



## FEMALE LEADERSHIP PORTRAITS IN COMMERCIAL MOVIES: GENDER SOCIAL REPRESENTATIONS FROM THE STEAM SECTOR

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### KEYWORDS

*Female Leadership  
Gender  
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### ABSTRACT

*To encourage girls and women to pursue STEAM careers, it is crucial to increase the positive representation of female role models in science. The study uses the Bechdel test and an adapted Greimas Actantial Method to analyse mainstream films. Results show that female characters are often attractive, Caucasian scientists, not mothers, and play secondary roles above all. The most represented careers were in Biology, Astronomy, and Social or Human Behavioural Sciences. Representation of women in leadership positions in the STEAM sector in commercial movies is clearly deficient.*

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### PALABRAS CLAVE

*Liderazgo femenino  
Género  
Mujeres  
STEAM  
Representaciones sociales  
Películas comerciales*

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### RESUMEN

*Para animar a niñas y mujeres a seguir carreras STEAM, es crucial aumentar la representación positiva de modelos femeninos en la ciencia. El estudio utiliza el test de Bechdel y el Método Actancial de Greimas adaptado para analizar películas comerciales de gran audiencia. Los resultados muestran que los personajes femeninos suelen ser atractivas científicas caucásicas, no madres, desempeñando papeles secundarios, sobre todo. Las carreras más representadas son Biología, Astronomía y Ciencias Sociales o del Comportamiento Humano. La representación de mujeres en puestos de liderazgo en el sector STEAM en las películas comerciales es claramente deficiente.*

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## 1. Introduction

The cinema, since its beginnings, connected traditional literature and theatre pieces, massifying and extending the function of these forms of communication for pure entertainment. "It is because of the cinema that the spectacle starts to have a major range of influence among audiences" (Guarinos, 2008, p. 103). For enjoyment is that people go to the cinema to watch a commercial film, and for the same reason is impossible to ignore the repercussions of female representation. In previous work done by Laura Mulvey (2006), she analyzed female representations in the cinema with a psychoanalysis approach, creating a bridge between concepts of how the cinema reflects and sometimes intervenes in the interpretation of social reality, and how this reinforces the patriarchal belief system that gives birth to certain social stereotypes for women, reproducing them through the big screen (Mulvey, 2006).

It is not accurate to assume that the lack of popularity of STEAM (Science, Technology, Engineering, Arts, and Mathematics) among women is solely due to its representation through role models in the cinema. Nevertheless, it does have an impact on the way young girls and adolescents see themselves reflected and drawn to reinforce stereotypes, behavior, and even physical appearance based on what they see in the films they are exposed to. In previous studies missing role models is one of the relevant aspects to battle in terms of gender inequalities (Kuschel et al., 2017). Although, these inequalities are present at various levels such as the microlevel (related to career progressions and glass ceiling), meso level (related to gender practices concerning the field of work/study), and macro level (related to networks of business and work, and relation of the field with the commercial world that confronts gendered language and attitudes) (Karataş-Özkan & Chell, 2015; Kuschel et al., 2017; Byrne, Fattoum & Díaz-García, 2019). Consequently, female representation in cinema playing key roles in STEAM is part of the social deconstruction that needs to be tackled.

The intersection between cinema and gender has been widely recognized and studied, some examples are "A theoretical perspective on Women's Cinema Representation" (Binimelis, 2016), "Phallic Female Models of Media post-modernism, an approach to analysis Avatar, Millennium and The Hunger Games" (Bernárdez, 2012), "Cultural Representations of Gender and STEM in popular firms from 2002-2014" (Steinke & Paniagua, 2017), among others. The social representation of gender is as consequence used to reproduce old schemes, and this is one of the reasons that makes invisible the key role of the scientific women in film characters, especially when talking about contemporary cinema. Therefore, it is necessary to delve deeper into how this low exposure of women leaders in the area of STEAM sciences represents a key factor that impacts the perception and influences the audience not only among young girls but in women about these areas of work and study.

The main objective of this research is to perform a qualitative and quantitative analysis, using the Bechdel test and an adapted Greimas Actantial Method, on the relevance and characteristics of the participation of female characters with leadership within the STEAM sciences, in commercial cinema from the period of 2000 to 2022, lastly seeking to motivate through public perception more young girls and women to participate and reflect in positive role models, to get involved in the STEAM sector as a future career path.

There has been limited research on the portrayal of specific stereotypes in regard to women in the professional realm of STEAM sciences. In most films, female scientists are depicted as single, strong, and intelligent, but not necessarily feminine, and sometimes depicted as being so consumed by the work that they neglect personal relationships. These characters often appear in the action, sci-fi, or dystopian films. The fantasy of an "unreal" world allows the authors to provide and play with the stereotypes as they pleased, challenging the heteronormative roles and only a few times breaking them.

This social representation is a system that nurtures culture, gives meaning to the existence of individuals, and, from there, to the structures of social distinction from which the different forms of power are erected. According to this theory, the social psychology of Moscovici (1961) arises. His proposal is a more social conception of attitudes, considering them as mental processes that determine the responses of individuals to a phenomenon of social characteristics such as values (Moscovici, 1961). Therefore, it is possible to claim that cinema and massive media are capable of influencing conduct, value, and even mental processes in individuals.

The Future of Jobs Report explains how is expected that by 2025, "approximately 85 million jobs may be displaced by a shift in the division of labor between humans and machines, giving as a result 97 million new roles that will be created, those are more adaptable between humans, algorithms, and machines across the 15 industries and 26 economies covered in the report" (World Economic Forum, 2020, p. 5). For this reason, was thought to be a slow-paced change for the labor market has increased in speed, and contrast, our future generations are not ready and will be the most affected by it. "Socially constructed gender differences and consequent inequalities persist today, resulting in the STEAM gender gap" (Wang & Degol, 2017, p. 119). Therefore, it is urgent to use all possible efforts not only to guarantee but to encourage young girls and women to join STEAM careers and to pursue jobs or be an entrepreneur in this field.

## 2. Theoretical Framework

By researching more about the origin of the underrepresentation of women in STEM areas, it is possible to observe that this is a problem of stereotypes due to the lack of female role models and a belief system that socializes gender in a marginalized way.

Hence, raising awareness of young girls and women and propelling their participation in STEM areas as well as, entrepreneurship is a political cause (European Education and Culture Executive Agency et al., 2018). Recent studies show that in higher education, there are no visible gender differences among students in these sciences (Marra et al., 2012). Nevertheless, there are significant gender differences in self-confidence (Eris et al., 2010), and previous research evidence shows that adolescents aged 12 and above watch a substantial number of movies annually, in various formats, with a preference for comedy, action and adventure, sci-fi, and fantasy films. Therefore, it is pertinent to review the causes that underlie in the role models they see in the cinema, and that might have somehow influence on them, as in adult reproduction of certain stereotyped behaviors.

In accordance with the theory of representations, which aims for a radical transformation of society through the modification of perceptions and stereotypes, “images, beliefs, and perceptions that are possible to change through social representations, which are already part of the culture” play a significant role in empowering women (Camberos, 2011, p. 45). Gender as a social construct defines expectations, roles, and social norms, and social representations of gender are often the result of new and/or old societal norms and relationships.

On the other hand, Judith Butler explained that “the sexual orientation, sexual identity, and gender expressions are the result of a social, historical, and cultural/production, and therefore there are no sexual roles or gender roles, essentially or biologically inscribed in human nature” (Butler, 1993, as cited in Duque, 2010, p. 87). Everything natural constitutes the naturalization of cultural constructions meaning that subjects are the effect and consequences of the production of knowledge and power devices that legitimize the essentialist conceptions of their gender and sexual differences, with which gender and sex become performative acts.

In other words, performative acts are forms of speech that authorize “they are expressions that enunciated and pronounced generate a binding action and power. As a result, performativity is a sphere in which power comes to life through the discourse aligned with acts” (Butler, 1993, p. 316). A relevant aspect of this concept is temporality. Performativity precedes history, meaning it is condition to contemporaneity, in such a way that this aspect detracts from the centrality of the present view of the subject according to which it is the origin or the exclusive owner of what is said (Butler, 1993, p. 319). Then, performativity creates reality through discourse that contrasts with the heterocentric hegemonic power that acts as a reproducer of its discourse in sociocultural contexts.

The hegemonic matrix with a hetero-centric perspective is exemplified by the societal expectation that men should not cry, dress in blue, have interests in power and masculinity, and avoid appearing “effeminate”. These norms are established and perpetuated through speech acts, gestures, and other cultural practices, becoming a requirement of the social environment and dictating predetermined behaviors related to sexual identity. As per the social cognitive theory, media such as films can be a crucial tool for analyzing the relationship between behavior and stereotypes, particularly with regards to women in the STEAM field. This theory hypothesizes that children absorb behavior patterns through continuous observation of models, in the same way, children can learn specific conducts through identificatory learning by watching films (Bandura, 1986, as cited in Steinke & Paniagua, 2017). The same can happen to viewers that will reflect on their own experiences and perceptions of what they see on the big screen (Faber, Brown & McLeod, 1979).

The relevance of social cognitive, representation, and feminist theories lies in the fact that as human beings, our social and psychological aspects are greatly influenced by the information we are exposed to, shaping our decision-making, raising questions within us, and constantly reshaping our reality, both consciously and unconsciously, as Mulvey emphasized throughout her work. For this reason, it is important to examine the concept of possible selves theory, which explains how individuals are and who they could become based on their past, present, and future experiences. These ideas reflect an individual’s personality and influence their behavior and decisions (Markus & Nurius, 1986). For instance, a person in a difficult situation may picture possible alternative mental scenarios and have a decision-making process led by their imaginary self of what to do. The impact of this concept is broad from leading conduct to life goals and career ambitions, as a result of this in the arts and cinema arena “films function as more than a simple mirror, it also works as a social memory and cultural metaphor” (Flicker, 2003, p. 308).

About the social representations of gender, “these are based on genetic social psychology and have undergone modifications thanks to a socio-genetic process, which consists of processes of generation of representations in which gender can be renewed” (Camberos, 2011, p. 47). Thus, social representations provide insight into how individuals perceive and organize their daily lives. This highlights the importance of communicative processes in creating collective knowledge, transforming historical events that are socially defined by time and space. It is relevant for this research to note that in

In political philosophy, there is a distinction between sexual orientation, rather than sexual identity, and gender expression, rather than gender identity, thus seeking to unify the public, collective but de-essentializing and de-

identifying it. This entails the deconstruction of the imperatives of binary logic of domination, such as good/bad, beautiful/ugly, normal/abnormal, black/white, straight/homo, and gay/lesbian (Duque, 2010, p. 92).

Therefore, the ultimate goal is to resolve contradictions and challenge rigid identities, fostering the rise of multiple, non-binary, and flexible differences.

### **2.1. Mediations and Greimas Actantial Method: the power of media**

Martín-Barbero, the primary proponent of the idea of mediation, states that “audiovisual and computer technologies are rapidly advancing in the era of globalization and aim to play a crucial role in shaping cultural policies that counteract the homogenizing effects of neoliberalism, which, in turn, transform cultural industries into the economic and political foundations of regions” (Martín-Barbero, 2002, p. 14).

For Martín-Barbero, media is a market mediator, one that perverts the political and cultural demands and that delegitimizes any questioning of social order. Media holds impressive power, and its impact is highly risky or constructive depending on its use. For this purpose, communication becomes a powerful engine of detachment and inclusion of cultures, ethnic, national, local, time, space, market, and global technologies. Martín-Barbero explains that “from the side of culture, it escapes compartmentalization, permeating all social structures. Today, the subject/object of culture is the same as art, health, work, or violence, as political culture, or the culture of drug trafficking, among others. Culture in this system acts as a machine producing symbolic goods for this “public of consumers” (Martín-Barbero, 2002, p. 14).

According to Martín-Barbero (2002), media allows politics to shape and redefine new models of interpellation and representation in society. This type of mediation is not only productive but also intensifies the ritualistic and theatrical aspects of politics (Martín-Barbero, 2002). Martín-Barbero describes media as not only a tool but also a crucial part of public life, shaping political culture through forms of interaction, language, and culture. The social production of politics is intertwined with symbols and participatory elements that create the public sphere and mass communication. However, as the author describes the market as one transactional in all its relationships, in which “subjects lack meaning in the communication process, precisely because of the market’s nature that can only provide small satisfactions or frustrations, based on profitability, not one that creates social innovations” (Martín-Barbero, 2002, pp. 16-17), a condition convenient for the film industry.

The exposure to media, audiovisuals, and social networks, among others, have become vitally important to convert a two-way exchange of values, customs, habits, thoughts, and criticisms, a process as Martín-Barbero says, “with endless interactions product of social dynamics subsequently materialized through television, radio, theater, among others; making it clear that the important reproductions are those of the market, those that far from providing value and meaning to the human being, make profitable and commodify everything around them” (Martín-Barbero, 2002, p. 17).

In addition to the mediations, it is important to mention its connection with the Actantial Method of Greimas, often used to analyze texts or images in the hope of finding the structure of the text, in other words, to explore the narrative in its paradigmatic level. So far, we have developed ideas around representations, mediations, and gender, alongside narratives and discourses we can attach the symbolic effect of power often implicit in all forms of communication and social interaction, and that is pertinent for this research.

Greimas’ theory was an advanced development of Levi-Strauss and Vladimir Propp’s theories “to understand the roles across narratives, the action schemes to what roles are embedded and the cognitive operations that underwrite both, roles and actions” (Carney, Robertson & Dávid-Barret, 2019, p. 4). The Greimas Actant method is based on a subject / Hero that does an action to solve a problem, often followed by activities divided into acts (Greimas, 1983, p. 59-60). Throughout the implementation of the Greimas method, it plays a crucial role in the subject, the object (the problem to solve), the sender (the element that sends the object), the receiver or destination (not necessarily a place), the helper or opponent as elements that assist or blocks the subject, as well as, the relation of conjunction or disjunction (positive/negative relationship between subject and object), and the power axis which can be conflictive, or cooperative (Greimas, 1983, p. 75-77). This way the pragmatic level of the narrative is plausible and it creates another level of understanding as a result of narrative trajectory, role identification, agency, and mediations of the women in STEAM portraits in the commercial cinema.

### **2.2. Context**

Gender studies applied to audiovisual communication and audiences nowadays count with a large number of research projects. During the 60s started the feminist movement to create a bridge between these theories applied to the communication and audiovisual sciences. Nevertheless, it was not until 70’s that the research and movement took off with authors like Sharon Smith who studied the participation of women in the cinema, among others, involved in a sociologic and empirical analysis of films (Binimelis, 2016, p. 11). As a result, during the ‘70s alongside with the second feminist wave, in Europe emerged several thinkers that critiqued historical materialism, structuralism, semiotics, and psychoanalysis that give birth to other interpretations of the political constitution of the subject, such as Laura Mulvey mentioned before.

In the semiotic approximation of the feminist cinema, the discussion is about women being the center of the representations that promote mainstream cinema, and what is the role of women in the processes through which it constructs meaning, in simple words, the cinema functions as a signifying system within which the woman acts as a sign, the relevance in the interpretation made by the semiotics is based in the meanings that arise from the relationships that happen between a system of signs (other individuals), those signs interact through norms, codes, and conventions that provide structure to the discourse (Binimelis, 2016). Thus, another still today famous analysis was the book *Visual Pleasure and Narrative Cinema* written by Mulvey (2006) where she described the reduction of the female figure to an object on which male fantasies are projected through certain codes and conventions, leading both the male spectator and the female spectator to develop processes of identification with the male protagonist.

The feminist movement kept growing and so did the number of authors studying the relationship between cinema, culture and, different categories such as Gender, Class, Age, Race, all within the complexities of hierarchical power relations. Most of these feminist authors based their theories or analysis on

Michael Foucault's theories of "technologies" of power (from "technos", "power", and "logos", "knowledge"), to his interpretation individuals are about forces in tension, coming from all directions, whereby each individual is both a product and producer of power, as he or she continually negotiates his or her position in the existing order of forces (Binimelis, 2016, p. 16).

In contrast, Mary Ann Doane focused on the agency capacity of spectators and the multiplicity of possible interpretations. Doane explained that the identification processes put the spectators in terms of proximity and distance concerning the feminine image, as a consequence different and complex forms can be perceived and interpreted without necessarily feeling identified with the dominant models (Doane, 1991, as cited in Binimelis, 2016, p. 17).

The scenario has evolved over the course of the feminist movement and the emergence of authors who have studied, published, and raised awareness about these issues since the 1960s. Initially focused on women behind the camera, the focus has shifted to the analysis of women in front of the camera and as part of narratives and power dynamics, offering various perspectives to comprehend the impact and representation of women in mainstream or commercial cinema.

Considering these theories, we believe is pertinent to briefly mention what is the audiovisual structure of the audiences in Europe to be able to land the topics to the eyes and minds of real humans. The European Commission did an online survey of 4.608 Europeans aged 4-50 in 10 countries (Croatia, Denmark, France, Germany, Italy, Lithuania, Poland, Romania, Spain, and the United Kingdom). The survey took place from March to April 2013 (The European Commission *et al.*, 2014). In this report, the main features were that "97% of respondents watch films at least sometimes, whereas 54% say they do so every day, compared to 56% that watch TV series. Across the 10 European markets, virtually 100% of respondents own at least, one device that enables the consumption of video or films at home" (The European Commission *et al.*, 2014, p. 5). Nevertheless, in the same report (2014) is stated that 87% of the people attend the cinema; "children's interest in films is strong by 85%, and they go more to the cinema than young adults. The main motivations to go to the cinema are 96% to entertain oneself and have fun, 96% to spend time with family or friends, 90% to discover and learn about people and cultures, 91% to experience strong moments and emotions" (pp. 5-6).

Regarding the question of how to decide what to watch, individuals replied that the most important criteria were genre and story, and an interesting cast. Women decides in terms of genre and type of film and whether it is adapted from a book, whereas men care more about the director and production values, the settings, and the lead character. Following, "recent European films had been seen only by 10-15%, while US films had been seen by 30-50% of the population in each country, even though the fact that they also agreed on "European films are less stereotypical than US films" (The European Commission *et al.*, 2014, p. 10).

When audiences were asked about what they disliked in US productions, they mentioned "the violence", "too commercial", "predictable", "exaggeration", "propaganda", "patriotism", "stereotypes", and "superficiality". Among the genres, the most watched by different targeted audiences are comedy, action, and adventure. However, when they were asked about which type of films, they would continue to see in the cinemas they said comedy, action, sci-fi, horror, adventure, fantasy, thriller, and animation. On the contrary, the least cited were historical films or epic films, documentaries or biographies, romance, and drama (The European Commission *et al.*, 2014, p. 10). In addition to the valuable insights provided in the report, the experts at the end of the report emphasize numerous concerns for both the European film industries and film policy.

From Southern European countries such as Spain and Italy, to Northern European nations like Lithuania and Denmark, the most widely watched films are from the U.S. Although they also pay attention to festivals and independent films, a connection is formed across the continent. Similarly, the waves of feminism have had a cross-border impact from the U.S. to Europe from the 1960s until today, strengthening the movement. Despite cultural differences that may exist between Spain and Lithuania, and the rest of European countries, it's important to note that these differences do not prevent individuals from experiencing the same emotions, feelings, and interpretations of the representation of women in mainstream cinema.

### 3. Methods

To analyze the films, a combination of techniques was utilized. Firstly, the Alison Bechdel (1986) test, which consisted of three simple questions being applied to every film watched, was used to identify more about the narrative function of female characters. Secondly, an adaptation of the actantial method developed by Algirdas Greimas was also employed.

This research aims to understand the representations and characteristics of women in STEAM as portrayed in commercial cinema, with a focus on their leadership and entrepreneurial aspects. The study analyzed films produced between 2000 and 2022 and compared the results to similar research in the field. The roles, power relations, mediation, and narrative characteristics of these STEAM female characters were analyzed in the light of recent theories to gain insight into the potential impact of the stereotypes portrayed in these films on the widespread audience.

The Bechdel test was created to assess the representation of women in movies, this way researchers could spot manlike preconceptions (Scheiner-Fisher & Russell III, 2012, as cited in Agarwal et al., 2015, p. 830). Nevertheless, "is a very general method as it only asks three simple questions: 1) are there at least two named women in the movie? 2) do these women talk to each other? And 3) do these women talk to each other about something besides a man? In case the answer is "yes" to all these questions, the movie passed the test" (Agarwal et al., 2015, p. 830). This method was also applied to measure the presence of women in conversations held on social media platforms (García, Weber & Rama, 2014). After analyzing these questions, it is possible to say that women are or not seldom portrayed as strong leaders and thinkers in popular media.

After applying the Bechdel test, an adaptation of Algirdas Greimas actantial method was made. "Since the moment we have considered the film character as a narrative category resulting from the sum of traits (physical, psychological, moral, or sociological characteristics)" (Pérez-Rufi, 2016, p. 539), in which people can be reflected and that has a significant impact on the way women is represented in the mainstream (dominant) or commercial cinema, it is important to bring these theories to understanding, into consideration

The method created by Greimas describes as "[Favoring] the verbal (referring to actions) as opposed to the nominal (referring to objects) aspects of narrative" (Marsen, Biddle & Noble, 2003, p. 4). In simple words, the narrative in the cinema begins with a problem to solve, in which some performers act, and as a result, the initial problem is solved or not. Accordingly, the theory developed in a trajectory or phases in which the individual/hero executes the action to solve the issue. The trajectory is defined as:

1 step) qualifying test which corresponds to analyzing the competence. The individual has resources to help bring them to another stage, 2 step) A decisive test where the subject/hero uses the resources to deal with the action, based on the initial problem, 3 step) Glorifying test where the recognition is made of either the solution or the lack of closure to the problem (Saraswati, 2022, p. 315)

Having the process of Greimas in mind, some adaptations have been made in the matrix for analysis considering the volume of movies to analyze. The axis analyzing the sender has been erased, as the purpose of this research is not of our interest, instead, we care about if the woman performed any relevant activity demonstrating her leadership and resources to solve the issue. Additionally, in the steps we have also included the following question: what is the main reason for helping or opposing? as a means to understand the conjunctions, disjunctions, and power-like traits between the object and the subjects and their motifs, this is to provide insights if it is the case, that women had the power to execute and solve the initial problem, among other relevant decisions in the plot of these films.

#### 3.1. Sample

Besides previous research done in this area such as the examination of how women are portrayed in films in the context of fourth-wave feminism, twelve characters were depicted from a sample of eight films (Kool, Azevedo & Avraamidou, 2022) using socio-logical film interpretation counting on categories such as occupation, socio-political theme, and timeframe. Nevertheless, the eight films were taken only from Movie Database (IMDB) considering keywords related to the topic, for us, it is vital to broaden the spectrum as IMDB is not the only and most used database when individuals look for a movie or a recommendation to watch, where for example Rotten Tomatoes, also plays a key role among others.

Therefore, we took part in the film database used in "Cultural Representations of Gender and STEM: Portrayals of Female STEM Characters in Popular films 2002-2014", research conducted with a similar objective but analyzed with their coding and signs method; despite this, we amplified the list of movies using the IMDB by (Steinke & Paniagua, 2017), Rotten Tomatoes and Google search released from 2014 to 2022. The keywords used for the search were: movie and scientists, women scientists movie, female scientists movie, women astronaut movie, women computer scientists movie, female researcher movie. From this search, we had to carefully select some movies, as simply searching by keywords was not sufficient to determine whether a female scientist was the lead or co-lead in a movie, unless it was a documentary that was based on someone's life. We also had to take into consideration the cast members of the movie to ensure that they were included in the list.

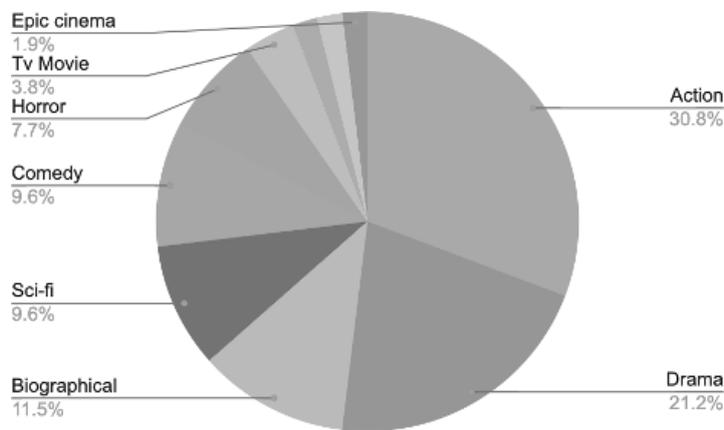
From this exercise, we have gathered a list of 60 films and series. However, we are not studying 5 of them because they were series, such as: *Diagnosis* (Lisa Sanders, 2019), *Emily's Wonder Lab* (Emily Calandrelli, 2020), *The dropout* (Elizabeth Meriwether, Michael Showalter, Francesca Gregorini & Erica Watson, 2022) and *Lost in Space* (Matt Sazama, Burk Sharpless, Irwin Allen, Tim Southam, Deborah Chow, Alice Troughton & Neil Marshall, 2018). In addition, three other movies that appeared in the search with past keywords but dated from 1994-1997 or earlier were not taken into consideration, leaving a total sample of 52 movies to be analyzed using the Bechdel test. As a result of the films that passed the Bechdel test, a representative sample of 4 out of 7 movies was selected for application of the adapted method of Greimas.

#### 4. Discussion & Results

As discussed in context and theories, audiences have as much responsibility as filmmakers, not only because of the impact of those productions they support but from the psychological conscious or unconscious impact of such representations compared to real life, which is dependable on the audience's will. Therefore, it is not strange that industries support what is more commercial and produce more profit. Despite this, there have been some changes already in the film industry as now is more frequent to find throughout different film genres, more minorities, social issues, and inequalities depicted, in an attempt to either connect at a deeper level with the political, economic and in general, with the social issues or an attempt, to connect, with people's emotions as another marketing/financial strategy to promote movies.

The female representation in the films analyzed with the Bechdel test is to provide information on how relevant the female character for the development of the plot was and, therefore, to understand in depth the stereotypes reproduced in films and their massive impact on the audiences who watch them. During the Bechdel test, the 52 movies passed through the following filters: T1) Are there at least two named women in the movie? T2) Do these women talk to each other?, and T3) Do these women talk to each other about something besides a man? Findings show that 51% of the total movies passed the T1 or first question, 38.8% of the movies approved the T2, and 10% managed to get the 100% of a "female successful representation" in a movie, as it is possible to see in the following graphic.

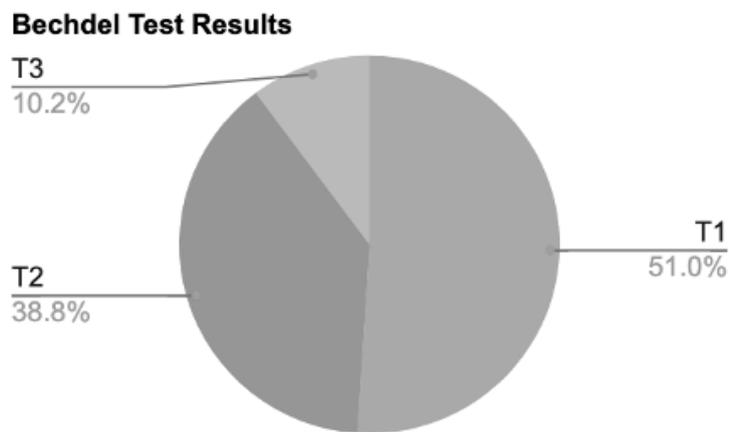
Figure 1. Bechdel Test Results.



Source: Authors' own elaboration, 2022.

Going beyond the Bechdel test, the results provided additional information such as the genre of the 52 movies 30% are action movies, 21% are drama, 11% are Biographical, and 9% are Sci-fi. In addition, only 11 % of these movies approved the three questions asked in the Bechdel test, compared to 88% of films that failed it.

Figure 2. Bechdel test vs. genre categories.



Source: Authors' own elaboration, 2022.

#### 4.1. Bechdel Test results in contrast with the context

"Film is a psychological product of human beings. The research on film cannot be divided into the single scope of linguistics or any single discipline" (Luan et al., 2022, p. 71). As a result, to interpret the Bechdel Test is necessary to mention theories related to psychology, behavior, and more, to contrast the results and to understand the impact of the underrepresentation of the scientific women portrait in current films.

In previous studies conducted by the University of Rochester, the evidence shows that the test fails to reveal the hidden gender disparity configuration, essentially because a film can pass the Bechdel test and still portray women as auxiliary characters with few screens time (Yang, Xu & Luo, 2020). Additionally, one aspect that seems highly important in Film studies is the Box Office Return, which functions as a success measure of movies. In the same Rochester Study, the evidence suggests that previous reports from the tech company Shift7 state "from all the 350 films analyzed those that passed the Bechdel test, also surpassed the box office returns of films that fail this test" (Shift7, 2017).

In this research the center of all is placed in the relevance for the market of those films, confirming that directors and filmmakers respond to trends, industry preferences, budgets, and material, not essentialist matters as Martín-Barbero explains in mediation theory. This might be the explanation why there is a movie *Hulk* (Ang Lee, 2003) and a recent She-Hulk character by Marvel in secondary movies, or *Thor* (Kenneth Branagh, 2011) and a Female version of Thor, as a secondary superhero story, responding to a current pinkwash trend in the industry; instead of creating a complete and whole new version of what any women can be, but that might not necessarily be as commercial, as De Beauvoir (2015) explained when discussing about the androcentrism, the man is the point of reference by which women is measured.

In this research, 88% of the movies that did not pass the Bechdel test significantly featured a female scientist as the lead or co-lead. However, the interactions of these characters were not necessarily with other women or about something other than a man. In fact, in most of these movie plots, the active and agentic individual was a man who had some sort of relationship with the female lead or co-lead scientist.

For better illustration, consider the film *"Bombhell"* (Jay Roach, 2019), which details the sexual harassment case at Fox News and focuses on Gretchen Carlson, a famous TV host who sues Roger Allies, the former FOX owner. Although Gretchen interacts actively with both men and women in the film, all conversations revolve around the male central figure, as he is a crucial part of the story. Another example is the film *"Interstellar"* (Christopher Nolan, 2014), which passes the first two questions of the Bechdel test, but the interactions between women and other men are centered around the mission to rescue Cooper, who is stranded on another planet. In both of these films, female scientists are depicted as strong co-leaders, one as an astrophysicist and the other as a powerful TV host, but their stories and characters are inextricably tied to the men who hold positions of power over them. This pattern can also be seen in other films, such as *"Contagion"* (Steven Soderbergh, 2011), *"Down of the Planet of the Apes"* (Matt Reeves, 2014), *"The Day the Earth Stood Still"* (Scott Derrickson, 2008), and more.

On the contrary, *Arrival* (Denis Villeneuve, 2012) and *Ágora* (Alejandro Amenábar, 2009) are plots where scientific women played a key role as lead or co-lead, however, the female character was the only one in the whole movie, with no interaction with other women and therefore, we can directly discard the third question/answer from the Bechdel test. The same happens in films such as *Gravity* (Alfonso Cuarón, 2013) where Dr. Ryan

Stone is alone in space and is practically a monologue about how to come back save to earth. Nonetheless, these portraits of women are “legit to the gaze” of a man, as they have fought with all physical strength to achieve their goals without recurring to their “women weapon’s” (Bernárdez, 2012, p. 92). Throughout these movie portraits and the Bechdel results, there is sufficient evidence of imbalances not only in the power relationship between the characters of those movies, lack of representation of scientific women in these contexts, and few interactions that place women as a crucial agent connected to the plot center.

Nevertheless, “if we understand the mediatic representations as a kind of collective imaginary, where not reality but a “symbolic representation” of that reality is represented, that is, a scenario where we see “incarnated” in fictions not only the structures of power but also its ghosts: all possible forms of subversion” (Bernárdez, 2012, p. 93). It becomes clear that media is a contradictory and invisible power that can be both conservative and reproducing of stereotypes, norms, and at the same time it has the capability to alter everything. This raises the question of who is responsible for demanding films with different characteristics - the consumers or the market? The truth is that, based on the results of the genres with more interest being action, drama, biographical, sci-fi, and comedy, and comparing it with audience reports from European countries, it can be concluded that the market and budgets dictate what filmmakers should do.

On the other hand, “film has a mirror image system with metaphorical meaning, which is composed by moving pictures” (Luan et al., 2022, p. 72). Having considered this, it becomes evident that film holds a significant place in our lives, as despite cultural and individual differences, certain visual images, such as “rain or sky”, are universally recognizable. As stated by Luan et al. (2022, p. 72), “film has more universality and general principles than language.” This challenges the notion that cinema does not shape people’s belief systems, and places responsibility on the consumers, as the images we see are a reflection of our own perspectives and worldviews.

To elaborate further, it has been noted that “the space-time processing of films produces second-level significance to the audience. For example, when describing a person living alone in the forest, under a panoramic shot, the person is in a corner of a dense forest; while under a close shot, the half-body image of a person matches with the dense forest behind” (Luan et al., 2022, p. 72). This is why films are so powerful and captivating, as they not only present images and narratives, but also tap into the symbolic and sensory aspects of viewing, engaging the audience in a way that mere words cannot. The audience is therefore not just passive receivers, but active participants in the experience that films provide.

Additionally, of the 65 female characters in STEAM-related careers, 22% were biologists, 11% worked in computer science, 8% in engineering, 6% in psychology and astronomy, and the remaining in professions such as pilots, archeology, medical engineering, writing, research, and neuroscience. A majority, 76%, of the female characters were White/Caucasian, 9% Black or African American, 9% Asian or Indian American, with at least 3% Hispanic/Latino and 1% multiracial. With regards to age, 40 out of 65 female characters analyzed were between 20 and 30 years old when they appeared in these movies, while 21% were aged between 30 and 40 and only 9% were over 50 years old. This goes beyond the Bechdel test and sheds light on the intersections of ageism, race, and ethnicity, thereby highlighting the presence of stereotypical narratives and symbolic visualizations.

At last, “studies have shown that African American music videos were significantly more likely to portray sexual content and sexualized female characters more than White videos” (Turner, 2011, as cited in Yang, Xu & Luo, 2020, pp. 12-13), thus showing a relevant factor that can influence the image of a film character. Besides this, “women and men above 60 are underrepresented” (Lauzen & Dozier, 2005, p. 437), as well as “Older actresses experience greater difficulties in finding jobs (...), the majority of the male characters are in their 30s to 40s, whereas the majority of the female actresses are in their 20s and 30s” (Treme & Lee, 2013 as cited in Yang, Xu & Luo, 2020, p. 13). The reason for this disparity is that as men age, they tend to attain leadership positions and wield greater power in their occupations. However, women are less likely to attain such goals (Yang, Xu & Luo, 2020, p. 13). This raises another concern, namely the lack of positive representation of scientific women in commercial cinema, without any barriers imposed by age, ethnicity, race, or gender.

#### **4.2. Greimas Adapted Method: Men is the verb, Women the vowel**

The grouping of the information obtained from the implementation of the adapted Greimas Method by the genre of the selected movies are now addressed. First of all, the results and analysis of biographical films, followed but not compared to, sci-fi films.

A brief outline about the first movies to analyze: *Hidden Figures* (Theodore Melfi, 2016) and *Radioactive* (Marjane Satrapi, 2020), are biographical films. In these films, the subject/hero is a scientific woman, on one side we have African American Technical Engineers and Mathematicians, and on the other Madame Curie, a Caucasian Physicist and Chemist recognized worldwide. *Hidden Figures* describes a story of segregation by race and sex that takes place in 1961, and the plot is about how Afro-American women helped NASA to take an astronaut on a space ride and bring him back home safe, against all odds. Whereas in *Radioactive*, we see a tale of Marie Curie’s life story in Paris in 1934 when she was trying to create her laboratory and, be able to find the polonium and the radium, which provided her with two Nobel Prizes in her later years.

This summary is here to contribute to the basis of the Greimas Adapted Method. The information has been grouped into patterns and highlighted the differences.

In *"Hidden Figures"*, the central focus was on the remarkable contributions of these women, who played a crucial role in sending a U.S. astronaut on a successful space mission, beating the Russians to it. On the other hand, the biopic *"Radioactive"* depicts the challenges and confrontations faced by the iconic scientist "Madame Curie", including the lack of a laboratory and support from the University, in her quest to prove the existence of a new chemical element. The narrative in *"Hidden Figures"* revolves around the protagonists' journey as they strive to prove their competencies and secure higher positions at NASA. Through their hard work and determination, they eventually take charge of the operation of an IBM machine and make the crucial calculations that led to the successful space mission. The story of "Madame Curie" follows her journey from her arrival in Paris and meeting Pierre Curie, who later became her husband and key collaborator. Despite the University's denial of support, they persevered and conducted experiments together, solidifying their legacy as one of the greatest scientific partnerships of all time.

The qualifying test: Crucial moments are in both movies when these women had to prove their competency to solve the initial problem. The African American women were presented with mathematical problems and formulas that they needed to solve in order to ensure the safe journey of the astronaut into space and back to Earth. On the other hand, Madame Curie's journey involved conducting various experiments with her husband Pierre, initially facing challenges and inefficiencies, but eventually discovering radium. Decisive test: The outcome of the challenges faced by these women was triumphant. Glorifying test: In *Hidden Figures*, the women were able to complete all necessary calculations on time, successfully sending the astronaut into space and bringing him back safely. Meanwhile, Madame Curie and Pierre were able to confirm their theories and discoveries of polonium and radium. These achievements were not only significant for the women themselves but also for the advancement of their respective fields.

To interpret this method, it is necessary to evaluate the nature of their relationship, the conjunctions or disjunctions, the helpers, and the opponents to be able to complete the narrative analysis. In both scientific female portraits, we can see how White men executed power in their privileged positions and created oppression in the life of these female characters, these women were working in fields where men were back then the rule, and women had not to leverage at all. Therefore, the main opposition was based on the grounds of gender, nationality, ethnicity, and race.

All the characters that opposed each other in the past movies were men acting out of jealousy, ignorance, and discrimination. Distinctive traits of psychological abuse included damaging their reputation through tactics such as obstructing their work and exerting leverage. Unfortunately, this type of behavior remains prevalent today. Conversely, women's proactive responses to challenges were shaped by their interactions with supportive individuals such as peers, husbands, and colleagues. These allies helped break the cycle of oppression by providing encouragement, building confidence, and offering support for women to pursue their passions.

In the axis of power, men are the one who carries the final decisions to solve the initial problem, holding both, agency, and leadership. However, these films showcase the triumphs of women who were ultimately vindicated. Through the medium of cinema, the viewer is given the opportunity to relive these moments and gain a deeper understanding of the injustices and discrimination faced by these women. The representation of these biographies, through the use of powerful language, gestures, and cinematographic effects, effectively transports the audience to a place of empathy and anger towards the oppression experienced by them. The films also challenge the stereotype of the solitary, unmarried scientist by showcasing women who had supportive families and spouses who admired and encouraged their ambitions.

Additionally, a noteworthy fact is the portraits of eastern women who were both scientists and inventors. The same passion and intuition that drive Madame Curie are present in Eva Maria Kiesler or "Hedy Lamarr" portrait. She became famous for being cataloged as one of "the most beautiful women" in the cinema during the 1930s. In *Hedy Lamarr's biography* (Alexandra Dean, 2017), it is possible to see her talent in the cinema, also her curiosity to build and create. Hedy's hobby led her to change airplane wing design and create a system to stop German torpedoes during the Nazi war with a frequency communication technique. Her inventions were stepping stones that led to the creation of WIFI and Bluetooth.

Two women from Austria and Poland had bright careers far from home, both accused at some point by "opponents" for expressing their sexualities freely, and for doing so, the press and society back then tried to jam their careers publicly. Nevertheless, Hedy Lamarr's story is not worldwide known as Madame Curie's movie is not the most watched. These movies create social conscience, but none of them was more box office successful than *Top Gun Maverick* (Joseph Kosinski, 2022) or even *Jurassic Park* (Steven Spielberg, 1993), films that effectively achieve the goals of the market (Martín-Barbero, 2002, pp. 16-17). Even though biopics contain facts that are part of the life story and work of the real women portrayed in these films, biographical films are less popular than other film genres.

Next movies are two exciting science fiction films, *Avatar* (directed by James Cameron in 2009) and *Prometheus*

(directed by Ridley Scott in 2012), both created by filmmakers from the US and UK. First a quick overview of each movie, *Avatar* takes place in 2154 and explores the story of humans trying to secure a mineral known as unobtainium from Pandora, a world inhabited by the Na'vi, a tribe of human-like beings with a deep connection to nature. Meanwhile, *Prometheus* follows a spacecraft as it responds to a persistent call from humanity's creators, which is interpreted by two archaeologists through a star map found in ancient wall drawings across the Earth. The crew embarks on a journey to investigate this map and make contact with their supposed forerunners, whom they call "the engineers."

Building upon the Greimas adapted method, the central conflict in *Avatar* revolves around humans seeking to obtain minerals from Pandora. To achieve this goal, they send in a spy, Jake Sully, who becomes a trusted ally to the tribe and helps the humans to understand their way of thinking, communication, and protection of the mineral-rich area. On the other hand, in *Prometheus*, humans have seemingly uncovered information about their creators and embark on a space journey, funded by the CEO of the Weyland Corporation, to meet these beings referred to as "the engineers". The expedition is led by the CEO's daughter, Mss. Vickers, who serves as the captain.

In the narrative sequence, Jake Sully is enchanted by the beauty of Pandora and its tribe. Through his adventures, he locates the mineral deposits. However, his initial plan to betray the tribe is foiled when he falls in love and forms a bond with a Na'vi named Neytiri. In *Prometheus*, the story begins to unfold as soon as the crew arrives on a distant planet. The scientists disembark from the spacecraft to explore what appears to be an isolated location. Upon entering a cave, they find that the air is breathable and remove their protective masks. Unfortunately, one of the crew members becomes contaminated with an unknown alien DNA.

The qualifying test: The time has come to extract the minerals, and Jake Sully is informed by the company leader of a military operation aimed at securing the unobtainium peacefully. On the other hand, in *Prometheus*, the alien DNA merges with human DNA, transforming some of the crew members. After undergoing an abortion of an "alien child", the archaeologist Elizabeth Shaw is left reeling with emotions. She has lost her boyfriend and just undergone a traumatic experience. Determined to understand what this DNA is doing and find a way to stop it, she sets out with David (a synthetic life form) and the elderly CEO of Weyland Corporation, who has discovered in secret that this location is actually the site of a crashed alien ship.

The decisive test starts in *Avatar* when Colonel Miles from military security starts a war and decides to take down the "giant home tree". Jake decides not to cooperate with humans, and so does Dra. Grace and other colleagues who wore their avatars to join them on the battlefield, many Na'vi and humans die in this confrontation. Na'vis was losing until Jake Sully appears with a dragon-like creature and regains Na'vis trust. On the contrary, in *Prometheus* all seems lost, David is the only one who can manage to understand the spaceship and he wakes up one "Engineer" that is still alive and sleeping in the vessel. But the "Engineers" starts to kill them all, therefore everyone tries to save themselves.

In the glorifying test of *Avatar*, Jake Sully assumes leadership of the tribe to join the war, Dra. Grace, other humans, Pandora's wildlife, and Na'vi clans join to fight. As a result, humans lose the battle, Jake becomes a Na'vi and Dra. Grace tries the same but unfortunately, she dies. On the contrary, in *Prometheus'* glorifying test, Elizabeth Shaw manages to run away with David at the end of the movie, although the answers she and the CEO of Weyland were looking for never got to be. The rest of the crew dies at the hands of the aliens.

Dystopian films and biographical movies cannot be compared, as science fiction movies are grounded in imaginative, alternate worlds where the laws of reality may be distorted and don't necessarily have to make logical sense. On the other hand, science fiction is a genre rich in symbolic systems that depict human-like forms of social organization, communication, and interaction that are easily relatable. For instance, the concept of "Engineers" symbolizes a divine or God-like entity, much like the story behind the Na'vi in *Avatar*. The power dynamics among the Na'vi are similar to those of a human tribe, with the oldest member serving as the leader and embodiment of wisdom, the mother functioning as the shaman who heals and connects the tribe to nature, and the children inheriting the leadership role. As such, Neytiri in *Avatar* is expected to mate with the strongest member of the tribe.

This symbolic way of re-signifying the dystopian characters follows a pattern of what is close to the ways we humans in real life interact, our environment, the problems we have, and the feelings that all those problems arise from us, therefore making the stories closer to our eyes and easy to identify with. Another great example is when Dra. Grace in *Avatar*, who represents a brilliant Astrobiologist that has years of experience treating the Na'vis, displays since the beginning of the movie the importance of nature for the Na'vis, which is equivalent to the real-like problems with climate change and indigenous people who protect nature.

Both *Avatar* and *Prometheus* feature greedy and violent business tycoons who seek to exploit the resources of Pandora without regard for the lives of its inhabitants or the environment. This mirrors the struggles faced by ecofeminism. In *Avatar* for instance, while Dr. Grace plays a crucial role in understanding the Na'vi language and culture, as well as uncovering the secrets of Pandora, a battle takes place, and she passes away before she can fully become her avatar. Instead, it is Jake Sully who rises as the hero and saves the day, continuing to live among the Na'vi people.

The situation is not too different in *Prometheus*. The company's CEO's daughter Ms. Vickers is an irrelevant character. She is against the expedition as she considers it a waste of money and time. Her portrait is intriguing because she is a selfish businesswoman who does not care about exposing her economic interest and is the foremost opponent of the expedition. All those who are in favor of the expedition as helpers are the archeologists, the elder CEO of the company who believes he can have certain "answers" about life from the "Engineers", and David, the life form.

In their characterizations, it is notable that Vickers embodies a woman who wants control, authority, and the freedom to express her sexuality without concern for others. However, she is portrayed as a spoiled child who defies her father's commands and is constantly sabotaged by David's attempts to undermine her leadership on the ship. In the end, Vickers meets a gruesome fate as she tries to save herself from the madness of the mission to meet the "engineers". In comparison, Elizabeth Shawn is a successful archaeologist who discovers life on a distant planet. She conceals her pain of being unable to have children, although is generally kind and possesses a more androgynous appearance. She prioritizes the safety of others, warning them to leave the planet, while Vickers showed no concern for anyone else.

Throughout the events of *Prometheus* and *Avatar*, it becomes clear that their missions ultimately fail, with more obstacles present than successes. The power dynamics in both movies are symbolic in nature. For instance, Ms. Vickers lacks agency, with the captain and David making most of the decisions along with the rest of the crew. Similarly, in *Avatar*, Dr. Grace's warnings about avoiding a hasty takeover are ignored. Women are once again portrayed as secondary characters, portrayed as strong but not capable of standing on their own. This is in contrast to *The Martian* (Ridley Scott, 2015), where the main character (a man) is stranded on another planet but is able to survive and even grow food, demonstrating his strength and resourcefulness in a place where nothing should be able to grow.

The value of adapting the Greimas Method for this analysis lies in its ability to reveal the narrative sequence and the power dynamics between characters, where men often occupy the central positions and drive the crucial actions that determine the outcome of the story and resolve the central conflict, either through force or audacity. Moreover, in most action and sci-fi movies analyzed, women are portrayed as fighting for maternal reasons, while men are rarely depicted as having a strong connection to family, reinforcing the notion that men are at the center of everything and do not need a backstory or motivation to be the hero or main character.

## 5. Limitations and future recommendations

The Bechdel test is not enough to provide insights into the representations of women in commercial cinema, despite its worldwide use for this purpose. Therefore, it is necessary to combine elements or create adaptations to other methods to provide in depth insight.

Moving forward, it is crucial to delve deeper into the issue of underrepresentation of women in STEAM fields in cinema. This requires a closer examination of factors such as the gender intersection with ethnicity, age, and gender. It is imperative to shed light on the impact that the lack of positive female role models in cinema has on promoting women's participation in these fields. Future studies could benefit from incorporating theories from behavioral sciences and conducting long-term experiments to assess the extent to which cinema unconsciously shapes our perceptions and attitudes.

Furthermore, it is worthwhile to analyze the impact that the popularity of certain movie genres has on societal movements and issues related to gender and human rights. This can provide valuable insights into the media's influence on these essential subjects.

## 6. Conclusions

"A useful way to understand characters is by considering them as a unit of psychology and action" (Pérez-Rufí, 2016, p. 538), By analyzing the various circumstances that make up a character in a film, such as their morals, psychology, physicality, and others, we can gain insights into their relationships, power dynamics, agency, and mediations. Moreover, the cinematographic effects interact with the audience as an active participant, leading to relevant conclusions, often without conscious awareness of the thought process. Although the Bechdel test alone provides limited information compared to other methods of analysis, it serves as a starting point for our examination of representation. Furthermore, the fact that only a small number of movies in our sample passed the test, and then went on to be analyzed using the Greimas Actant Method, highlights the need for improvement in terms of representation of female scientific characters in today's commercial cinema.

Despite the current push for the feminism of difference, which has made its way into literature, theater, and cinema, there is still much work to be done in terms of portraying positive and impactful role models for women in STEAM fields. These role models should be liberated from the male gaze and not be centered around pleasing male interests or lifestyles disconnected from the realities of women in STEM. The purpose of this analysis is not to find a message or moral in the films, but rather to highlight the differences in the characterization of characters, the psychological messages being conveyed by filmmakers, and how patriarchal and divisive ideals continue to be

perpetuated, often unconsciously, as future generations shape their role models.

As audiences, it is crucial that we examine the content we consume and the messages it conveys. By being more mindful of the information that enters our belief systems, we can help break away from harmful and outdated gendered attitudes. What we need to see is women scientists portrayed as powerful, independent figures, free from the constraints of family obligations or being defined by their relationships with others. Instead, let there be a celebration to their ambitions, purposes, and personal journey, truly embracing their scientific pursuits as a central aspect of their lives, just as Madame Curie, authentic, irreverent, though, firm in her convictions.

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