**Eduardo CARCABOSO-GARCÍA**
Universidad de Extremadura. Spain. ecarcabosog@unex.es. https://orcid.org/0000-0001-9542-1139

**Samanta FLORES-JARAMILLO**
Universidad de Extremadura. Spain. samantafj@unex.es. https://orcid.org/0000-0002-9401-5718

**Dr. Rocío GÓMEZ-CRISÓSTOMO**
Universidad de Extremadura. Spain. mrgomcri@unex.es. https://orcid.org/0000-0002-3258-6283

**Dr. Javier TRABADELA-ROBLES**
Universidad de Extremadura. Spain. jtrarob@unex.es. https://orcid.org/0000-0001-5338-9257

## Use and distribution of scientific allusions in fiction tv series. The case of The Big Bang Theory

### Uso y distribución de las alusiones científicas en las series de ficción. El caso de The Big Bang Theory

## Abstract

Fiction tv series can command large audiences and become effective vehicles for scientific communication. Although not many series currently incorporate scientific material in their scripts, the practice of incorporating expert advisors in different fields, including science, into the scriptwriting team is on the rise. This research aims to show the relationship that may exist between audio-visual production and the dissemination of science. We performed a study of the scientific allusions included in the series "The Big Bang Theory" and its relationship with the educational function attributed to audio-visual products. Different objectives are addressed, including analysing the training capacity of this series, through a quantification and distribution of citations or mentions in this audio-visual product. What is particularly novel is the analysis linking the scientific allusions identified with the place of their appearance within the narrative structure of each chapter. The sample was made up of the first five seasons (2007-2012) of this series. The main results enabled us to meet our objectives. It is worth noting that the most common type of scientific mention in the series is "Theory/Principle", followed by "Articles" and "Authors"; also, mentions of scientific content are established in the first two acts within the plot of the series, reserving the third, with hardly any scientific mentions, to present the moral of the plot.

## Keywords

Audio-visual products; The Big Bang Theory; Fiction series; Scientific allusions; Science communication; Scientific dissemination

## Resumen

*Las series de ficción cuentan con una gran audiencia y pueden llegar a convertirse en un vehículo efectivo en relación a la comunicación científica. Si bien en la actualidad no son numerosas las series que incorporan en sus guiones material científico, está en aumento la práctica de incorporar a la plantilla de guionistas personal experto-asesor en diferentes ámbitos, entre ellos, el científico. Esta investigación tiene como finalidad mostrar la relación que puede existir entre la producción audiovisual con la divulgación de la ciencia. Se realiza un estudio de las alusiones científicas incluidas en la serie "The Big Bang Theory" y su relación con la función formativa atribuida a los productos audiovisuales. Se abordan diferentes objetivos, entre ellos analizar la capacidad de formación de dicha serie, mediante una cuantificación y distribución de citas o menciones en el producto audiovisual. Resulta especialmente novedoso el análisis que vincula las alusiones científicas encontradas con el lugar de la aparición desde el punto de vista de la estructura narrativa de cada capítulo. Se han tomado como muestra las cinco primeras temporadas (2007-2012) de la serie. Los principales resultados han permitido dar respuesta a los objetivos planteados. A destacar que el tipo de mención científica más utilizado en la serie es "Teoría/Principio", seguido de "Artículos" y "Autores"; también, que las menciones a contenido científico se establecen en los dos primeros actos dentro del argumento de la serie, reservando el tercero, sin apenas menciones científicas, para plantear la moraleja de la trama.*

## Palabras clave

*Productos audiovisuales; The Big Bang Theory; Series de ficción; Alusiones científicas; Comunicación de la ciencia; Divulgación científica*

## 1. Introduction

### 1.1. Science communication in audio-visual productions

Scientific advances contribute to social welfare and development, but the information society receives about science does not match the significance of these advances, or at least not with what might be expected. The media should not be held solely responsible for this situation, yet they no doubt hold a key position as a source of access to knowledge (Paz Martín, Acosta Damas and Costales Pérez, 2017).

If we focus on the television landscape, the communication and dissemination of scientific research can be complicated for scriptwriters and producers. This may be part of the reason why science programmes are scarcely featured on television schedules, despite the importance that scientific issues are gaining in today's society (León, 2002). According to a study entitled *Percepción Social de la Ciencia* [the Social Perception of Science] by *Fundación Española para la Ciencia y la Tecnología, FECYT* (2020) [Spanish Foundation for Science and Technology], television continues to be the main channel of information for citizens. Thus, "In addition to entertaining the viewer, television has an educational purpose as well" (Molina Santoja, 2020: 110).

The main challenge lies not only in the task of interpreting the complex content of science to make it understandable to the general public, but also in considering all aspects of science communication and dissemination. It is important to communicate the entirety of this complex scientific knowledge using techniques and languages familiar to the public, such as audio-visual media. Yet to do so, as pointed out by De Lara González and García-Avilés (2019: 188), one must "know the characteristics, formats, and narratives that are most successful in conveying scientific knowledge".

Productions regarding science in televised formats, whether documentaries, television series, magazines (García-Regalado, Flores-Jaramillo and Carcaboso-García, 2020), and even films, can help to forge "a scientific culture" by creating "portrayals of the world and science", in order to awaken the public's interest in the scientific realm (Scalfi and de Oliveira, 2015).

However, for this scientific programming to succeed, science must separate itself from its "common wisdom" and decrease the distance that separates it from "common knowledge" (León, 2002). As explained by León (2002), "Even today, dissemination discourse often employs narrative structures that create an efficient connection with ways of gaining knowledge that are familiar to the audience" (León, 2002).

Nowadays, science communicators use narrative structures that efficiently establish a connection with the audience in their informative discourses with the use of codes that are familiar to them. These messages are created to generate a link between science and "common sense" (León, 2002).

For these reasons, disseminating or making scientific content available to society so that citizens can understand and decipher it without a major effort is not something new. For example, on Spanish radio (Díaz, 2014; Sánchez Fundora and Roque García, 2011), we find several programmes such as *Tesis* [Thesis], a weekly broadcast focusing mainly on the dissemination and disclosure of cultural, academic and research activities carried out at Andalusian Public Universities. Another is entitled, *A hombros de gigantes* [On the shoulders of giants], which is "a science diffusion programme on *RNE* [...] closely related to current affairs with the most recent findings, the latest news published in leading scientific journals, and the voices of key participants" (Sinc, 2022), among others.

In the field of television, science-related programmes focus on the documentary genre (León, 2002), or the *docuseries*, which is an eminently structured and high-quality format, but mainly aimed at a specific audience; examples include the famous programme, *El hombre y la tierra* [Man and Earth] (Salcedo, 2012), and *Redes* [Networks], broadcast from 1996 to 2014 in Spain and presented by Eduard Punset. On the international scene, one that stands out is the classic and award-winning docuseries *Cosmos: A Personal Voyage*, by Carl Sagan (1980), or *The Underwater World by Jacques Cousteau* (1966-1976). In this context, audio-visual productions of fiction can play a fundamental role in reaching a wider target audience (Cros Alavedra, 2017; Gutiérrez-Lozano, 2002; Ortega Gálvez and Albertos Bofarull, 1998; Toharia, 1990).

Although the challenge lies in finding the best way to transform scientific knowledge into audio-visual language (Blanco López, 2004), this medium is undoubtedly an ideal channel for the diffusion of this kind of knowledge. Diverse studies have focused on analysing the role of "online video" in social media as a tool for scientific diffusion (Davis et al., 2020; De Lara González and García-Avilés, 2019; Gómez-Domínguez et al., 2020; Marín Arraiza and Vidotti, 2019; Romero-Luis, Carbonell-Alcocer and Gértrudix Barrio, 2020; Dubovi, and Tabak, 2021), as well as science fiction productions (Barnett et al., 2006; Marín Ramos, 2018; Petit Pérez and Solbes Matarredona, 2012; Scalfi and de Oliveira, 2015; Hargittai, Füchslin, and Schäfer, 2018; Yammine et al., 2018; Orthia, 2019; Teo, 2021), and medical TV series (De la Torre, 2016; Hoffman et al. 2017; García, 2018).

In medical series on television, scientific rigour and procedures become insignificant more often than not, as opposed to offering the patient the most accurate diagnosis possible, as Lisa Sanders discusses in De la Torre:

> In ER, for example, which is one of the longest running medical series, one of the doctors comments to his patient, "We have the results of the blood test; you have leukaemia", but he says it without giving it much thought. Blood is drawn, tests are carried out, and an answer is found: leukaemia. Then the story returns to its original plot. In these series, diagnosis is like mathematics. Fatigue, coupled with abnormal test results, means leukaemia. In reality, the diagnosis of this type of cancer is often much more complex. Were there any clues in the physical examination, such as paleness of the face and eyes? Did the patient have splenomegaly? Weight loss? None of this is important or especially mysterious when the diagnosis is only a small part of the human drama of a different kind (2016: 15).

In spite of this, there is currently a practice of incorporating scientific material into audio-visual scripts, and an increasing number of productions are being produced with the help of an expert scientific-technical advisor, in order to create content that is capable of diffusing science that is as genuine and verified as possible (*Agencia EFE*, 2019; Barceló Garcia, 2012; Polo Díez and Ezquerra Martínez, 2009; Romero, Fesharaki and García, 2014; Sánchez, 2015; Smaglik, 2014; Sulbarán, 2019; Thorne, 2014; Trumbore and Nelson, 2019).

### 1.2. *The Big Bang Theory* television series: object of research

The television series known as *The Big Bang Theory* is an American sitcom starring four quirky scientists (Dominguez Gutiérrez, 2017), in which real-life problems are intertwined with problems of scientific significance. Sheldon Cooper (Jim Parsons), the most symbolic and prominent character in this audio-visual work, has dedicated and tailored his entire life to science, linking it to any situation, always looking for a scientific reason for everything that happens.

The series ended in 2019 with a total of 12 seasons, in which mentions made about science became an indispensable part of the storyline. Since its premier in 2007, the team of scriptwriters had the collaboration of David Saltzberg, a physicist and professor at the University of California, in order to avoid errors in the scripts.

Similarly, as a result of its huge popularity, a spin-off entitled *Young Sheldon* was created, as well as books such as *Life According to Sheldon* (De la Torre, 2014) and *The Science of The Big Bang Theory* (Cererols and De la Torre, 2018), among others.

*The Big Bang Theory* has been analysed from different perspectives and disciplines. Thus, among others, there have been numerous studies related to the following: linguistics (Bednarek, 2012; Lasekan, 2021; Lv, Wang and Gao, 2015; Van Zyl and Botha, 2016; Wu and Wang, 2015; Zhang, Wang and Gao, 2018); gender issues (McIntosh, 2014; Rubin, 2021; Weitekamp, 2015; White and White, 2018); the religious field (Lewis and Molloy, 2015); cultural and social analyses (McWan and Cramer, n. f.; Rourke and McGloin, 2019; Wang, 2021); economic points of view (Stratton, 2016); and coinciding partially with the focus of the present study, from the point of view of science dissemination (Brodesco, 2018; Li and Orthia, 2016; Martin, 2019).

The present study is based on bibliometrics, but it also takes a communicational and narrative approach as well, associating the mentions made about science in the series to the narrative structure of each episode, or small macrostructure, under analysis (Comparato, Cano Alonso and Vázquez Mota, 1992). The main objective of this research is to analyse the number of mentions made about science and their typology in the television series *The Big Bang Theory*, and to find out how scientific content is used in the storyline in relation to science dissemination. To this end, the following specific objectives are set out:

SO1. To count and classify the mentions made in the series and calculate the ratio of scientific content per episode.

SO2. Analyse the placement of these mentions according to the Syd Field paradigm and compare it with the structure of a scientific article.

SO3. Compare the narrative structures of scientific articles with the mentions made about science.

This study is based on the following initial research questions:

• Q1 - Is it possible to establish and apply a typology of scientific mentions in the series under study using the bibliographic databases of Web of Science (WoS) and Scopus?

• Q2 – Has any pattern been found when analysing the distribution of mentions according to the narrative distribution in the acts of the plot?

• Q3 - Is it possible to establish an analogy between the distribution of mentions according to the narrative structure of each episode, and the distribution in sections of a typical scientific article?

In response to the above research questions, the following hypotheses are proposed:

• H1 - Mentions made about science in the series can be categorised into different typologies and their ratio will not be very high.

• H2 - It is generally considered that there will be more mentions made in the first and second acts of each episode of the series.

• H3 - It is believed that an analogy can be established, due to the fact that if H2 is verified, it would be similar to the distribution of citations in a scientific article with a standard structure.

## 2. Methodology

To carry out this research, the case study methodology was used along with the first five seasons of the TV series *The Big Bang Theory* (2007-2011). These seasons have a total of 111 episodes, with an approximate duration of 38 hours. The content analysis of this sample is based on a complete viewing of each episode, with a meticulous examination of the dialogue, and retrieval of the mentions made about scientific content that are broadcast directly (Carcaboso-García and Gómez-Crisóstomo, 2020; Cererols and De la Torre, 2018). Furthermore, in order to avoid any possible bias in the analysis, or even errors of translation, the original script was used to more accurately find the quotations.

Once the sample described above had been viewed, and an ad hoc database using office software had been completed, we proceeded to delimit and classify the type of mentions to which it corresponded, differentiating between mentions of scientific journals, authors, science articles, popular science books, patents, theories/principles, studies, and conferences.

### Table 1. Defining the type of mentions

| Typology | Definition |
|---|---|
| Journals | Specific mentions of popular science periodicals (scientific journals). |
| Authors | Specific mentions about individuals related to the field of science |
| Articles | Mentions of scientific articles, their authors, and the journal of publication |
| Books | Mentions of scientific monographs, or works related to the field of science, and their authors |
| Patents | Mentions of inventions or patented products, and their authors |
| Theory/principle | Mentions of scientific theories or principles |
| Studies | Mentions of scientific studies |
| Conferences | Mentions of conferences or master classes |

Similarly, after examining each mention made about the scientific content in the audio-visual product and extracting the key information, such as authorship, title of the publication, year, etc., a search was carried out on the Web of Science (WoS) and Scopus platforms with the intention of confirming the veracity of the information provided, without assessing whether the content or opinion was accurate according to the scientific publication.

Regarding the process used to determine the distribution of mentions within each episode, the first step was to systematically segment each episode according to the paradigm of Syd Field (1995), including the set-up, confrontation, and resolution, which is the basic structure followed by any audio-visual production.

However, after cross-referencing the data corresponding to the season, episode, and duration of the latter, the formula used to determine the distribution of the mentions was the following:

$$ACT\ 1 = Minutes < 25\%\ duration$$

$$ACT\ 2 = 25\%\ de\ duración \leq Minutes \leq 75\%\ duration$$

$$ACT\ 3 = Minutes > 75\%\ duration$$

Finally, in order to calculate the ratio of scientific content per episode, we have used the formulation presented by García-Regalado, Flores-Jaramillo and Carcaboso-García (2020), in order to quantify the amount of scientific material broadcast in the television programme *Cuarto Milenio*, adjusting the formula presented by the authors to a television series or sitcom format. A preliminary version of this

$$Ratio = \frac{Mentions\ per\ episode}{No.\ of\ acts}$$

indicator for the purpose of revealing this ratio is as follows:

In which:

- *Ratio*, expressed as a percentage, is the result of the series' use of scientific content in each episode studied.

- *Mentions per episode* represents the total number of scientific comments.

- *No. of acts* refers to the total number of acts into which each episode is divided.

As this study is an analysis of a fictional audio-visual production, the number of acts is set at three (set-up, confrontation, and resolution). Thus, the optimal ratio is estimated to be equal to 1, since a hint or mention is expected in every act of each episode.

To analyse the results, office software has been used, specifically spreadsheets and a database management programme.

## 3. Results

### 3.1. Number and classification of the mentions made in the audio-visual productions

Having retrieved and examined the scientific mentions that are part of the audio-visual script of the first five seasons of the television series *The Big Bang Theory*, we proceeded to categorise the 225 mentions identified by using different bibliographic databases that provided information on the typology of each of the mentions. The databases used were the Web of Science (WoS), supplied by Clarivate Analytics, and Scopus, from Elsevier. The results obtained are shown in Graph 1.

With this information (Graph 1), we can say that the type of mention most frequently used is *Theory/Principle* at 32.44%, followed by *Articles* and *Authors* at 28.89% and 17.78%, respectively. These three types of mentions account for a total of 79.11%.

**Graph 1. Distribution of the typology of mentions**
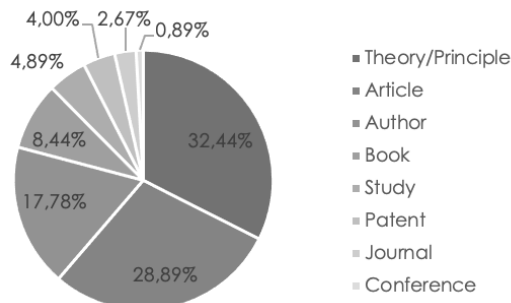


The remaining mentions, which are categorised into five different types (Books, Study, Patent, Journal and Conference), account for the remaining 20.89%.

## 3.2. Distribution of the mentions according to the paradigm of Syd Field (Field, 1995)

The Syd Field paradigm is a three-act structure that audio-visual productions rely on to present and organise their plot in a normative-based way.

Adhering to the rigorous procedure described in the methodology section, and the distribution of the mentions within the plot, it can be seen that the second act (Act II) is where the largest amount of scientific content is concentrated, at 51%, followed by Act I with a total volume of 39%. Finally, with a clear difference, 10% are grouped in Act III (Graph 2).
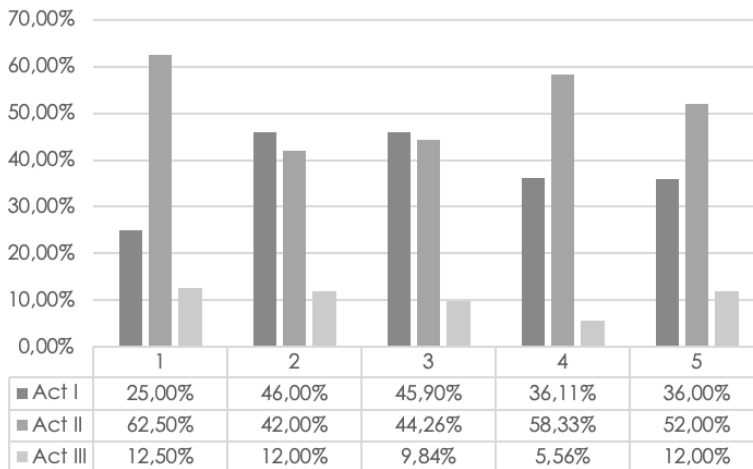
**Graph 2. Distribution of the mentions according to the Syd Field paradigm**
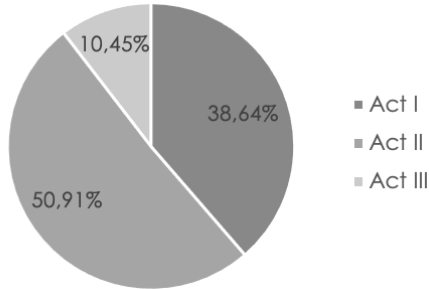


Thus, mentions of scientific content within the plot of the series are mostly made in the first two acts. As such, scientific information is used to introduce or present a problem, or as a way of trying to confront a dispute. However, mentions are hardly used in the resolution of the stated problem, as this narrative moment is reserved for presenting the moral of the story.

Likewise, if we apply this methodology individually to each season (Graph 3), we can see that in seasons 1, 4 and 5 there is a clear use of scientific content in the second act (Act II), with values above 50%. As for seasons 2 and 3, the tendency is similar in Acts I and II, with values between 40%-45%, with a higher occurrence in Act I.

**Graph 3. Distribution of the mentions made by season according to the Syd Field paradigm**



|         | 1      | 2      | 3      | 4      | 5      |
|---------|--------|--------|--------|--------|--------|
| Act I   | 25,00% | 46,00% | 45,90% | 36,11% | 36,00% |
| Act II  | 62,50% | 42,00% | 44,26% | 58,33% | 52,00% |
| Act III | 12,50% | 12,00% | 9,84%  | 5,56%  | 12,00% |

## 3.3. Ratio of scientific content per episode

To determine the ratio of content per episode, we applied the formula described and proposed in the methodology section, which allowed us to determine the amount of scientific content present. This amount is related either to the number of categories available, according to the version proposed by authors García-Regalado, Flores-Jaramillo and Carcaboso-García (2020), or to the number of acts into which an audio-visual production can be divided, as proposed in this study. Consequently, we have found that a value equal to or greater than 1 is almost never reached.

**Table 2. Average and median ratios by season**

| Season | Episode | Average Ratio | Median Ratio |
|--------|---------|---------------|--------------|
| 1 | 17 | 0.9216 | 0.6667 |
| 2 | 23 | 0.7246 | 0.6667 |
| 3 | 23 | 0.8841 | 0.6667 |
| 4 | 24 | 0.5000 | 0.3333 |
| 5 | 24 | 0.3472 | 0.1667 |

As you can see, the season with the highest average ratio is season 1, with 0.92. However, season 5 has the lowest ratio at 0.34. As for the median value per season, the highest figures are found in the following: the first three seasons have 2 scientific mentions per episode; season 4 has a median of 1 mention per episode; and season 5, which is similar to the average value category, is the lowest.

## 4. Discussion

We compared the results to the initial research questions posed and the starting hypotheses. With regard to Q1 on the typology of mentions and whether it can be applied to the analysis by using the Web of Science (WoS) and Scopus bibliographic databases, we found that its application is possible. It can be affirmed that the values obtained are not unusual, since the very nature of the *The Big Bang Theory* revolves around the field of physics. With a leading role, yet not the main character, Sheldon Cooper puts all his efforts into winning the Nobel Prize in Physics for solving the *string theory*, thus justifying the use of the *Theory/Principle* category as the most commonly used.

The characters name or cite scientific articles in their conversations, giving importance to their conclusions in order to justify their own actions or arguments in the dialogue. One example is in Episode 23 of season 3, where Sheldon cites a scientific article by the year of publication, author, and title of the work; another example of many that stand out occurs in season 1 during the Halloween party at the flat where Penny (Kaley Cuoco) lives, when Sheldon again cites the work published by Jane Goodall on gorilla behaviour.

As for the ratio of scientific content per episode, if we return at this point to the values presented in the results section, it is worth recalling that the first season of the series was affected by the scriptwriters' strike in 2007 (Series Addicts, 2016), which resulted in the number of episodes being reduced to 17, a situation that may have influenced the high ratio in that season.

Moreover, in that same season the series revolved around the five main characters: Sheldon Cooper, Penny, Leonard Hofstadter (Johnny Galecki), Howard Wolowitz (Simon Helberg), Rajesh Koothrappali (Kunal Nayyar). Except for Penny, all of them have a high level of education in science. Thus, the high value of this ratio could be the result of the relationships between the characters being limited to the areas of science, work, and leisure, and given the peculiarity of these four characters, it also revolves around the scientific and technical realm.

The decrease in the ratio in the following seasons could be attributed to the addition of new characters, among other reasons. This is the case with the introduction of love interests between the characters, as Howard Wolowitz and Rajesh Koothrappali are paired off with Bernadette Rostenkowski (Melissa Rauch) and Emily Sweeney (Laura Spencer), respectively. Although they interpret highly educated characters dedicated to scientific study, the plot veers toward interpersonal relationships, lessening the scientific mentions in the script and focusing more on developing the emotional aspects of the characters.

On the other hand, the lower ratio obtained in season 5 is noteworthy. This could be attributed to the personal development of another character, Amy Farrah Fowler (Mayim Bialik), which results in the plot taking a sharp turn.

Although the inclusion of this character takes place in season 3, in which she has a romantic relationship with Sheldon, the development of her role is brief, as her personality is similar to that of her partner Sheldon, although she has more skills in social-personal relationships. The intensely scientific personality of Amy may be one of the reasons why the ratio increased in season 3. However, as this character interacts with those of Penny and Bernadette Rostenkowski, her developmental path becomes more focused on her personal and romantic relationship with Sheldon, thereby lessening the scientific aspects of the interaction between the two characters (Amy and Sheldon). As a result, the number of mentions about science, and specifically a decrease in the number of references or allusions made by Sheldon,

which declined from 47 in season 3 to 17 in season 5, is reflected in a ratio decrease as well in the latter season.

With regard to the second question raised (SO2), it has been confirmed that mentions made about science in the series appear in the first two acts. In trying to find similarities between an audio-visual programme with three acts and a scientific paper (Q3), which has several sections, including Introduction, Methodology, Results, Discussion, and Conclusions (IMRDC), one might considered that in the former, Acts I and II would be the set-up or introduction, presentation of the problem, and the first challenge to be overcome, and Act III would be the outcome. In scientific papers, the first two sections could be composed of the introduction and theoretical framework, or in other words, the introductory sections, and the third would be the results and conclusions.

Consequently, there is a certain similarity between an audio-visual programme and a scientific paper, which are assumed to be very different, as most of the mentions or citations in scientific papers are made in the first two sections (introduction and theoretical framework), as occurs in the audio-visual programme used as a sample for the present study (Bertin et al., 2013, 2016; Ding et al., 2013; Pak, Yu and Wang, 2018).

In the first season, the episodes were stand-alone plots, yet the storyline was evolving in a common direction. In the following seasons, the main plot became more prominent and mentions made about scientific references were used both for the problem statement and confrontation or conflict (Acts I and II).

As for seasons 4 and 5, with the introduction of new characters, the trend returned to using scientific content to solve the problem posed (Act II).

## 5. Conclusions

After presenting a summary of the research, with regard to SO1, it can be affirmed that the series *The Big Bang Theory* includes several mentions made about science, which can be categorised and quantified. Moreover, the mentions displayed in the results section stand out.

Generally speaking, one could say that audio-visual productions and television series, and especially the series being analysed, sometimes include scientific content, although the ratio is not very high. Moreover, they are a useful way of disseminating this type of content, so they assume an educational role, which is frequently attributed to the media as well. Furthermore, it becomes clear that the scientific content embedded in the dialogue in this series has a certain level of quality, judging by the fact that the information is indexed in scientific bibliographic platforms such as WoS and Scopus. As such, the content has obviously been subjected to a process of selection and peer review, so the material received by the viewer has a certain level of rigour and reliability; nevertheless, we must differentiate the use or focus that the narrative itself bestows on the series, as we must not forget that this is a TV series broadcast in a specific time slot and aimed at a certain target audience, and in order for the dialogue to flow, scientific rigour must sometimes be sacrificed.

The use and quantity of scientific content or mentions made about science in each episode might be considered scarce, given that the ideal value of 1 is not attained, which is expected in calculating the ratio, as proposed by García-Regalado, Flores-Jaramillo and Carcaboso-García (2020). Likewise, a considerable decrease has been observed in each season, indicating that the addition of new characters makes the use of scientific content less important.

With regard to SO2, among other reasons, the specific placement of scientific comments is used to pose a problem to be solved and to move the plot along. Based on the results and the foregoing, it can be inferred that the mentions made are usually located in the first two acts, as the third act generally includes the resolution of the plot, in which scientific comments are not as appropriate.

Finally, as for the third objective (SO3), based on the analysis carried out, it can be affirmed that an analogy has been observed between the narrative structure of each episode, or small macrostructure, and the usual structure of section headings in a scientific article, so that scientific references are mainly located in Acts I and II, which occurs in scientific articles in a similar way in the introductory and theoretical framework sections.

Based on the aforementioned analysis and presentation, the following recommendations are offered in order to efficiently incorporate scientific and technical content into audio-visual productions.

1.  Include on the professional staff at least one scientific advisor who is an expert in the subject matter of the audio-visual story. As stated by Michalakis (*Agencia EFE*, 2019), in this specific case, "make science, especially quantum physics, interesting and attractive for scriptwriters and for the audience".

2. Try to give visibility to the world of science, providing data and information. Contribute to, and for, the scientific world.

3. Consider the structure of the audio-visual story by using Syd Field's Paradigm when incorporating scientific content.

4. Have a high regard for the importance of scientific content, as opposed to *pseudo-science*.

5. Find a balance between scientific content and personal relationships. Developing the personal relationships in the plot should not be overly prioritised, so as not to leave scientific content on the side-lines and detract from its presence.

## 6. Limitations and future lines of research

In addition to the limitations inherent to the case study methodology chosen, another limitation of the present research is that the content analysed consists of only the first five broadcast seasons. Although this implies that a significant number of episodes were examined (111 episodes and around 38 hours of broadcasting), the rest of the seasons and episodes could also have been analysed. Nevertheless, we consider that the analysis of the content chosen provides conclusions of interest to the scientific community.

A comparative study could also have been carried out between the series analysed and others that have scientific content as well. The series under analysis is considered paradigmatic in the way scientific research is mentioned, so it would be difficult to compare it with a similar production. Nevertheless, this is proposed as a future line of research.

Likewise, another line of research for the future, which could be of interest, would be to analyse the gender perspective with regard to the incorporation of scientific mentions.

## 7. Specific contribution of each author

| Contributions | Authors |
|---|---|
| **Conception and work design** | Author 1, 3 |
| **Documentary search** | Author 1, 2, 3, 4 |
| **Data collection** | Author 1, 2 |
| **Analysis and interpretation of data** | Author 1, 2, 3, 4 |
| **Review and approval of versions** | Author 4 |

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## 9. Statement regarding conflict of interest

The authors hereby declare that there is no conflict of interest involved in this study.

## 10. Acknowledgment

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