these pronouns. In the specific context of popular science blogs, *you* and *your* resulted to predominantly work as direct addresses to the entire reading public. However, these linguistic items were also utilised to speak to well-defined individuals or groups of people – for instance, mothers of schoolchildren, individual scientists working in laboratories, young girls aged 16.

On this basis, a careful investigation at the level of concordances made it possible to confirm that 2nd person pronouns perform different discursive functions, which are listed in Tabs. 81 and 82 below, and that are visually represented in the histograms represented in figures 74 and 75. Within this context, since no previous categorisation was developed to represent the different discursive function associated with 2nd person pronouns, the labels appearing in the tables below were created specifically for this study.

DISCURSIVE FUNCTIONS ASSOCIATED WITH THE PRONOUN YOU	BLOG POSTS	
	RF	NF (PTT)
CONTENT EXPLANATION	45	2.7
EXEMPLIFICATION	18	1
GUIDE THROUGH THE TEXT	13	0.8
ATTENTION-GRABBING	9	0.5
ADVICE	5	0.3
INTERVIEW TO AN EXPERT	5	0.3
SUGGESTIONS FOR EXTRA MATERIALS	5	0.3
TOTAL	**100**	**5.9**

Table 81. Frequency distribution of the discursive functions associated with the pronoun *you* in the Blogs subcorpus.

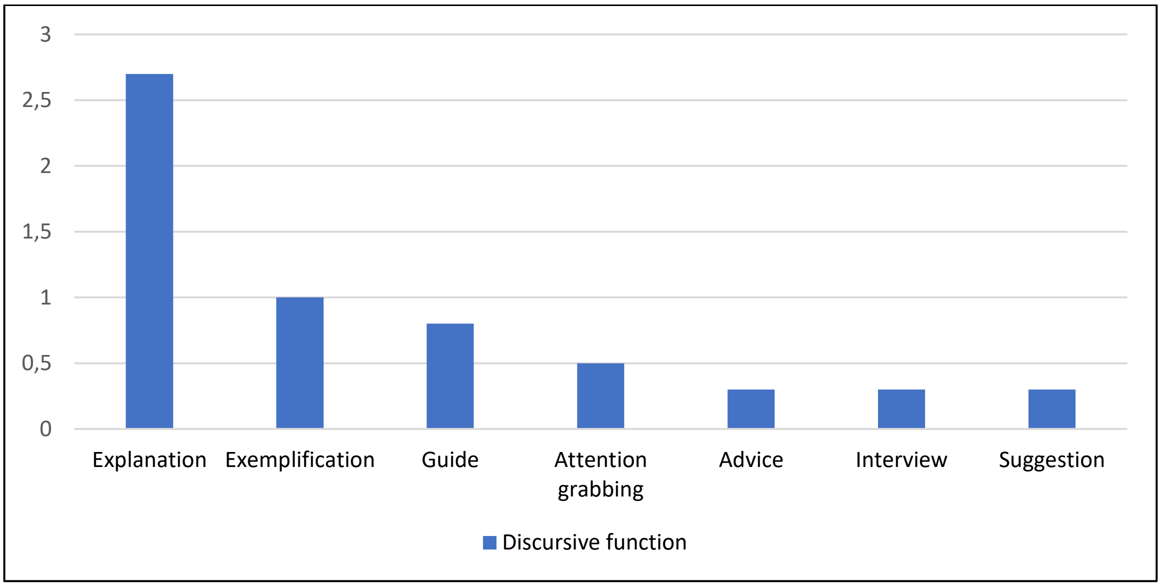

Figure 74. Frequency distribution of the discursive functions associated with the pronoun *you* in the Blogs subcorpus (histogram).

DISCURSIVE FUNCTIONS ASSOCIATED WITH THE PRONOUN YOUR	BLOG POSTS	
	RF	NF (PTT)
CONTENT EXPLANATION	35	2
EXEMPLIFICATION	5	0.3
INTERVIEW	4	0.3
TOTAL	**44**	**2.6**

Table 82. Frequency distribution of the discursive functions associated with the pronoun *you* in the Blogs subcorpus.

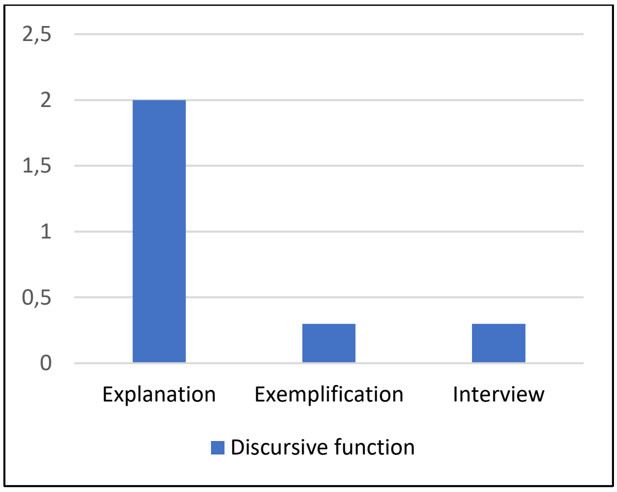

Figure 75. Frequency distribution of the discursive functions associated with the pronoun *your* in the Blogs subcorpus (histogram).

The most frequent discursive strategy associated with the use of 2nd person pronouns in science blogs was labelled as 'content explanation'. Normally found in conjunction with *material process* verbs (Halliday & Matthiessen 2014) as in (256), or, in the case of the possessive *your*, associated with nouns referring to domain-specific concepts (e.g., parts of the body involved in biological or chemical processes), as in (257), this function allows authors to connect with the readers for content transmission purposes. In these cases – as in a real-life educational setting – bloggers address receivers to engage them in the learning process, consequently making them feel part of the knowledge production procedure and facilitating their content understanding and memory retention. See the following examples.

(256) *When **you** convert the chemistry of these two minerals, amphibole and olivine, into temperatures and water contents as we do in this paper, the results are remarkable both in terms of how much water and how low a temperature we're recording.* (ECN_2021-01-23)

(257) *Cilia also aid in moving dust and mucous out of* ***your*** *body, sweeping them from* ***your*** *nose down through the throat and the rest of the GI tract, where they can be flushed out of* ***your*** *system.* (BIOB_2019-07-03)

Secondly, 2nd person pronouns are also exploited for exemplification purposes: this function turned out to be the second most frequent in the context of science-themed blogs. Frequently found in conjunction with phrases such as *for example* or hypothetical sentences, as in (258), pronouns *you* and *your* enable bloggers to provide the audience with clarifying examples. Adopting such structures is particularly important in this context, as they enable bloggers to make the discussed issues more concrete and practical, bringing contents that are normally difficult to visualise closer to people's everyday lives.

(258) ***If you*** *break* ***your*** *arm, for example,* ***you*** *might put in a metal pin that has to be removed with a second surgery after* ***your*** *bone heals.* (PHY_2019-04-23)

Thirdly, 2nd person pronouns can also be 'guides through the text'. Normally accompanied by modal verbs of possibility (e.g., *may, might, can*) and *perceptive mental* verbs (e.g., *see* or *observe*), as in (259), they serve to guide people throughout the line of reasoning presented in the post. Addressing readers for these purposes appears to be extremely significant in this context, as it enables bloggers to ensure that their public has the necessary tools to interpret these issues correctly.

(259) *As* ***you can see*** *in the following graph, in the last two years, CO2 emissions have doubled in the area under analysis.* (ECN_2019-08-05)

Afterwards, the so-called 'attention grabbing' function turned out to play a role of the utmost importance in this medium. Mostly associated with the employment of slogans, questions, passages containing ironic statements (260) and thought experiments (261), it is typically lexicalised through *cognitive mental* verbs such as *think* or *imagine* (265). From a discursive point of view, resorting to such strategies enables authors to catch readers' attention and create a sense of intrigue and curiosity. On the one hand, slogans and provocative questions contribute to challenging existing beliefs and encourage reflection and emotional responses. On the other hand, thought experiments are 'mental exercises' that involve imagining a hypothetical scenario or situation. When in conjunction with 2nd person pronouns, they contribute to drawing readers into the text by prompting them to participate in experiments – even though only in their minds – while projecting themselves into a specific situation.

(260) *What do **you** have in common with rodents, birds, and reptiles?* (BIOB_2019-05-15)

(261) ***Suppose you** were a police detective investigating a robbery.* (BIOB_2018-06-20)

In addition, 2nd person pronouns are also frequently found in conjunction with modals such as *should* and *ought to* or in phrases like *if I were you*: these instances represent the so-called 'advice-giving' function (262). In science blogs, pieces of advice can play an important role in helping readers understand and apply scientific concepts to their own lives: by providing practical guidance on science-related matters, bloggers can thus help to bridge the gap between scientific knowledge and real-world actions, empowering readers to make informed decisions and positive changes in their lives and communities.

(262) *If you test positive to COVID-19, **you should** stay at home, eat healthy, drink liquid and contact your GP.* (BIOB_2021-01-13)

'Interview' is another crucial discursive function retrieved in blogs. During these occasions, bloggers do not use pronouns to address the entire reading public, but normally talk to scientists or experts in the field. Excerpts from these conversations are incorporated into the text, with the pronouns servings as tools that contribute to posing questions regarding research (263). From a linguistic perspective, this particular function involves using the pronoun *you* in interrogative sentences and the possessive *your* in conjunction with nouns related to the research process (e.g., *results*, *research*, *work*, *team*). By incorporating quotations from recognized individuals in the field, writers also enhance the credibility of the information presented and provide the public with a more nuanced understanding of the topic.

(263) *Can **you** briefly explain what **your** results show?* (ONB_2018-04-11)

Ultimately, these pronouns are also associated with the function labelled as 'suggestions for extra materials'. In these instances, authors directly address their readers, providing recommendations for online resources to expand their knowledge, encyclopaedia pages to consult in case of doubts, teaching materials useful for transmitting knowledge to students, or even social network pages for engaging in discussions on the issues at hand. Linguistically speaking, 2nd person pronoun *you* is typically found in combination with modal verbs expressing possibility and/or advice such as *can* and *should* (e.g. 'you can find'). Alternatively, it can also be embedded in clauses introduced by a *relational* verb (Halliday & Matthiessen 2014) such as *invite* or *encourage* (264). In popular science blogs, the inclusion of suggestions for extra materials not only provides an opportunity for individuals to deepen their knowledge but also serves as a source of inspiration.

> (264) *We* ***encourage you*** *to check out the other educational resources from SEPA.* ***You can*** *also* ***find*** *more interactives on our activities and multimedia webpage.* (BIOB_2021-02-17)

5.5.1.2 Discussion of the results

The joint analyses of the 2nd person personal pronoun *you* and *your* provided valuable insights into the role played by these linguistic items in science blogs. Above all, this analysis has made it possible to highlight an interesting phenomenon: bloggers predominantly exploit direct addresses for the purpose of specialised content transmission rather than for the mere entertainment of readers.

Indeed, as we can observe from the two tables above, among the eight functions identified in this context, six lexicalise the *docere* rhetorical goal – 'content explanation', 'exemplification', 'guide through the text', 'advice', 'interview' and 'suggestion for extra materials'. This aspect marks the tendency of bloggers to prioritise the accurate and coherent transmission of specialised contents rather than using these linguistic tools solely for the purpose of amusing the audience. Recalling a real-life educational setting, bloggers address the audience through the 2nd person pronouns with the aim of engaging them in the learning process and making them feel part of the knowledge transfer process. Whether it is explaining the latest findings in a particular field, describing complex scientific concepts, analysing new scientific developments or listing the various steps to undertake during an experiment, by using direct addresses with 2nd person pronouns, authors can maintain an instructional tone that provides the public with precise and relatable examples. At the same time, this also contributes to making people feel like active participants in the learning experience rather than mere passive recipients of information. Additionally, *you* and *your* are also used to provide readers with practical guidance and support both within the text and in the real world.

On the one hand, these items anticipate potential questions or concerns that readers may have and point them towards specific verbal or visual elements within the text. On the other hand, they give receivers actionable advice tailored to their own everyday lives and suggest further readings that can deepen their understanding of the issues. This, in turn, contributes to the creation of a more engaging reading experience, since readers feel that bloggers are talking to them on a personal level and are addressing their specific needs and concerns.

However, while this analysis suggests that direct addresses are, in this context, primarily used for content transmission purposes, this does not mean that the aspect of reader engagement is completely left out. Indeed, 2nd person pronouns *you* and *your* are also inserted in segments containing slogans, questions, ironic statements and thought experiments that encourage personal critical reflections and intimate emotional responses.

5.5.2 Reader pronouns in YouTube video scripts

5.5.2.1. Presentation of the results

As far as the distribution across the YouTube corpus is concerned, the quantitative analysis on 2nd person *you* and *your* revealed that these linguistic items represent 11.3% of the entire population of the pronouns, as shown in Fig. 76 below.

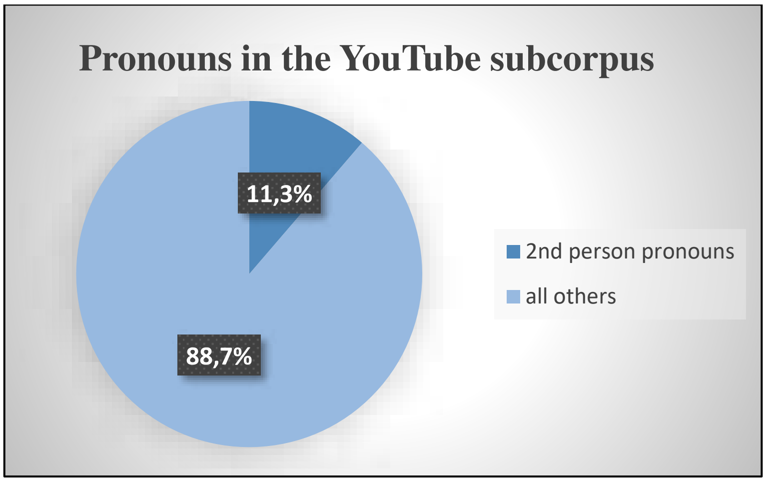

Figure 76. Distribution of 2nd person pronouns *you* and *your* in the YouTube subcorpus (pie chart).

To be precise, 537 instances of the pronoun *you* and 314 of *your* were retrieved in this subcorpus. Their raw and normalised frequencies are displayed in Table 83 and in Fig. 77.

READER PRONOUNS	YOUTUBE	
	RF	NF (PTT)
You	537	31.5
Your	314	18.5
TOTAL	**851**	**50**

Table 83. Frequency distribution of 1st person pronouns *you* and *your* in the YouTube subcorpus.

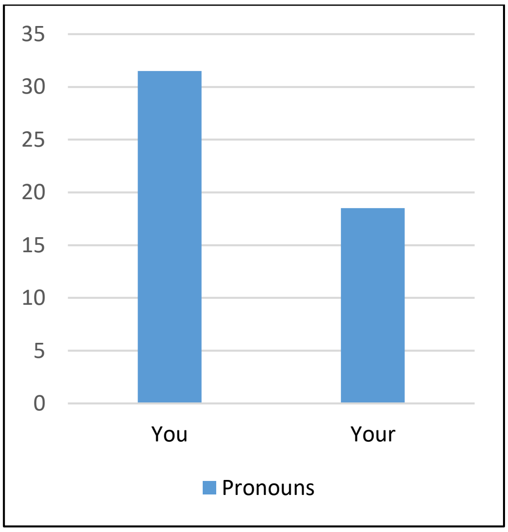

Figure 77. Frequency distribution of the pronouns *you* and *your* in the YouTube subcorpus (histogram).

As far as the referents of these pronouns are concerned, only one type of addressee emerged: the audience in its entirety. This may be motivated by the fact that, in this educational content, speakers strive to cultivate a sense of community and to promote a shared learning experience. By doing so, they can underscore the notion of shared learning and, simultaneously, encourage individuals to feel like they are part of a larger educational community.

Moving forward, Tabs. 84 and 85 illustrate that 2nd person pronouns in videos perform nine different discursive roles. See also the visual representation displayed in Figs. 78 and 79.

DISCURSIVE FUNCTIONS ASSOCIATED WITH THE PRONOUN YOU	YOUTUBE VIDEOS	
	RF	NF (PTT)
ATTENTION GRABBING	15	0.9
DIRECT QUESTIONS	15	0.9
ACTION PROMPTING	15	0.9
COMMUNITY BUILDING	14	0.8
ANTICIPATING POSSIBLE DOUBTS	11	0.6
CONTENT EXPLANATION	9	0.5
EXEMPLIFICATION	8	0.4
DISCOURSE FRAMING	8	0.4
ADVICE	5	0.2
TOTAL	**100**	**5.8**

Table 84. Frequency distribution of the discursive functions associated with the pronoun *you* in the Blogs subcorpus.

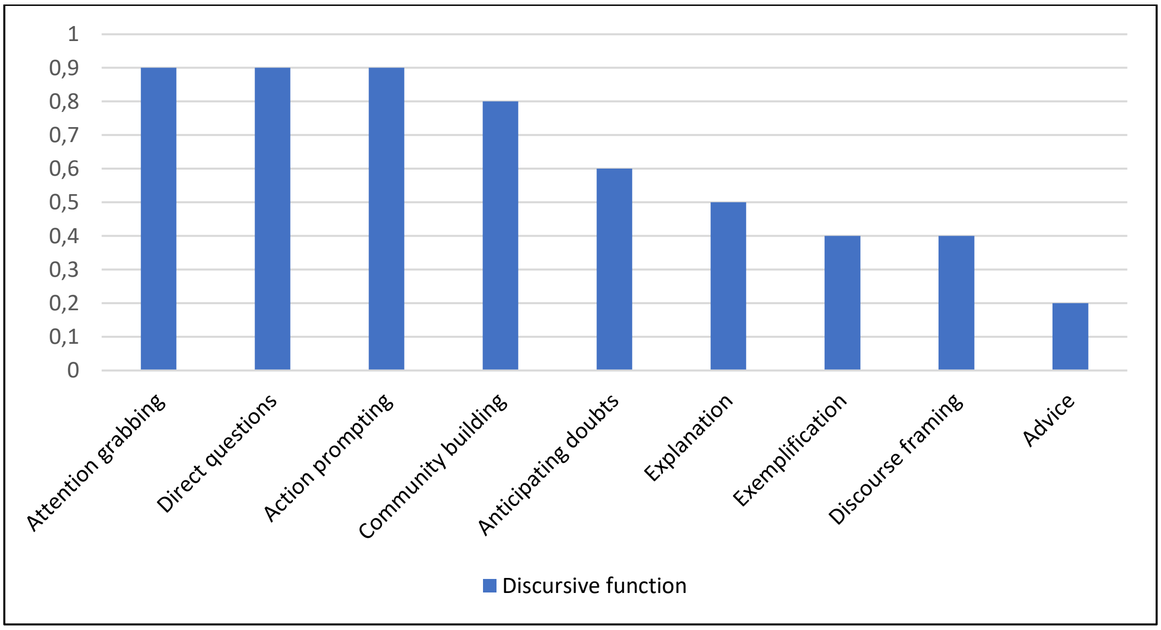

Figure 78. Frequency distribution of the discursive functions associated with the pronoun *you* in the YouTube subcorpus (histogram).

DISCURSIVE FUNCTIONS ASSOCIATED WITH THE PRONOUN YOUR	**BLOG POSTS**	
	RF	NF (PTT)
DIRECT QUESTIONS	28	1.6
ATTENTION GRABBING	24	1.5
EXPLANATION	21	1.2
ADVICE	17	0.9
EXEMPLIFICATION	10	0.6
TOTAL	**100**	**5.8**

Table 85. Frequency distribution of the discursive functions associated with the pronoun *you* in the YouTube subcorpus.

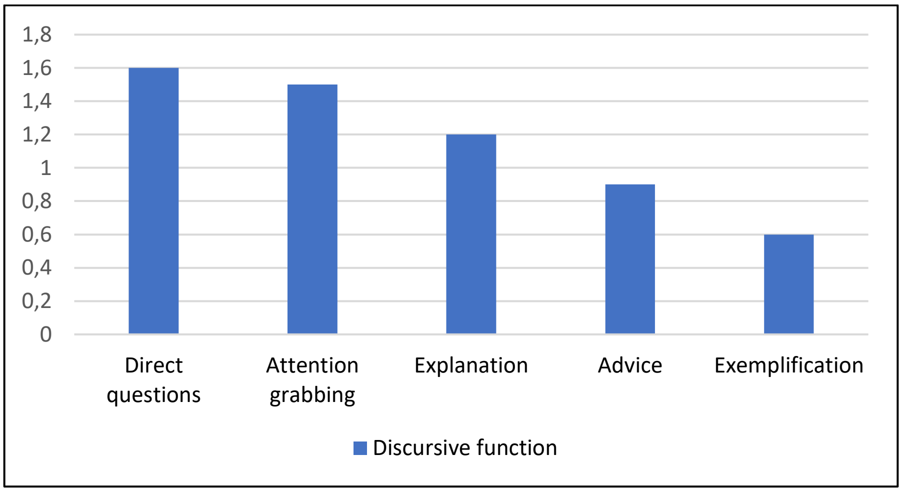

Figure 79. Frequency distribution of the discursive functions associated with the pronoun *your* in the Blogs subcorpus (histogram).

As readers can observe, in the specific context of YouTube educational videos, the most frequent discursive strategy associated with 2nd person pronouns is the so-called 'attention grabbing' function. This label refers to the employment of *you* and *your* as part of a series of techniques that capture and maintain viewers' attention throughout the video. Among these, we can identify slogans, catchy titles, provocative statements, questions, thought experiments and engaging scenarios, whose primary role is to establish a direct connection with the audience, foster active engagement and amplify the overall impact of the educational content.

(265) *Let's say **you're** an infectious disease with dreams of spreading as far and wide as possible. **Your** logical starting point might be to invade a host and make as many mini-yous as fast as you can to spread to as many other hosts as **you** can.* (MIN_2018-01-09)

Direct questions stand out as the second most frequently occurring strategy associated with *you* and *your* in YouTube videos. Lexicalised under the form of *wh-*, *yes/no* or *alternative* interrogatives, these utterances can perform multiple functions, as already discussed in section 5.4.2. In videos, speakers normally resort to direct questions to create a sense of interactivity and encourage people's participation. Whether used to check viewer's understanding of the issues (266), elicit answers and stimulate critical thinking (267), or to seek agreement (268), these tools prompt the audience to become active participants in the learning process through critical reflections, expressions of their viewpoints and formulations of responses.

> (266) *Did **you** understand which is which?* (REA_2019-12-24)

> (267) *What would **you** say if we told you that humanity is currently making a collaborative effort to engineer the perfect superbug?* (KUR_2016-03-16)

> (268) *The Amazon rainforest is often called the "lungs of the planet", but it feels a little more like the heart, don't **you** think?* (OTBS_2018-10-23)

Thirdly, we encounter the so-called 'action prompting' function, which, from a linguistic perspective, is lexicalised through 2nd person pronouns associated with directives (269) or hypothetical structures (270). In these utterances, speakers actively motivate their audience to act in support or opposition to specific issues, drawing them into a participatory role and instilling a sense of personal responsibility and agency. Examples of these instances include practical steps, recommendations and actions in favour of the surrounding environment:

> (269) *There's no perfect set of rules I can give you, because the rules are different everywhere. So go to the website of **your** local recycler, or even call them on the phone if talking to actual humans is your thing, and find out.* (OTBS_2019-12-10)

> (270) *If **you** want to help keep all Crash Course free for everybody, forever, **you** can join our community on Patreon.* (CC_2020-05-06)

Moving on, authors of YouTube educational videos also use 2nd person pronouns to anticipate and address possible doubts, questions or misconceptions that viewers may develop while watching their content. As can be observed from the following example (271), speakers place themselves in the viewers' shoes: not only do they openly acknowledge possible concerns and uncertainties related to the topics under analysis, but they also show how these concepts can be applied to people' own lives. This approach not only establishes a personal connection with the audience but also fosters trust and credibility, encouraging them to continue watching the video.

> (271) *I know what **you're** thinking, plants hoard metal to defend themselves from herbivores, but what can I use to protect my internet activity from being snooped on?* (MIN_2020-12-21)

As previously observed in blogs, personal and possessive pronouns are also frequently employed in conjunction with explanations (272) and exemplifications (273). In both cases, these functions work to involve the audience in the discussion and to make them feel part in the knowledge construction and transmission processes. Additionally, using *you* and *your* in conjunction with clarifying examples enables viewers to see the connection between such specialised issues and their own personal everyday lives.

> (272) *After **you** eat protein, **your** body breaks it down into it's amino acid parts. Which brings us back to **your** damaged muscles. The damage causes **your** body to string together amino acids into new proteins to repair the microtears.* (REA_2016-07-19)

> (273) *So for example, if **you** have a worm that has a normal copy of chromosome IV, but then it has this chromosome, the inductive effect is where the electron density is sort of spread out through the sigma bonds to stabilize the positive charge.* (BIO_2016-12-21)

In YouTube videos, the 'community building' function acquires a role of the utmost importance (274). In these instances, 2nd person pronouns are purposefully employed to foster a sense of belonging and connection among viewers by tapping into shared experiences, values and interests. Specific importance is placed on ensuring that the audience feels part, together with the speakers, of a community with shared values, beliefs, common challenges and experiences. This aspect, in turn, plays a key role in cultivating empathy and support, motivating people to actively engage with the topics under discussion and to take meaningful action in response to these issues.

> (274) *If climate change is stressing you out, **you**'re not alone.* (OTBS_2016-11-23)

In YouTube educational videos, direct addresses are also employed for discourse framing purposes (275). This function holds significant importance in this context for several reasons. Above all, it enables the management of viewers' expectations by providing a clear understanding of what they can learn or gain from watching the video. Furthermore, it offers contextual information and orientation, making it easier for people to follow along with the content. Finally, it contributes to the creation of a more accessible, inclusive and welcoming learning environment that fosters a sense of belonging among the audience.

(275) *And I'll tell* ***you*** *more about that in Parts 2 and 3 of this series.* (BIO_2020-01-20)

Finally, one last important function associated with the exploitation of *you* and *your* in YouTube videos concerns the employment of these pronouns for advice giving purposes (276). In this specific context, suggestions and recommendations hold particular importance because they make it possible for speakers to provide people with practical guidance and establish a more intimate connection with the audience.

(276) *Always careful hand-washing is key and it should be done with soap or alcohol-based hand sanitisers, scrubbing for 20 seconds. Also avoid touching* ***your*** *eyes nose and mouth.* (OSM_2020-03-05)

5.5.2.2 Discussion of the results

In conclusion, creators of YouTube educational videos predominantly resort to direct addresses to engage viewers and establish with them a closer and more intimate relationship.

As we can see in the tables displayed above, specific importance is associated with the *delectare* rhetorical goal – lexicalised through the ‘attention grabbing’, ‘direct questions’, ‘action prompting’ and ‘community building’ functions. This may be connected to the fact that videos are designed to reach a broad audience, made of people of different ages, education and levels of expertise: as a consequence, within this context, while it is clear that it is undoubtedly important to accurately transmit the contents, engaging the audience can be a crucial first step in the achievement of this goal. With this in mind, speakers mostly use 2nd person pronouns as verbal techniques to capture and maintain viewers’ attention throughout the video. In a similar fashion, they also employ these pronouns in conjunction with direct questions that demand people’s active participation through reflections, interactions with the speaker and individual research. Additionally, by tapping into collective experiences, feelings, values and interests, speakers effectively cultivate empathy and support, allowing individuals to feel part of a large community of people sharing needs, everyday challenges, doubts and fears.

Nonetheless, while this analysis suggests that direct addresses are, in this context, primarily used for audience engagement purposes, this does not mean that the aspect of content transmission is completely left out. Indeed, in YouTube educational videos, 2nd person pronouns are also used for the *docere* rhetorical goal, which is lexicalised through the 'anticipating possible doubts', 'content explanation', 'exemplification', 'discourse framing' and 'advice' functions. In addition to the instances in which these pronouns are employed in explanations and exemplifications, to make viewers feel active participants in the knowledge production and transmission processes, *you* and *your* are mostly associated with functions that allow for a coherent and well-structured accommodation of the specialised contents. This is the case, for example, of the instances in which they perform the 'discourse framing' function, which provides the audience with a logical and easy approach to the product. At the same time, the function 'anticipating possible doubts' is specifically used to accommodate the various messages to the audience as well: by putting themselves in peoples' shoes, speakers are thus able to pre-emptively address possible doubts, questions or misconceptions that non experts may come up with while watching their content. This, in turn, helps create a sense of personal connection with them and promotes a sense of trust and credibility that enhances both the overall effectiveness of the communication and the sense of personal engagement in the presented issues.

5.5.3 Reader pronouns in comic books about science

5.5.3.1. Presentation of the results

In comic books, 2nd person personal and possessive pronouns *you* and *your* account for 22.4% of the total pronoun population, as depicted in Fig. 80.

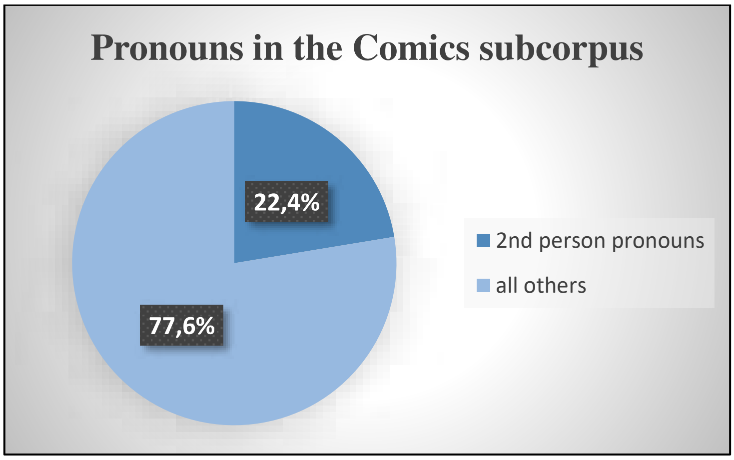

Figure 80. Distribution of 2nd person pronouns *you* and *your* in the Comics subcorpus (pie chart).

From a quantitative point of view, 829 instances of the pronoun *you* and 301 of *your* were retrieved in the corpus, as demonstrated by the data displayed in Tab. 86 and Fig. 81.

READER PRONOUNS	**COMICS**	
	RF	**NF (PTT)**
You	829	49.6
Your	301	18
TOTAL	**1.130**	**67.6**

Table 86. Frequency distribution of 1st person pronouns *you* and *your* in the Comics subcorpus.

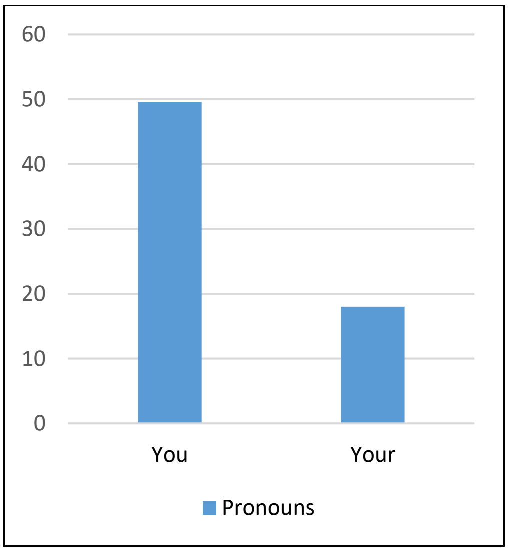

Figure 81. Frequency distribution of the pronouns *you* and *your* in the Comics subcorpus (histogram).

In the specific context of popular science comics, *you* and *your* have different referents: They can either function as direct or indirect addresses to the readers. The latter category, which is commonly found in this particular subcorpus, involves using the pronouns to address one or more characters within the story, encouraging readers to relate and identify with them. This is thus an ‘indirect’ type of address because it allows authors to communicate with the reading public through the words directed at characters within the narrative. The ‘direct address’ type, on the contrary, refers to the instances where authors directly engage with the reading public by asking questions, giving advice, and encouraging specific actions.

From a discursive perspective, then, *you* and *your* perform different functions, which are listed in Tabs. 87 and 88 below, and that are visually represented in the histograms displayed in Figs. 82 and 83.

DISCURSIVE FUNCTIONS ASSOCIATED WITH THE PRONOUN YOU	**YOUTUBE VIDEOS**	
	RF	NF (PTT)
CONTENT EXPLANATION & DISCOURSE FRAMING	43	2.5
STORYLINE DEVELOPMENT	29	1.7
QUESTIONS	25	1.5
READER-ORIENTED ADVICE	3	0.1
TOTAL	**100**	**5.8**

Table 87. Frequency distribution of the discursive functions associated with the pronoun *you* in the Comics subcorpus.

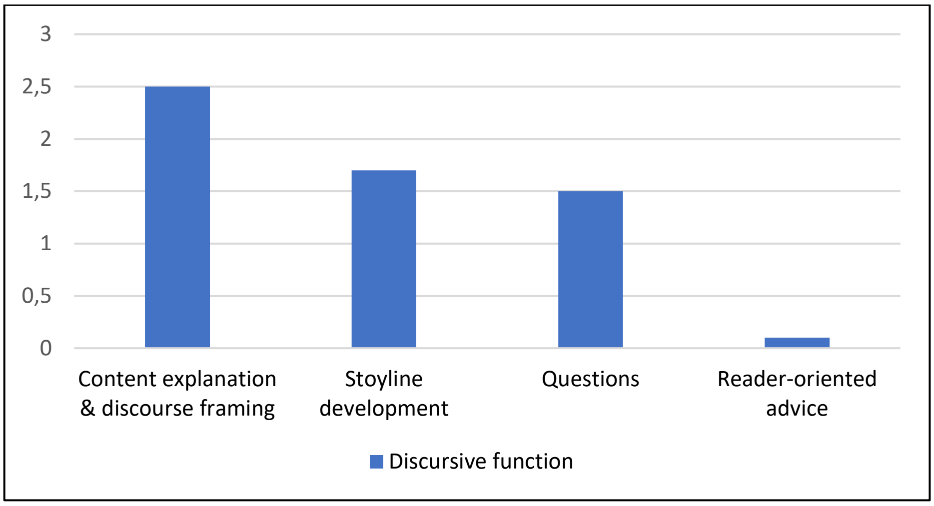

Figure 82. Frequency distribution of the discursive functions associated with the pronoun *you* in the Comics subcorpus (histogram).

DISCURSIVE FUNCTIONS ASSOCIATED WITH THE PRONOUN YOUR	**BLOG POSTS**	
	RF	NF (PTT)
CONTENT EXPLANATION	62	3.7
STORYLINE DEVELOPMENT	38	2.1
TOTAL	**100**	**5.8**

Table 88. Frequency distribution of the discursive functions associated with the pronoun *you* in the Comics subcorpus.

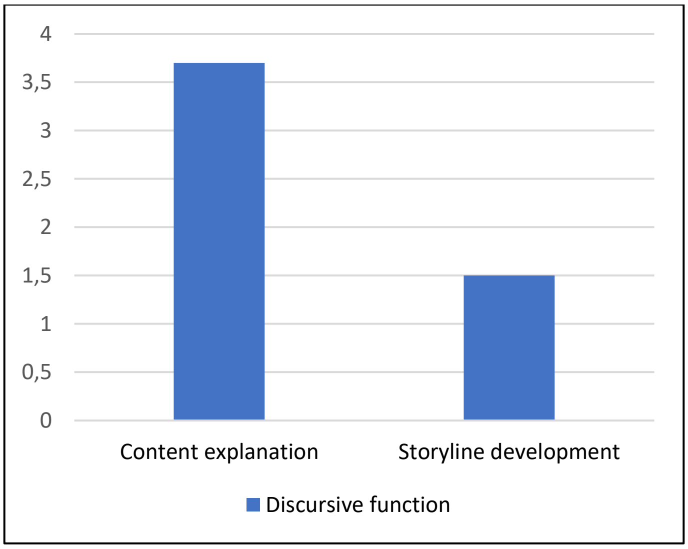

Figure 83. Frequency distribution of the discursive functions associated with the pronoun *your* in the Comics subcorpus (histogram).

‘Content explanation and discourse framing’ stands out as the most commonly observed category in comic book texts. This strategy involves the use of *you* and *your* to provide information and explanations about scientific concepts (277), as well as to guide readers through the texts (278). In this medium, domain-specific knowledge is transmitted via the interactions between the main speaker, who acts as an informed omniscient narrator, and the different characters encountered in the book: authors speak through the voices of the main protagonists and explain specialized concepts to the readers by addressing the other characters within the story. Furthermore, through dialogues indirectly addressed at the readers, the speakers offer clues on what to observe and how to interpret concepts and figures (278).

> (277) *About 10-15% of all the cells in **your** brain are microglia. Microglia protect **your** brain from intruders, and they also keep the place clean. These cells are active! They move around the brain a lot, and they change shape in order to do this.* (B_TheBrain)

> (278) *The next thing **you'll** notice after the squishy pudding-y thing is that the brain is divided into two parts-the left and right hemispheres! The big valley down the middle of the brain is a special kind of sulcus, called a fissure. This one is the longitudinal fissure, and it's what separates the two halves of the brain.* (B_TheBrain)

Secondly, 2nd person pronouns are also frequently employed in dialogues that do not carry any specialised or technical information. In these cases, the focus is not on the explanation of the specialised contents but on the development of the narration. Examples include characters introducing themselves (279) or discussing their personal lives and past experiences (280). From a discursive standpoint, creating relatable characters who act and speak like humans enables readers to emotionally connect with the story and become more engaged with the presented material.

> (279) *I am Dr. Cerebrum, and I will be removing **your** brain for science today! It’ll be fine.* (B_TheBrain)

> (280) *Nour, you know I have better things to do with my weekend than help **you** sell these Woodland Adventures cookies.* (B_TheBrain)

Thirdly, 2nd person pronouns are also employed in conjunction with interrogative utterances: the ones posed by the various characters to the narrating voice, and the ones asked by the main speaker to the other characters. The former represents laypeople seeking further explanations or clarifications, like in a real-life educational setting (281). The latter type includes, instead, the utterances where the main speaker asks questions to the characters to assess their level of understanding. This serves to anticipate potential doubts or uncertainties that real-life readers may have (282). From a discursive perspective, resorting to 2nd person pronouns in conjunction with interrogative sentences strengthens the idea of a dynamic exchange between the characters with which readers are asked to identify. As a consequence, people reading the comic are prompted to engage in the dialogue and seek knowledge actively: this last aspect is crucial not only for enhancing readers' investment in the topics, but also for improving their overall reading experience.

> (281) *Wait! Wait!* ***You*** *said that brain science has come a long way – what did* ***you*** *mean?* (B_TheBrain)

> (282) *Oh, jeez. Am I moving too fast for* ***you****, Chase? [...] Let's make sure we're on the same page first.* (ES_Wildweather)

Finally, one last function associated with the use of 2nd person pronouns in the context of science comics is the so-called 'reader-oriented advice' (283). In these instances, speakers directly address the real-life audience to provide guidance, suggestions and practical pieces of advice related to the specialised content under discussion. From a discursive point of view, using pronouns *you* and *your* in this context creates a direct and un-mediated connection between authors and readers, allowing them to show laypeople the practical applications of the presented domain-specific information, while simultaneously offering personalised advice for their own everyday lives. Through these utterances, authors empower readers, encourage them to apply specialised knowledge in practical contexts and enhance their sense of agency.

> (283) *If* ***you're*** *nervous about any situation in this book it helps to make a plan about what to do in case of emergency. Talk to* ***your*** *family about what sort of emergency situations are likely where you live. Make a plan together for where* ***you*** *will go in case you need to evacuate. Put together a list of emergency contacts, including work and school phone numbers.* (ES_Wildweather)

5.5.3.2 Discussion of the results

In comic books, authors skilfully balance their attention between an accurate transmission of the contents and the engagement of readers.

As the two tables above suggest, specific importance is associated with transmitting specialised knowledge in a way that engages the audience and piques receivers' interest in the topics being analysed. The objective is to create a learning experience that is not only informative in nature, but also engaging, relatable and thought-provoking. In comics, this result is, above all, obtained through the exploitation of 2nd person pronouns in dialogues which resemble real-life conversations and to which readers can emotionally connect. Likewise, the use of questions contributes to this aspect by drawing readers into the discussions and by making them feel not passive recipients of information, but active participants in the exploration and transmission of the specialised and technical issues.

However, specific attention is also attached to transmitting the contents in an accurate and effective way, which is achieved by using 2nd person pronouns performing the 'content explanation & discourse framing' and the 'reader-oriented advice' functions. As discussed above, the former type of utterances contributes to the bridging of the expert/non-expert gap. The 'reader-oriented advice' function, instead, enables authors to offer personalised guidance and suggestions to the public, empowering readers and encouraging them to actively apply the presented information.

Conclusions

The final chapter of this thesis brings together the insights and reflections acquired throughout the study. The opening paragraph (section 6.1) offers a comprehensive overview on the work, with its research objectives and the methodological approaches that have been used for its realization. Section 6.2 is centred on the presentation and discussion of the outcomes that emerged from this analysis, in light of the research objectives outlined at the beginning of this work and the scholarly literature consulted for this study. The ensuing section 6.3 delves into methodological reflections, providing a comprehensive discussion on the implications and outcomes resulting from the research approach selected for this study. In the end, the concluding paragraph (section 6.4) is devoted to both the description of the pedagogical implications of these outcomes and the importance these insights might have in relation to the study of specialised communication, as well as the discussion of a number of possible future developments of this research work.

6.1 Overview of the research work

At present, we are living and experiencing an era characterised by a progressive 'scientificisation' of everyday life (Daum 2009: 332). From education to healthcare, the domains of commerce, government and communication, every aspect of the industrialised modern society is somehow touched and shaped by scientific and technological advancements. As a consequence, highly specialized languages related to these domains have "endemically permeated the core of our society"[1] (Canepari 2013: 17) and every individual is now required to understand these discourses to make well-informed choices and take part in public debates in an active way. Yet, people who do not possess a solid background in these fields find it extremely difficult to understand and engage in such topics, so much so that they frequently trust unreliable sources of information when seeking knowledge on these subjects. As a result, in the attempt to improve public outreach and engagement, scientists, practitioners and institutions alike are now turning to new media such as, *inter alia,* web-

[1] "[…] si sono ormai infiltrati in modo endemico nel tessuto della nostra società".

based platforms and visual products, which serve the dual purpose of educating the general public and facilitating direct communication between them and scholars from different fields.

Against this backdrop, and on the basis of scholarly perspectives that argue for the essentiality to *reformulate* (Gotti 2014; Mattiello 2015) – or *re-draft* and *re-model* (Zou & Hyland 2019) the internal linguistic material – as well as to *recontextualise* (Calsamiglia 2003; Gotti 2013: 16) the information into new contexts and/or formats, this study seeks to examine which linguistic, discursive and rhetorical strategies are employed by authors of blogs, YouTube educational videos and comics to convey domain-specific knowledge in the fields of biology, chemistry and Earth sciences.

In order to tackle these issues, a 504,762-word corpus, which was purposefully built for this research, was compiled by assembling 364 texts extracted from 6 Institutional blogs, 9 YouTube channels and 15 comics. Once the data were manually collected and copy-pasted into .txt files, raw texts were uploaded and queried using *ad-hoc* softwares, specifically designed for linguistic and textual analyses. Data were studied in two phases by adopting a 'concurrent' mixed-methods approach (Creswell 1998, 1999; Dörnyei 2007; Clark et al. 2008).

The initial stage of this work consisted in a macro-textual analysis of the samples, which were investigated at the rhetorical level of their *dispositio*. Here, in line with Swales' *Structural Move Analysis* approach (1981, 1990, 2004), the complete set of 15 comic books, together with a sample of 135 blog posts and 103 YouTube scripts, were hand-tagged and queried using the computer-assisted annotation tool CATMA (https://catma.de/), in order to identify the distinct 'move' and 'step' types that make the internal organization of the discourse possible.

The last phase of the work consisted in a micro-textual study of the texts at the rhetorical level of their *elocutio*, specifically focused on the linguistic items that lexicalise the *docere* and *delectare* rhetorical goals. Here, in line with the methodology of corpus linguistics, self-mentions, definitions, interrogatives and 2nd person reader pronouns were extracted through CQL queries via the tool AntConc (https://www.laurenceanthony.net/software/antconc/), and were studied – both quantitatively and qualitatively – by looking at their frequencies of occurrence, their lines of concordance and their collocates.

The insights and reflections gathered from these two parallel investigations shed light, above all, on the potentialities these three media have for the dissemination of specialized information and on their role within the domain of scientific popularisation. What is more, these results both provide detailed information on the linguistic, discursive, and rhetorical means used to accommodate science in blogs, YouTube videos and comics, and also highlight a number of similarities and differences between these three media.

6.2 Concluding remarks

In view of the results reported in chapters 4 and 5, and in accordance with prior academic studies in the realm of popular science, this research has demonstrated that the three media under analysis are highly effective tools for scientific popularisation purposes in the fields of chemistry, biology and Earth sciences.

The identification of a number of different 'moves' and 'steps' in the texts, together with the linguistic and discursive strategies employed for *docere* and *delectare* (Zaleska 2016) demonstrate that the three abovementioned media align with the contemporary view of popular science. This perspective sees this genre not as a mere translation or simplification of specialised knowledge, but as a dynamic process of *recontextualisation* of the contents (Calsamiglia & Van Dijk 2004; Gotti 2005; Hyland 2010; Gotti 2013; Caliendo 2014) and of *reformulation* (Gotti 2014; Mattiello 2015) of the internal linguistic material. Retrieving these linguistic and discursive techniques thus proves that the three media effectively bridge the gap between non-experts and the world of Academia, consequently contributing to the enlightenment and empowerment of lay citizens in an age of information overload. Additionally, the identification, in all three subcorpora, of textual segments and linguistic items devoted to both transmitting specialised knowledge and to engaging and entertaining the public is in line with the 'edutainment' strategy (Singhal & Rogers 2003; Aksakala 2015), widely acknowledged as one of the defining pillars of the contemporary popular scientific enterprise (Burns *et al.* 2003; Moirand 2003; Myers 2003;).

However, the results of this study also reveal a series of differences in the way the three media engage with their public and promote scientific literacy through the communication of domain-specific information. As discussed in the following paragraphs, within the realm of popular science, blogs, YouTube videos and comic books configure themselves as three media that are not rhetorically and discursively identical: indeed, they posit themselves as distinct communicative genres, each displaying unique strengths, features and strategies for organizing contents, involving the public and conveying information.

As far as institutional science-themed blogs are concerned, the investigation conducted at the level of their internal organisation made it possible to prove that both ‘research’ – that is, the texts devoted to the account of research studies and findings – and ‘didactic’ posts – namely the ones aimed at educating and teaching readers about specific topics – appear to be characterised by a dominant and stable *dispositio*, which adopts a deductive rhetorical pattern that starts with the presentation of the necessary background information, moves on to the description and explanation of the topics at hand, and closes with the reference to its main outcomes. These aspects, in addition to the emphasis on the research results and their implications for people’s everyday lives (see Move 5 and 6 in ‘research’ posts, which were found in 100% of the texts), the employment of a repeated discursive pattern in displaying the concepts (e.g., *inter alia*, 3A>3B>3C in ‘didactic’ texts), and the incorporation of introductory steps devoted to referencing to shared knowledge (Step 1A) all contribute to enhancing the accessibility and relatability of the presentation of specialised scientific knowledge. Additionally, within this context, bloggers also insert textual segments that contribute to involving people in the topic of discussion: this is the case, for example, of step ‘Reference to an anecdote’, which provides interesting and ironic stories.

However, the analysis and prototypes developed in chapter 4 demonstrate that the textual content of the blog post is predominantly devoted to the comprehensive description and explanation of specialized topics. As paragraph 4.2 shows, blog posts display an internal information structure composed of 8 moves for ‘research’ post types and of 6 moves for ‘didactic’ ones. In the introduction, posts open with a segment working to provide the necessary context to the topic under discussion. This is then followed by a move that introduces the specific issue or type of research being undertaken, simultaneously highlighting its purposes, relevance and primary findings. In ‘research’ posts, bloggers also provide additional details concerning the state of the art within the field or compile a comprehensive list of the previously conducted research, which is something that targets more expert readers looking for detailed information on the issue at hand. The body of the text provides a thorough and comprehensive presentation, description and explanation of the topic under analysis, or, in the case of ‘research’ posts, an in-depth explication of the research, indicating its authors, experimental procedures and outcomes. Here, direct quotes or excerpts of interviews with professional scientists are also often included in order to enhance the credibility and authenticity of the information presented. Finally, in the closure, blogs insert three moves that are devoted, respectively, to the explanation of the implication and relevance of the results, the description of the remaining unsolved problems and the exploration of possible future scenarios or research directions. This concluding section plays a role of the utmost importance, since it summarises key points, fosters critical thinking and encourages further exploration in the realm of science and research. Furthermore, taking advantage of the hypertextual allowances of blogs, authors also insert references to other sites such as Wikipedia, YouTube channels or official institutions' websites, therefore providing people with suggestions for additional information sources that deepen their knowledge on the discussed topics. In light of these considerations, the analysis at the level of the *dispositio* thus emphasises that, despite devoting space to drawing readers into the discussion, bloggers are primarily dedicated to delivering high-quality informative and insightful material that resonates with their readership and that enables them to expand their knowledge on the scientific issues at hand.

Looking at the rhetorical *elocutio*, namely the linguistic choices made to craft compelling and impactful content to communicate effectively specialised messages, a deeper understanding of bloggers' communication strategies emerges. Above all, the investigation into the techniques for *docere* highlighted that they present specialised contents by adopting two main rhetorical roles – 'opinion-holder' and 'recounter of research processes' – and by using definitional chains, which provide the public with a more articulated and complex presentation of the information. On the one hand, by assuming the aforementioned roles, they are not only able to convey insightful in-depth analyses and explanations to help readers better understand, navigate and critically reflect on complex topics, but they also have the power to give them empirical evidence and concrete examples that ensure clarity and replicability of experiments, thereby enhancing visualisation. On the other hand, by resorting to definitional chains containing implicit hinges, domain specific verbal and nominal structures, and a flexible arrangement of the internal constituents, authors can successfully condensate the core notions and the more practical aspects of knowledge into focused segments, resulting in a more precise and accurate depiction of the issues. At the same time, however, they also require readers to decode various types of structures, which is something that compels them to independently understand the interconnections between concepts.

The investigation into the mechanisms for *delectare*, on the contrary, reveals that, in this specific context, these items serve a purpose that extends beyond surface-level 'reader engagement' and can be better characterised as 'educational reader engagement'. Indeed, in this context, interrogatives and reader pronouns are strategically used not for mere entertainment, but to captivate people's attention and interest into the intricacies of the topics, in order to further contribute to the transmission of the contents. As demonstrated by the analysis, interrogatives retrieved in this context mostly perform a *content-oriented* function, thus are mainly devoted to emphasising the most relevant points of the discourse, organising the information load, summarising key points, enhancing critical thinking skills and facilitating receivers' cognitive processing and knowledge retention. Likewise, 2nd person pronouns *you* and *your* are mainly used to make people feel part of the learning process and of the knowledge production and information transfer procedures. Whether it is explaining the latest findings in a particular field, describing complex scientific concepts, analysing new scientific developments or listing the various steps to undertake during an experiment, by using direct addresses with 2nd person pronouns, authors can effectively maintain an instructional tone while conveying a range of scientific information, actionable pieces of advice and suggestions for supplementary resources.

All in all, the investigation conducted at these two levels of analysis prove that while it is true that bloggers put into practice a number of strategies that both tailor the concepts to the needs and interests of the audience, the foremost objective remains the accurate and detailed transmission of knowledge. This, in turn, results in a more complex – and dense – internal informational structure (*dispositio*) and linguistic *elocutio* of the specialised concepts. On this basis, it is thus plausible to affirm that, within this specific discursive genre, the language of popular science predominantly serves a 'referential' (Jakobson 1963) or 'ideational' (Halliday 1985a) function. As a consequence, these aspects make this medium more beneficial to an audience possessing a certain degree of background knowledge of the issues, because readers who already possess a level of familiarity with these concepts are better equipped to navigate and comprehend the amount of information presented.

Subsequently, as far as YouTube science-themed educational videos are concerned, the exploration into the internal structure of the scripts allowed for the identification of a well-defined stable – and therefore audience-friendly – *dispositio* of the contents, characterised by a deductive rhetorical pattern, whereby the necessary background information is provided initially, followed by the explanation of the main issues, and culminating with a summary of the results. This structure is well exemplified by pattern M3>M4>M5 in the body of the videos and by the order 4A>4B>4C>4D>4E>4F in the so-called 'Topic development' move, which represents the progressive unfolding of the explanation of the domain-specific issues (statement of the topic, definition and classification, explanation of some necessary background concepts, description of a number of problems related to the issue at hand, explanation of the research work and description of its related outcomes). The emphasis on the research outcomes and their implication for people's everyday lives (Step 5A), the depiction of possible future scenarios (Step 5D), the employment of a repeated discursive pattern in the presentation of the concepts and the suggestion of extra materials (Step 6D), all contribute to an accurate, detailed and accessible presentation of the domain-specific contents. Additionally, within this context, great importance is given to the audience, with speakers attempting to grab and maintain their attention and interest, as well as trying to establish a sense of emotional connection and dialogue with them. Hence, on the one hand, at the beginning, they employ two initial moves (Move 1 and 2) to orientate the viewers and to tackle their curiosity. On the other hand, in order to establish a personal connection with the audience and cultivate a sense of community around the video, speakers include in their presentations a number of segments that evoke a real-life conversational environment (Steps 1A, 1B, 1C) and that prompt viewers to stay engaged with the channel (Step 6E), thus connecting with them on a more personal level.

As we can observe in paragraph 4.3, YouTube video scripts display an internal information structure composed of 6 moves. In the openings, videos begin with an introductory segment where listeners are oriented and the speaker is introduced: this includes steps such as 'greetings' and 'speaker presentation'. What follows is, then, a part devoted to inform and prepare viewers for the video, in which the background context is described, the main topic of discussion is announced and the structure of the talk is outlined. Subsequently, the central part of the video provides a detailed presentation and description of the issue under analysis. It starts with a move providing the background information that is necessary for understanding the topic, which includes references to widely shared knowledge and personal anecdotes that set the stage for the following exploration into the specialised issues. At a later stage, it shifts to the accurate exploration and analysis of the various intricacies of the topic, and it ends with a segment devoted to the explanation of its relevance, the summary of its main outcomes and the description of possible future scenarios and research directions. This final move is specifically aimed at leaving the audience with a clear understanding of the topic and at fostering an appreciation for the importance of science and the work of scientists. In the end, the video culminates with a final move that serves to conclude the speech effectively, thanking the public for their attention, announcing future videos, providing viewers with suggestions for additional resources on the topic, inviting their interaction through subscribing or commenting, and motivating them to take action to translate the newly acquired knowledge into tangible and meaningful actions. In light of these considerations, the study at the level of the *dispositio* thus underlines that alongside the accurate presentation of the concepts, high relevance is given to two other key aspects: the involvement of the audience and the establishment of a more intimate connection with them.

Moving forward, and considering the level of the rhetorical *elocutio* of the contents, a number of well-identified discursive strategies emerge. Above all, the investigation into the techniques for *docere* highlighted that speakers present the specialised contents by adopting four main roles – 'architect', 'individual', 'opinion-holder' and 'recounter of research process'. By assuming these discursive identities, authors of educational videos are, on the one hand, able to provide the public with an effective and user-friendly presentation of the contents, ensuring accuracy of the information and effortless navigation in a context where the information is presented at the pace of the video. On the other hand, by leaving space for personal asides and for clearly voicing their individuality, speakers are also able to create and nurture their relationship with the public, fostering both a sense of relatability, trust and authenticity, and a more informal and relaxed educational environment. Additionally, authors also convey specialised contents through definitions: in this specific medium, concepts are presented in a way that strikes a balance between the attention given to the accurate transmission of knowledge and the focus on the diverse needs and backgrounds of the audience. Definitions are mostly presented in the form of *definitional patterns*, which are shorter than the definitional chain but that nevertheless ensure an accurate and detailed presentation of the specialised notions. In addition, resorting to a fixed pattern of the constituents – with the object under analysis always preceding its definition (*definiendum>definiens*) – and embedding explicit hinges, examples and questions within the definition itself, helps viewers become familiar with the format, thus making it easier for them to recognise and understand the topics at hand. Finally, including in the patterns *figurative* and *incomplete* definitions as well, speakers are capable of effectively engaging the public, creating expectations, stimulating their curiosity and bringing the concepts closer to their everyday lives.

The investigation into the mechanisms for *delectare*, then, reveal that the linguistic items that are normally associated with this rhetorical goal (questions and reader pronouns), are, in this context, specifically employed to strengthen the establishment of a more personal and intimate connection with the audience. Indeed, interrogatives retrieved here are mostly located in the opening of the videos, thus acting as attention-grabbing devices and as triggers for curiosity. What is more, they are mainly employed as *audience-oriented* devices, with the intention of eliciting real responses and critical reflections from people, checking their understanding and inspiring their emotional responses. Similarly, 2nd person pronouns *you* and *your* are mostly used to capture and maintain viewers' attention throughout the video, elicit their active participation, prompt their individual actions and foster a sense of unity and shared experience among the viewers.

All in all, the investigation conducted at the two aforementioned levels of analysis has demonstrated that while it is important, in videos, to ensure an accurate and precise presentation of the concepts, a substantial emphasis is also placed on the role played by the audience, who is regarded as an active agent in the process of knowledge production and transfer: this specific focus also results in a less complex and more accessible internal information structure (*dispositio*) and linguistic *elocutio* of the specialised concepts. More specifically, in this context, the focus extends beyond engaging receivers and drawing them into the discussions: it entails also nurturing a deeper and more intimate rapport between the speaker and the viewer. On this basis, it is thus possible to state that, within this specific discursive genre, the language of popular science not only performs a 'referential', or 'ideational' function, but it also fulfils what Halliday (1985a) refers to as 'interpersonal'. More precisely, given that the emphasis is on both engaging the public and on establishing with them a more intimate relationship, two other functions can be associated with this genre: Jakobson's (1963) 'emotive' function, which refers to the expression of the sender's emotions and subjective experiences, and the 'conative' function, which attempts to engage, motivate, instruct or persuade the receiver of the contents of discussions. As a consequence, these aspects make this medium suitable for viewers of different ages, levels of expertise and educational backgrounds, because speakers skilfully use various discursive strategies that effectively adapt the contents to cater to diverse audiences.

Ultimately, as far as science-themed comic books are concerned, the exploration into the internal structure of the texts allowed for the identification of a well-defined stable – and therefore reader-friendly – *dispositio* of the contents that contributes to removing the barriers average non-expert receivers normally encounter when dealing with such specialized information. In this specific context, authors focus their attention on both the accurate transmission of the contents and on their readers. Hence, to achieve this, they put into practice a combination of strategies. Above all, they make use of a deductive rhetorical pattern – that starts with the contextualisation of the issues, moves on to the announcement and description of the contents and closes by summarising the main points. Then, they also employ various segments that connect the contents to readers' everyday lives (see the steps called 'Call for action', 'Final recommendations and links to external resources', 'Reference to the historical background' and 'Reference to shared knowledge'). Furthermore, they adopt a number of 'moves' and 'steps' that orient the public, create a sense of suspense and motivate them to continue reading – the so-called 'Content orientation', 'Anticipation of the ensuing contents' and 'Story opening'– thus guaranteeing that the audience is effectively engaged and captivated.

As discussed in paragraph 4.4, comic books organise their textual content into four main moves – one located in the introduction, two in the body and one in the conclusion. However, the variations in the internal arrangement and discursive functions of each segment and sub-segment lead to the proposition of three sub-genres within the overarching category of science comic books.

The first is represented by the so-called 'didactic' books, in which no storyline unfolds along the book, but the scientific notions are presented sequentially. In this context, the opening move aims at setting the context and introducing the issues that will be dealt with in the book, making sure that readers are well oriented and prepared to delve into the subject matter. Then, two central ones are dedicated to the presentation of background information, historical context or grounding knowledge, all elements that are necessary for the understanding of the topic, as well as for the elaboration of the concepts themselves. In the concluding part, several important elements are assembled: there is a summary of the main points discussed, the announcement of the ensuing contents and emphasis on the importance and practical application of such topics for people's everyday lives.

The second sub-genre within the science comics category is represented by the so-called 'didactic-narrative' books, in which the explanation of the contents develops simultaneously with the narrative storyline. Here, the opening move works not only as a tool for the setting of the context and for the announcement of the topic of discussion, but also for the presentation of the speakers and other relevant characters within the story. The central moves within the book are, as in 'didactic' comics, devoted to the accurate and accessible presentation of the concepts, while the concluding part incorporates a number of elements that are characteristic of the 'didactic' sub-genre, namely the summary of the key points covered in the chapter, the explanation of the topic's significance, the depiction of unresolved issues and the invitation for readers to take action.

Finally, one last sub-genre retrieved in this corpus is represented by the so-called 'narrative-didactic' comics, in which authors detach themselves from the expository/argumentative structure of traditional scientific texts and opt for a more dynamic and character-driven narration. These comics prioritise storytelling and use the opening and closing segments of the books to develop the plot, with segments specifically devoted to the accurate depiction of the setting and scene, the presentation of the main and secondary characters, and the exposition of the core problems or conflicts. The central part of the plot becomes, instead, the vehicle for the transmission of the domain-specific concepts. Finally, the concluding segments leads to both the conclusion of the narrative arc and to reinforcing the acquired knowledge. It provides the public with a resolution to the plot while simultaneously encouraging them to take action and tackle the debated issues, suggesting specific resources to further deepen their knowledge.

Moving onto the level of the rhetorical *elocutio* of the contents, it is possible to identify a number of specific linguistic and discursive strategies employed for the transmission of the contents and for the engagement of the public. Above all, in popular science comics, authors transmit the domain-specific concepts through the voice of their characters, which, in turn, assume two main roles – 'individual' and 'architect of the essay'. The former role allows for dynamic, engaging and accessible explanations that convert theoretical notions into tangible and palpable events, as well as presenting a closer and more relatable depiction of the specialised concepts. The latter, instead, provides the public with a well-organized and coherent reading experience, and fosters a sense of anticipation and suspense that keeps readers invested in the story. Furthermore, authors also convey specialised contents through definitions: in this specific medium, writers generally avoid using dense definitional strings and, on the contrary, present the information contained in the *prototypical*, *procedural* and *figurative* segments as standalone elements. By conveying specialized contents in distinct parts, authors are thus able to guide their public across the contents, leaving them the necessary time to focus on each aspect. Here, the use of a fixed pattern of the constituents – with the object under analysis always preceding its definition – the reliance on a fixed and repeated number of explicit hinges, and the presence, in most cases, of examples and questions embedded within the definition itself, enables a consistent and predictable structure in the presentation of the information, which, in turn, helps the audience navigate the contents more easily. Ultimately, the *docere* rhetorical aim is also achieved through the employment of a number of questions and 2nd person pronouns that facilitate a process of 'educational engagement': this is the case of *content-oriented* interrogatives and 2nd person pronouns performing the 'content explanation & discourse framing' and 'reader-oriented advice' functions, which directly address people to navigate them across the information load.

On the contrary, the investigations into the mechanisms for *delectare* reveal that the linguistic items that are normally associated with this rhetorical goal engage the public in two ways: by directly addressing the reading public and by developing the narrative line. The former is lexicalised through the use of the so-called *audience-oriented* interrogatives and 2nd person pronouns, which directly address the real-world audience to encourage them to find answers and reflect upon their learning process. The latter, instead, is rendered through the employment of *character-oriented* interrogatives and 2nd person pronouns serving the function of advancing the storyline.

All in all, the investigation conducted at these two aforementioned levels of analysis demonstrates how, in comics, the attention is placed simultaneously on the transmission of contents and on the engagement of readers: this aspect, in turn, is realised simultaneously through the development of the narrative line and the address to the real-world reading public. On this basis, it is thus possible to state that, within this specific discursive genre, the language of popular science not only serves a 'referential', or 'ideational' function, but it also fulfils what Halliday (1985a) refers to as 'interpersonal' or 'conative' function. Additionally, within the segments devoted to the development of the narrative storyline, the language takes on a ‘phatic’ function (Jakobson 1963), since, rather than conveying domain specific information, it is used to establish and maintain the social relationships between the characters. These segments, focused on the development of dialogues and interactions between characters, recreate the essence of real-world conversations and interpersonal dynamics: readers are therefore more inclined to develop a sense of realistic connection, empathy and familiarity with the characters, which, in turn, fosters a deeper level of emotional engagement with the contents presented in the book. In this light, language thus assumes an additional dimension, aligning with Jakobson’s ‘emotive’ function, since, in the end, it also elicits an emotional response from the audience. Consequently, these aspects make this medium suitable for audiences of different ages, levels of expertise and educational backgrounds, because speakers skilfully use various discursive strategies that effectively adapt the contents to cater to diverse audiences.

All in all, this research has unearthed a number of similarities and differences between the three media under analysis that indicate the presence of a *continuum*. This *continuum*, however, is not solely confined to the dichotomy between highly specialised and popular genres, as posited by Myers (2003), but operates also inside the genre of scientific popularisation. The analyses displayed in chapters 4 and 5 effectively portray this notion. On one end of the cline, we find the Institutional blog, which is composed of a complex and dense internal *dispositio* comprising a series of moves and steps mostly devoted to the accurate delivery of informative materials to the readers. Herein, highly structured and dense *definitional chains* are utilised in conjunction with two main authorial roles in order to provide insightful in-depth analyses on the topics at hand, and the linguistic items normally employed for the *delectare* rhetorical goal go beyond mere entertainment and serve the purpose of an ‘educational’ reader engagement. Moving along the *continuum*, we then encounter YouTube videos and comics: these media go beyond the accurate presentation of the concepts and place a strong emphasis on the engagement of the audience as well as on the establishment with them of a more intimate connection. Here, the internal *dispositio* of the information displays less structurally dense move structures in which the focus is on creating insightful contents resonating with the public: indeed, in these contexts, initial and final segments are dedicated, respectively, to orienting and intriguing the audience, and to leaving a lasting impact and prompting further explorations. Additionally, alongside a less structurally complex and more relatable presentation of the specialised concepts (definitions are presented in the form of shorter *definitional patterns* or as standalone elements and authors frequently make themselves visible by acquiring roles that allow the audience to better visualise the concept and to empathise with them), greater prominence is given to the different linguistic items employed for the engagement of the audience: herein, questions and reader pronouns both try to elicit their active participation and attempt to nurture a connection with them on more personal levels.

6.3 Methodological reflections

From a methodological point of view, conducting a corpus-assisted discourse study for the investigation of popular science in Institutional blogs, YouTube videos and comics turned out to be necessary for a comprehensive and detailed understanding of the linguistic and discursive organization of the specialised discourse in question.

On the one hand, applying the Structural Move Analysis approach (Swales 1985, 1990, 2004) to the study of the collected texts enabled a systematic and in-depth exploration of the underlying rhetorical *dispositio* of the contents that unveiled significant structural differences according to the medium under analysis. More specifically, the quantitative analysis of the frequency of each move and step made it possible to retrieve valuable insights concerning their occurrences: these hints provided a solid foundation for understanding whether these segments were essential or optional for the overall rhetorical structure and construction of the message. Then, the qualitative investigation into each move and step's discursive functions and positions proved to be highly valuable for the identification of the most relevant patterns, collocations and argumentative roles within the overall construction of the specialised discourse. Furthermore, integrating pre-existing models (e.g., *inter alia*, Nwogu 1991; Chang & Huang 2015; Li & Li 2021) into the analysis of the collected data made it possible to build upon prior knowledge and extend the understanding of the topic based on the contribution of the newly extracted data. In the specific context of comic books, this phase allowed for the identification of a gap in the literature, which lead to the elaboration of a framework that had not been previously created.

Subsequently, using the open-source tool CATMA, which makes it possible to create personalised tagsets, to keep track of frequency counts and that avoids rigid annotation schemata, provided more systematic and empirical evidence that played a crucial role in the development of the final prototypes.

Finally, since as argued by Biber *et al.* (2007), top-down approaches are normally highly labour-intensive and excessively complex to be applied to the entire population of texts within a corpus, the application of Cochran's 1977 formula for the determination of the sample ensured that the outcomes of the study were reliable and generalisable to the entire population of the texts.

On the other hand, resorting to the principles and tools of corpus linguistics in the study of discourse (Baker 2006; Baker & Mc Enery 2015) enabled a systematic and in-depth investigation into the rhetorical *elocutio* of the contents, which revealed a substantial degree of dependence on the specific medium under investigation. In this context, using the corpus analysis tool AntConc, which allows for frequency counts, word lists, linguistic collocates and lines of concordance, proved to be essential for conducting a thorough investigation from both quantitative and qualitative perspectives. The quantitative inquiry made it possible to systematically measure the language items and the discursive functions that hold particular significance in the constructions of the argumentation. Simultaneously, the qualitative investigation conducted at the level of the linguistic collocates and extended concordances of each item – which, according to Stubbs (1996) point to the way in which words are associated, and, as a consequence, to the way discourses are built – allowed for the retrieval of different well-identified discursive techniques that were purposely employed by authors to shape the argumentation. More specifically, the application of this methodology to the study of authorial references not only made it possible to confirm that the role of the speaker is not "a pre-fixed language entity, but is 'chosen' when writing" (Tang & John 1999), but it also allowed for the retrieval of a number of authorial roles that had not been identified in previous scholarly works on the topic (e.g., *"I" as the individual, "I" as the experimenter*). As far as definitions are concerned, then, this investigation not only enabled the identification of various definitional patterns, but also brought attention to the existence of particular language cues that lexicalise and encapsulate the different segments.

In turn, as far as interrogatives are concerned, this investigation made it possible to retrieve a category that had not been identified in other works (the so-called 'character-oriented' type), while simultaneously emphasising that, in this specific environment, *content-oriented* and *audience-oriented* types can achieve multiple discursive functions and can even be associated with rhetorical objectives that deviate from their conventional associations (see, for example the case of blogs, in which the *audience-oriented* questions contribute to the process of knowledge transmission, thus serving the *docere* rhetorical goal, rather than the *delectare*).

Finally, the study on 2^{nd} person personal and possessive pronouns shed light onto the existence of a number of discursive functions associated with *you* and *your* that are crucial for understanding how the author-public relationship is crafted within diverse media contexts. In an analogous fashion to the study on the rhetorical *dispositio*, by taking pre-existing scholarly studies as reference models (e.g., *inter alia*, Webber 1994; Tang & John 1999; Pilkington 2018, 2019; Zou & Hyland 2020) and integrating them with the newly extracted data, it was possible to deepen the knowledge concerning the linguistic and discursive strategies employed for information tailoring and audience engagement purposes.

6.4 Research implications and possible future developments

Providing valuable insights into the structure, discursive organization, and communicative strategies exploited for conveying contents related to the fields of biology, chemistry and Earth sciences, the results displayed in chapter 4 and 5 may have a number of possible applications that extend beyond the linguistic analysis of specialised discourses and delve into the realms of science communication and pedagogy.

On the one hand, outcomes of the structural move analysis and of the corpus-assisted study on the *elocutio* of the contents have conclusively demonstrated that all three media effectively align with the main features and goals of scientific popularisation. As a consequence, these media represent important resources for both teachers of scientific subjects and ESP instructors. Within this context, using these materials for the transmission of domain-specific scientific topics or for teaching students specialised languages, particularly in the early stages, allows educators to provide them with authentic materials that cater to their different levels of proficiency and learning preferences: for instance, their consistent thematic structure, together with their use of a variety of cohesive devices, paraphrases and reformulations make these texts especially beneficial for novice learners (Nwogu & Bloor 1991; Myers 1991). Additionally, as claimed by Parkinson and Adendorff (2004), these materials also enable students to become more aware of the existence of scientific genres different from the canonical science-themed textbook or research article: this, in turn, contributes to raising their awareness on the credibility, reliability and validity of different information sources. Furthermore, these texts also contribute to presenting students with different perspectives and interpretations of science and the work of scientists: this exposure stimulates their intellectual curiosity and prompts them to question, challenge and de-construct established arguments, as well as teaching them to articulate their ideas in a clear and coherent way, support their claims with evidence, and engage in respectful and meaningful dialogues with peers who hold different opinions. Lastly, as claimed by Hyland (2010), although these texts display a different model of science if compared to research articles, such differences may have an attention-raising function for students, contributing to focusing their attention onto the rhetorical and linguistic peculiarities of both discourses.

On the other hand, research at the levels of the rhetorical *dispositio* and *elocutio* of the specialised contents in popular science could work as a useful guide for students, teachers and science communicators alike willing to work on the creation of a popular science product. Writing and creating popular science products has become increasingly important in recent years due to the pressure researchers and scientific institutions are experiencing from society. Within this context, various how-to manuals have been published (see, for example, Baron 2010; Bowater & Yeoman 2012; Meredith 2021), but quite often their insight into language is limited. On the contrary, findings derived from this analysis would be of the utmost importance for integrating the existing literature and providing people with strategies and techniques that are useful for crafting effective scientific popularisation materials. Indeed, a comprehensive understanding of their internal move and step structure would help them understand the conventions and internal organisation of written and spoken discourses of science, thus aiding them in the choice of the most suitable framework to effectively convey the concepts to the general public. Likewise, a thorough awareness of the different linguistic means and their corresponding discursive impact on the transmission of the messages is crucial, as it would make it possible to skilfully structure the discourse and employ the strategies that are most suitable and effective for the intended audience.

As seen throughout this work, the present research has been confined to the analysis of three genres, namely science-themed Institutional blogs, YouTube educational videos and comic books specialized in the fields of chemistry, biology and earth sciences. While the findings obtained from this study shed light on the linguistic and discursive configuration of popular science – which, as stated above, has important repercussions for science communication and pedagogy – there remains considerable room for future developments and broader investigations.

One possible expansion of this research could involve the exploration of a broader spectrum of disciplines, in order to investigate the linguistic and discursive variation among them and examine the specific techniques that are involved in the construction of knowledge in different fields. Investigating cross-disciplinary variation within the field of popular science would provide important insights into how knowledge is conveyed, disseminated and constructed within different domains, and this, in turn, would shed light onto the foundational principles, norms and conventions that shape disciplinary communication.

Moreover, another potential development of this research could concern the inclusion of other genres beyond the ones investigated so far. Examples of other emerging formats of scientific popularisation include audiovisual media such as documentaries and TV series, auditory products like podcasts and radio programs, popular outlets on social networks like Twitter and Instagram, and visually captivating materials such as infographics. By incorporating other media in the study, it would be possible to achieve a more comprehensive understanding of the linguistic and discursive strategies employed for scientific popularisation purposes. At the same time, such analysis would enable a deeper understanding of the characteristics and affordances of each medium that impact on the internal construction of the discourse: studying the interplay between media and discourse may be beneficial for uncovering crucial information concerning how instructional content is tailored to suit specific media and audience's needs and expectations.

Finally, one last potential development of this research could involve the expansion of the corpus to include resources originally produced in other languages, in order to bring to the fore the culture-related conventions that might influence both the internal organisation of moves and steps, and the linguistic and discursive techniques employed for the *elocutio* of the specialised contents. Investigating resources originally produced in languages other than English, valuable insights could be gained in terms of the strategies employed to educate and entertain the audience. Such an investigation would help testing whether there exists what House (1997) calls the 'cultural filter': according to this theory, specific rhetorical patterns and discursive conventions may vary across languages due to disparities in national cultural values, norms, communicative preferences, and socio-linguistic factors. Conducting such research would therefore contribute to a deeper understanding of the impact of culture on rhetorical strategies and linguistic conventions across different contexts.

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