THE CHANGING STEREOTYPES IN POPULAR FILMS STEM THEMED: ON BREAKING THE TRADITIONAL RIGID VALUES AND THE POPULARISATION OF SCIENCE

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ABSTRACT:

This study analyses STEM identities in STEM fields represented in popular films. The authors argue that the recently produced big-budget popular films directly or indirectly affirm STEM characters with their portrayal of STEM fields. This analysis focuses on how popular narratives can be an essential tool to communicate the idea that women can be scientists and how they can inspire young women to enter science. These narratives reflect a significant problem in the interactions between the audience and science. The audience thinks the scientists are heroes and the public expect that scientists will automatically accept scientific solutions to problems. Nevertheless, scientists find a solution in these films, and everything gets better. Thus, recent popular STEM-themed big-budget films provide identification with the audience and STEM characters. These narratives construct an alternative STEM discourse by breaking down gender stereotypes and dominant ideology. These films can be coded as films that produce ideology against the dominant ideology and patriarchy, especially regarding STEM, character and gender representation. There is a positive change in the hierarchical order in the STEM field and the representation of women and Others. And these representations do not have any marginalisation.

KEY WORDS:

diversity, gender, high-budget film production, popular films, popularisation of science, STEM, stereotyping

1 Introduction

STEM consists of the first letters of "Science, Technology, Engineering and Mathematics" and means the integration of these disciplines. In the Global Gender Gap Report, which is the result of research conducted in 144 countries, it is stated that more women are needed in science and technology, especially with the spread of Industry 4.0. However, the same report says that closing the gap between male and female employment rates

in the STEM field is an elusive goal.[1] According to the World Economic Forum, if the gender gap in the STEM field continues to close at its current rate, it is estimated that it will take 217 years to close the gap. According to the UNESCO's report, only 35% of STEM students in higher education globally are women, and differences are observed within STEM disciplines. For instance, only 3% of female students in higher education choose information and communication technologies studies.[2] This gender gap is alarming.

Moreover, a shortage of women in many STEM fields like engineering and computer science is observable in countries like Spain.[3] Nevertheless, this under-representation can be observed in many Western and Middle Eastern countries, such as in Germany, 27% of researchers were female in 2016, respectively in Spain, 40%, 37.3% in Turkey, according to UNESCO.[4] In the USA, women made up less than one-quarter (24%) of those employed in 2015.[5] In Saudi Arabia, while the share of women scientists is only 23.2%, it is 27.7% in Iran, according to the UNESCO factsheet. The connection between occupational representations in media and their influence on people's academic and occupational decisions is still unexplored. Patriarchy is the prevalence of specific patriarchal values, reflected through the experience of socialisation in the Middle East. It places women at a highly disadvantaged status. Whether it is due to patriarchal views or other reasons, the difficulty of achieving full gender equality continues throughout the world. In no country are women equal to men in politics, economics, and cultural participation; the extent to which women's political subordination encompasses various cultures, economic arrangements, and the regimes in which they live.[6] These views are more obvious in the Middle East countries. Shafik states that there is a significant finding that gender equality is associated with economic growth and human development.[7]

Besides, the audience is influenced by the characters they watch in TV series and films and take them as examples for their career goals[8] and fictional representations significantly impact people's attitudes toward science.[9] In particular, the attribution of some professions to men can be destroyed through media.[10]

While such an uneven distribution exists in the STEM field, where do popular films stand, and what do they do? Popular films do not destroy traditional gender roles, even reproduce these roles;[11] however, where do hit blockbusters stand in STEM and gender representation? This study discusses how popular films after 2015 handled STEM characters and explores the diversity of STEM characters, considering the power of recent popular films to inspire STEM identity. This study aims to contribute to the literature by depicting STEM characters in popular films content produced in recent years. While this study discusses how the ever-changing gender definition of scientists in recent popular films is depicted through scientists, on the other hand, it is a pioneering study on how these characters, the audience who consume popular products, can read the sexist attitude in these popular films. On the other hand, this study argues that when the entertaining dose of the elements used in popular narratives is increased, even science and the scientific knowledge in question can capture the masses.

1   CROTTI, R.: *Global Gender Gap Report 2020*. Cologne, Geneva : World Economic Forum, 2020, p. 9-12.
2   UNESCO: Women in Science. In *UIS Fact Sheet*, 2018, No. 51, p. 1-4. [online]. [2022-05-12]. Available at: <https://uis.unesco.org/sites/default/files/documents/fs51-women-in-science-2018-en.pdf>.
3   SAINZ, M., MULLER, J.: Gender and Family Influences on Spanish Students' Aspirations and Values in STEM Fields. In *International Journal of Scientific Education*, 2018, Vol. 40, No. 2, p. 188.
4   CHOI, S. H.: *Cracking the Code: Girls' and Women's Education in Science, Technology, Engineering and Mathematics (STEM)*. Paris : UNESCO, 2017, p. 29-32.
5   NOONAN, R.: *Women in STEM: 2017 Update*. Washington : US Department of Commerce, Economics and Statistics Administration, 2017, p. 3.
6   CHOWDHURY, N., NELSON, B.: Redefining Politics: Patterns of Women's Political Engagement from a Global Perspective. In NELSON, B., CHOWDHURY, N. (eds.): *Women and Politics Worldwide*. New Haven : Yale University Press, 1994, p. 18.
7   SHAFIK, N.: *Closing the Gender Gap in the Middle East and North Africa*. Bingley : Emerald Publishing, 2001, p. 13-31.
8   See also: ANDERSON, C. A. et al.: The Influence of Media Violence on Youth. In *Psychological Science in the Public Interest*, 2003, Vol. 4, No. 3, p. 81-110; MITTELL, J.: Narrative Complexity in Contemporary American Television. In *The Velvet Light Trap*, 2006, Vol. 58, p. 29-40.
9   See also: GREENBAUM, D.: Is It Really Possible to Do the Kessel Run in Less than Twelve Parsecs and Should It Matter – Science and Film and Its Policy Implications? In *Vanderbilt Journal of Entertainment & Technology Law*, 2020, Vol. 11, No. 2, p. 249-333; KIRBY, D., OCKERT, I.: Science and Technology in Film: Themes and Representations. In BUCCHI, M., TRENCH, B. (eds.): *Handbook of Public Communication of Science and Technology*. 3rd Edition. New York, London : Routledge, 2021, p. 138.
10   See also: GÜRKAN, H.: The Experiences of Women Professionals in the Film Industry in Turkey: A Gender-Based Study. In *Acta Univ. Sapientiae, Film and Media Studies*, 2019, Vol. 16, No. 1, p. 205-219; SIMPSON, C.: *Science of Coercion*. New York : Forbidden Bookshelf, Open Road Media, 2015; TUCHMAN, G.: The Symbolic Annihilation of Women by the Mass Media. In CROTHERS, L., LOCHART, C. (eds.): *Culture and Politics*. London : Palgrave Macmillan, 2000, p. 150.
11   See also: GAUNTLETT, D.: *Media, Gender, and Identity*. New York, London : Routledge, 2008; KEARNEY, M. C.: *Girls Make Media*. New York, London : Routledge, 2006; MATTERN, E.: Caucasian Girls and Samurai Swords: Dualism in Kill Bill. In *First Class: A Journal of First-Year Composition*, 2014, Vol. 2015, No. 1, p. 30-37.

This study focuses on using a specific definition of "stereotype" or "diversity" as a starting point – and discusses how the findings challenge/confirm this definition. This is an approach to better streamline and clarify the focus, methods and argumentation. The state of research on the topic of film/representation/narrative/scientist stereotypes and science communication (also from the perspective of science communication) are outlined. Most pertinently, while this study refers to a form of science communication, namely 'science in fiction', there is discussion on how this relates to, interacts with science, gender and equality communication practice or scholarship.

From this point of view, it is examined how contemporary popular films have broken the moulds of the lack of diversity, gender and ethnic inequality in STEM. Thus, it reveals (i) how popular cinema includes the dominant ideology about STEM; (ii) how it spreads this view; and (iii) how it serves the patriarchal ideology to place it in the people's minds. According to McQuail, there is a direct relationship between the ideas and thoughts disseminated through the cultural industries, including Hollywood, and the interests of the global capitalist class controlling this industry.[12] Accordingly, popular films reproduce and legitimise inequalities based on class, gender and nationality, all forms of exploitation and consumption-based commercial culture. This study deals with the hidden and displayed contents of the films. The films try to clarify how the more widely used values of the STEM field, such as race, class and gender, are represented and what is happening in the group(s) where social neglect is commonly used.

2   Literature Review

Explaining the STEM field with gender stereotypes and roles is one of the most common conceptualisations. Gender stereotypes refer to beliefs and rules about how men and women should behave, which facilitate understanding of what is masculine or feminine in every society. In this respect, stereotypes constitute a factor that reveals the importance of cultural context in STEM fields.[13] In other words, developing assumptions about why men prefer these areas more than women. For example, Smeding examines gender stereotypes in STEM fields and their relationship to performance in engineering and humanities students and claims that female engineering students have weaker gender stereotypes than humanities students.[14] According to Cheryan et al., certain career stereotypes act as watchdogs keeping women out of specific fields. For example, computers and engineering are stereotypically male-oriented careers as they involve social isolation and a focus on machines.[15] According to Master et al.[16] and O'Connor et al.,[17] cultural stereotypes that associate STEM careers with men act as 'barriers' that prevent women from engaging in such professions.

On the other hand, Cheryan et al. identify three general factors that explain the STEM gap: male cultures, lack of experience and gaps that drive women away from STEM fields because they do not belong.[18] In addition, studies on gender stereotypes and the STEM gap suggest the stereotype threat theory to explain how stereotypes negatively affect women's professional performance.[19] Amarasekara et al. state that women manage only 32 of 391

12   MCQUAIL, D.: *Mass Communication Theory: An Introduction*. London : SAGE, 1994, p. 262.
13   See also: NASSAR-MCMILLAN, S. et al.: New Tools for Examining Undergraduate Students' STEM Stereotypes: Implications for Women and Other Underrepresented Groups. In *New Directions for Institutional Research*, 2011, Vol. 2011, No. 152, p. 87; PRIVES, L.: Studying Stereotypes: Examining Why Many Women Do Not Pursue STEM Careers. In *IEEE Women in Engineering Magazine*, 2013, Vol. 7, No. 2, p. 15.
14   SMEDING, A.: Women in Science, Technology, Engineering, and Mathematics (STEM): An Investigation of Their Implicit Gender Stereotypes and Stereotypes' Connectedness to Math Performance. In *Sex Roles*, 2012, Vol. 67, No. 11-12, p. 620.
15   CHERYAN, S. et al.: Why Are Some STEM Fields More Gender Balanced Than Others? In *Psychological Bulletin*, 2017, Vol. 143, No. 1, p. 30.
16   MASTER, A., MELTZOFF, A.: Building Bridges between Psychological Science and Education: Cultural Stereotypes, STEM, and Equity. In *Prospects*, 2017, Vol. 46, No. 2, p. 230.
17   O'CONNOR, P., O'HAGAN, C., GRAY, B.: Femininities in STEM: Outsiders within. In *Work, Employment and Society*, 2018, Vol. 32, No. 2, p. 317.
18   CHERYAN, S. et al.: Why Are Some STEM Fields More Gender Balanced Than Others? In *Psychological Bulletin*, 2017, Vol. 143, No. 1, p. 30.
19   See also: SHAPIRO, J., WILLIAMS, A.: The Role of Stereotype Threats in Undermining Girls' and Women's Performance and Interest in STEM Fields. In *Sex Roles*, 2012, Vol. 66, No. 3-4, p. 175; SHAFFER, E., MARX, D., PRISLIN, R.: Mind the Gap: Framing of Women's Success and Representation in STEM Affects Women's Math Performance under Threat. In *Sex Roles*, 2013, Vol. 68, No. 7-8, p. 460; CANNING, E. et al.: STEM Faculty Who Believe Ability Is Fixed Have Larger Racial Achievement Gaps and Inspire Less Student Motivation in

scientific communication channels related to STEM careers. However, this male-dominated gap shows itself in the STEM field and every institution and field globally.[20] Many studies show the gender gap in the STEM field.[21] That there are more men than women in science, technology, engineering and mathematics careers can be explained by the underrepresentation of women in STEM fields for various reasons such as prejudice, discrimination and gender stereotypes. Today, these stereotypes in the field of gender persist. Botella et al. argue that women in STEM fields face many barriers. At the beginning of these difficulties, they list the lack of mentors, lack of female role models, unequal opportunities and gender-based prejudices. They claim that the solution to this is a gender-sensitive cultural evolution.[22] Moreover, Eaton et al. emphasise that understanding the underrepresentation of women and racial minorities in STEM requires examining racial and gender biases and how they intersect.[23]

Representation refers to the fact that essential elements such as places, objects, events, cultural identities and other abstract concepts are built-in any medium – especially in the mass media.[24] At this point, representation is inevitably selective and puts some things in the foreground and other elements in the background; while doing this, it should not be forgotten that it requires interpretation, and the meaning is subject to individual interpretation. Representation always involves the construction of reality from a particular perspective. Representation systems are tools by which it is framed to create ways to look at texts through ideologies, and these value systems frame issues. For this reason, the representation in media studies is related to gender, race, ethnic identity, etc. It is discussed that gender, race, ethnic identity and the representations in the media texts have positive and/or negative effects on the audience.

Mass media, especially TV shows and films, play an essential role in constructing the *status quo* for the audience. The representations in films and television dramas give clues about how society should perceive stereotypes. Dyer states that people develop a "schema-stereotype" for the social group with their 'mental cookies'. Stereotypes can not only be seen as scornful, but they also have a propensity to serve intent.[25] For instance, as Steinke states, when female scientists have appeared in the mass media, they have often been under-represented and depicted in ways that have marginalised their contributions and have perpetuated cultural myths about science as an inappropriate career for most 'ordinary' women.[26]

Much research suggests that real-life role models have a strong influence on the development of STEM identity.[27] However, some research suggests that even fictional role models in the media can have almost the same impact as real-world role models.[28] This is especially strong for people who live in places that do not have

Their Classes. In *Science Advances*, 2019, Vol. 5, No. 2, p. 3; CASAD, B., HALE, P., WACHS, F.: Stereotype Threat among Girls: Differences by Gender Identity and Math Education Context. In *Psychology of Women Quarterly*, 2017, Vol. 41, No. 4, p. 520.
20   AMARASEKARA, I., GRANT, W.: Exploring the YouTube Science Communication Gender Gap: A Sentiment Analysis. In *Public Understanding of Science*, 2019, Vol. 28, No. 1, p. 69.
21   See also: SMITH, E.: Women into Science and Engineering? Gendered Participation in Higher Education STEM Subjects. In *British Educational Research Journal*, 2011, Vol. 37, No. 6, p. 1013; REINKING, A., MARTIN, B.: The Gender Gap in STEM Fields: Theories, Movements, and Ideas to Engage Girls in STEM. In *Journal of New Approaches in Educational Research*, 2018, Vol. 7, No. 2, p. 148.
22   BOTELLA, C. et al.: Gender Diversity in STEM Disciplines: A Multiple Factor Problem. In *Entropy*, 2019, Vol. 21, No. 1, p. 3-5.
23   EATON, A. A. et al.: How Gender and Race Stereotypes Impact the Advancement of Scholars in STEM: Professors' Biased Evaluations of Physics and Biology Post-doctoral Candidates. In *Sex Roles*, 2020, Vol. 82, No. 3, p. 127-129.
24   See also: HALL, S.: *Representation: Cultural Representations and Signifying Practices*. London : SAGE, 1997; MOSCOVICI, S.: Social Representation and Pragmatic Communication. In *Social Science Information*, 1987, Vol. 33, No. 2, p. 163-177.
25   DYER, R.: *The Matter of Images*. New York : Routledge, 1993, p. 160.
26   STEINKE, J.: Portrayals of Women Scientists in the Mass Media, International Companions to Media Studies Content and Representation Volume. In MAZZARELLA, S. (ed.): *The International Encyclopedia of Media Studies*. Bromsgrove : Blackwell, 2013, p. 1-18.
27   See also: CHEN, C., SONNERT, G., SADLER, P. M.: The Effect of First High School Science Teacher's Gender and Gender Matching on Students' Science Identity in College. In *Science Education*, 2020, Vol. 104, No. 1, p. 75-77; CHIMBA, M., KITZINGER, J.: Bimbo or Boffin? Women in Science: An Analysis of Media Representations and How Female Scientists Negotiate Cultural Contradictions. In *Public Understanding of Science*, 2010, Vol. 19, No. 5, p. 609-611; FOGG-ROGERS, L., HOBBS, L.: Catch 22 – Improving Visibility of Women in Science and Engineering for Both Recruitment and Retention. In *Journal of Science Communication*, 2019, Vol. 18, No. 4, p. 4; STEINKE, J.: Adolescent Girls' STEM Identity Formation and Media Images of STEM Professionals: Considering the Influence of Contextual Cues. In *Frontiers in Psychology*, 2017, Vol. 8, p. 716; STEINKE, J., APPLEGATE, B., PENNY, J.: Effects of Diverse STEM Role Model Videos in Promoting Adolescents' Identification. In *International Journal of Science and Mathematics*, 2022, Vol. 20, p. 255-257; VERHOEVEN, M., POORTHUIS, A. M. G., VOLMAN, M.: The Role of School in Adolescents' Identity Development. A Literature Review. In *Educational Psychology Review*, 2019, Vol. 31, p. 35.
28   See also: FLICKER, E.: Between Brains and Breasts – Women Scientists in Fiction Film: On the Marginalization and Sexualization of Scientific Competence. In *Public Understanding of Science*, 2003, Vol. 12, No. 3, p. 307; FILOSO, K.: *Female Adolescents' Perceptions of Self, of Their Television Fictional Role Models, and of Their Real-World Role Models: An Exploratory Study*. Ohio : The Ohio State University Proquest Dissertations Publishing, 1974; GEHRAU, V., BRÜGGEMANN, T., HANDRUP, J.: Media and Occupational Aspirations: The Effect of Television on Career Aspirations of Adolescents. In *Journal of Broadcasting & Electronic Media*, 2016, Vol. 60, No. 3, p. 465-467.

easy and direct access to many STEM professionals. Steinke indicates the relationship between gender and STEM, claiming that media representations of female scientists have reinforced gender stereotypes through images that minimise female scientists' expertise and concentrate on the struggles involved in counterbalancing women's professional and personal lives. This shows women in professional roles as submissive to male supervisors, advises female scientists are potentially placed behind male scientists and features women and men interacting in ways that reveal overt and subtle forms of stereotyping and discrimination against women.[29]

Women's and men's representations in mainstream media support the patriarchal ideology. All mass media products, such as films, TV shows or print news, have consistently emphasised gender gaps and negated 'Other' except hegemonic masculinities. Brooks et al. highlight that the media, therefore, reproduce gender stereotypes; demonstrate and reinforce gender segregation through the cultural industry.[30] Besides, as Goodall discusses, individuals are influenced by the content produced by the media following the broadcasting policies of the means of communication and messages of open/secret gender discrimination in the contents.[31]

While mass media and its productions, such as popular films, are so critical in manipulating people, where does STEM representation stand in this importance? In their study, Johnson et al.[32] and Steinke[33] state that male scientists are portrayed significantly more than female scientists. Men and women are similarly depicted according to their professional, marital and parental status. Moreover, science images convey general science information and often reflect societal stereotypes present in mass media (for example, depictions of science and scientists in movies, novels or comics). The representation of science exceeds the possibilities of the image. Yet science has a collective and popular vision. The products we see in popular culture products build this mental image. On the other hand, Kirby proposes the term "diegetic prototypes" and states that in popular narratives, the plot is rationalised, character interactions and narrative structure are developed, and narrative prototypes are created.[34] This allows the character's depiction in the story to be controlled and normalised by people. As Kirby points out, although there is a growing literature on film science, this literature covers a wide range of approaches from various disciplines, including sociology, communication, film studies, history, literature, science fiction studies and cultural studies which utilise different methodologies. For example, according to Kirby, as in science and news media studies, the discovery of science communication in popular movies raises the question "How is science represented?".[35]

3 Research Objectives and Methodology

The main objective of this study is to seek answers to these research questions:

RQ1: Does STEM produce an ideology with/or against the traditional rigid values that serve the dominant ideology in these films?

RQ2: Are all STEM areas represented as male-dominated?

29   See also: STEINKE, J.: A Portrait of a Woman as a Scientist: Breaking Down Barriers Created by Gender-Role Stereotypes. In *Public Understanding of Science*, 1997, Vol. 6, No. 4, p. 409; STEINKE, J.: Women Scientist Role Models on Screen: A Case Study of Contact. In *Science Communication*, 1999, Vol. 21, No. 2, p. 113; STEINKE, J.: Reinforcing Cultural Representations of Gender and Science: Portrayals of Women Scientists and Engineers in Popular Films. In *Science Communication*, 2005, Vol. 27, No. 1, p. 27-29.
30   BROOKS, D. E., HEBERT, L. P.: Gender, Race, and Media Representation. In DOW, B. J., WOOD, J. T. (eds.): *The SAGE Handbook of Gender and Communication*. Thousand Oaks : SAGE, 2006, p. 297.
31   GOODAL, H.: Media's Influence on Gender Stereotypes. In *Journal of Media Asia*, 2012, Vol. 9, No. 3, p. 161.
32   JOHNSTON, C.: Women's Cinema as Counter Cinema. In ERENS, P. (ed.): *Sexual Stratagems: The World of Women in Film*. New York : Horizon Press, 1979, p. 140.
33   See also: STEINKE, J.: A Portrait of a Woman as a Scientist: Breaking Down Barriers Created by Gender-Role Stereotypes. In *Public Understanding of Science*, 1997, Vol. 6, No. 4, p. 409; STEINKE, J.: Women Scientist Role Models on Screen: A Case Study of Contact. In *Science Communication*, 1999, Vol. 21, No. 2, p. 113; STEINKE, J.: Portrayals of Women Scientists in the Mass Media, International Companions to Media Studies Content and Representation Volume. In MAZZARELLA, S. (ed.): *The International Encyclopedia of Media Studies*. Bromsgrove : Blackwell, 2013, p. 1-18.
34   Compare to: KIRBY, D. A.: *Lab Coats in Hollywood: Science, Scientist, and Cinema*. London : Massachusetts Institute of Technology, 2010.
35   See: KIRBY, D. A.: *Cinematic Science*. New York, London : Routledge, 2008.

RQ3: Though popular films do not destroy traditional gender roles or even reproduce these roles, where do hit blockbusters stand on STEM and gender representation?

Examining how social injustice, gender and diversity (or lack thereof) are represented in culture is very important as cultural products such as mainstream films are powerful vehicles for communicating science ideas and concepts. Research on science in fiction and film is expanding rapidly; therefore, it is useful to consider it in the context of science communication. Thus, it will be possible to explain the social relationship with the STEM fields and reach measurable and verifiable results on mass media's social facts. When it comes to big budgets in films, it is all about action and sweeping melodrama; on the other hand, philosophical thoughts and scientific details are little included.[36] However, to what extent are these scientific details kept in the foreground in contemporary big-budget films?

This research uses textual analyses to understand the social relationship with the STEM fields, and the situation of STEM male and female characters in the films, mainly those mentioned above. This method enables people to understand the meaning in the construction of certain speeches, words, images and characters depicted on cultural and media platforms.[37] In this study, the words, images and characters of popular mainstream movies targeting the general audience worldwide and the features of these characters, such as body language, are analysed by the text analysis method. Jäger states that there is a tendency to use language widely in cultural and media studies and that language should not be neglected in communicative and symbolic terms.[38] Moreover, Jäger describes qualitative content analysis in mass media as a *"comparative research of the selected mass media's themes and interrelation between the main and subsidiary themes in mass media".*[39] A textual analysis allows for a natural and flexible examination of the cases studied at cultural and individual levels. Jäger states that language is effective in creating meaning.[40] Thus, meanings can be found in the STEM characters represented in these movies. By examining the context, sentences and representations used in these famous films produced recently, the similarities between them and the desired message can be determined. Thus, it is understood how STEM characters in popular movies are identified, coded and represented by text analysis.

In this study, films are used as the study's sampling. Films are included based on their relevance[41] for the research and they are well-known among a broad audience. Films included in the research cover the period starting with the year 2015 up to the present, and it is intended to cover the representation of STEM professionals in the last decade. Moreover, popular films with a high budget were included in this study. A mainstream film should earn about twice its budget at the box office, so it can be said that the budget spent for that film and the box office success should be in harmony and that it is a high-concept film. Especially popular films with STEM characters and themes were preferred in this study. The list of popular films[42] produced with STEM themes after 2015, which are involved in the research, follows.

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36   MORRIS, D.: *Narrative, Ethics, and Pain: Thinking with Stories*. New York, London : Routledge, 2004.
37   See also: STAM, R.: *The Theory and Practice of Film Adaptation*. Pordoneno : Domitor, 2001; GÜRKAN, H., BIGA, N. T.: Women's Narratives Inhibiting Scopophilic and Voyeuristic Views: Woman as the Saviour in Contemporary Turkish Women's Films. In *Feminist Media Studies*, 2022, p. 1-15. Published on 21st March 2022. [online]. [2022-07-20]. Available at: <https://doi.org/10.1080/14680777.2022.2055106>; LAZAR, M. M.: Feminist Critical Discourse Analysis: Articulating a Feminist Discourse Praxis 1. In *Critical Discourse Studies*, 2007, Vol. 4, No. 2, p. 141-143.
38   Compare to: JÄGER, L.: *Sprache als Medium politischer Kommunikation. Zur diskursiven Ordnung des Politischen in der Medialen Wissensgesellschaft*. London : Vortrag, 2003.
39   Compare to: JÄGER, L.: *Sprache als Medium politischer Kommunikation. Zur diskursiven Ordnung des Politischen in der Medialen Wissensgesellschaft*. London : Vortrag, 2003.
40   Compare to: JÄGER, L.: *Sprache als Medium politischer Kommunikation. Zur diskursiven Ordnung des Politischen in der Medialen Wissensgesellschaft*. London : Vortrag, 2003.
41   Remark by authors: Every film has at least one or more STEM characters in its narrative. These STEM characters are central to the narrative.
42   Remark by author: The budget and box office revenues were obtained from: *The Numbers*. [online]. [2022-05-26]. Available at: <https://www.the-numbers.com>.

Table 1: Popular films produced with STEM themes

Film's Title	Released (Year)	Budget	Worldwide Gross
The Aeronauts	2019	40.000.000 USD	6,628,720 USD
The Hummingbird Project	2019	16.000.004 USD	1,108,905 USD
The Current War	2019	30.000.000 USD	12,868,552 USD
Driven	2019	92.000.000 USD	103,035 USD
The Boy Who Harnessed the Wind	2019	29.000.000 USD	
Radioactive	2018	20.000.000 USD	2,878,528 USD
First Man	2018	70.000.000 USD	105,703,325 USD
The Founder	2017	25.000.000 USD	24,403,192 USD
Arrival	2016	47.000.000 USD	202,863,303 USD
The Odyssey	2016	21.000.000 USD	9,491,587 USD
Hidden Figures	2016	25.000.000 USD	231,771,716 USD
The Man Who Knew Infinity	2016	10.000.000 USD	12,382,122 USD
Joy	2015	60.000.000 USD	101,134,059 USD
Steve Jobs	2015	30.000.000 USD	35,579,007 USD
Spare Parts	2015	4.000.000 USD	7,517 USD
The Martian	2015	108.000.000 USD	653,609,107 USD

Source: This table is based on the data from the website: The Numbers. [online]. [2022-05-26]. Available at: <https://www.the-numbers.com>.

Arrival, Hidden Figures, and *The Martian* are examined amongst the films in this list in accordance with their budget and worldwide gross. As a result, analysing films will allow us to answer the research questions and formulate conclusions for the benefit of the scientific community and the different interest groups. The main methodological premises of this study can be summarised:

• Thematic analysis: by establishing the units of analysis and determining the themes that are most significant for the research in terms of content;
• A categorisation of the results facilitates the elaboration of a new paradigm with the most compelling indicators of STEM representation that provide a solid basis for creating new knowledge around the representation of individuals in STEM in films.

4   Findings and Discussion

Diversity of STEM Characters in Contemporary Popular Films

Each character with STEM expertise in the films analysed was included. These characters were coded not only as research scientists or academics but also as people operating in any of the fields of science, technology, mathematics and engineering. At this point, the types of STEM expertise can be classified as follows:

Table 2: STEM fields of the characters in the analysed films

Science	Technology	Engineering
Astronomy/Astrophysics	Computer Science	-
Physics	-	-
Earth Science	-	-
Mathematics	-	-

Source: Own processing

As seen in Table 2, each STEM field is included in the narrative in recent popular films. While science and its sub-fields, astronomy, astrophysics, physics, earth science and mathematics, are more represented in these fields, computer science is given a place in the technology field. On the other hand, the engineering field is also included in the narrative; however, the detail is not given. Each character in the films was coded according to the importance of their role in the story: the main character, the supporting character, etc. In general, 22 characters are specified.

Table 3: The features of the characters in the films

Film	Character	STEM Identity	Protagonist/ Antagonist/ Supporting	Gender	Sexual Orientation	Race/ Ethnicity
The Martian	Mark Watney	Astronaut and the Botanist	Protagonist	M	N/A	White Anglo-Saxon
The Martian	Melissa Lewis	Astronaut and the Biologist (The Captain)	Supporting	F	N/A	White Anglo-Saxon
The Martian	Beth Johanssen	Astronaut	Supporting	F	N/A	White Anglo-Saxon
The Martian	Teddy Sanders	Director of NASA	Supporting	M	N/A	White Anglo-Saxon
The Martian	Rick Martinez	USAF officer, Engineer	Supporting	M	N/A	Latin American
The Martian	Chris Beck	Astronaut	Supporting	M	N/A	White Anglo-Saxon
The Martian	Alex Vogel	Chemist and Astronaut	Supporting	M	N/A	German
The Martian	Vincent Kapoor	Scientist	Supporting	M	N/A	Indian-African-American
The Martian	Bruce Ng	Scientist	Supporting	M	N/A	Asian-American
The Martian	Mindy Park	Communication Engineer	Supporting	F	N/A	White Anglo-Saxon
The Martian	Rich Purnell	Physicist and Rocket Scientist	Supporting	M	N/A	Afro-American
The Martian	Tim Grimes	Engineer	Supporting	M	N/A	Middle Eastern
The Martian	Zhu Tao	Scientist	Supporting	F	N/A	Asian-American
The Martian	Guo Ming	Scientist	Supporting	M	N/A	Asian-American
Hidden Figures	Dorothy Vaughan	Mathematician	Protagonist	F	Heterosexual	Afro-American
Hidden Figures	Katherine Johnson	Mathematician	Protagonist	F	Heterosexual	Afro-American
Hidden Figures	Mary Jackson	Engineer	Protagonist	F	Heterosexual	Afro-American
Hidden Figures	Al Harrison	Head of Research Centre	Supporting	M	Heterosexual	White Anglo-Saxon
Hidden Figures	Paul Stanford	Statistician and Theorist	Supporting	M	Heterosexual	White Anglo-Saxon
Hidden Figures	John Glenn	NASA Astronaut	Supporting	M	Heterosexual	White Anglo-Saxon
Arrival	Louise Banks	Linguistics Professor	Protagonist	F	Heterosexual	White Anglo-Saxon
Arrival	Ian Donnelly	Theoretical Physicist	Protagonist	M	Heterosexual	White Anglo-Saxon

Source: Own processing

This table shows that the gender distribution of the characters in the recent popular films is almost equal. Considering that popular films construct the male language and serve the male gaze,[43] it can be seen that these films position the woman or man at the centre of their narratives. However, these narratives are not 'male' narratives. In these films, the values of being human and scientist are conveyed to the audience, which is sometimes lived in a genderless way (without emphasising the importance of being male or female). At this point, these films construct an ideology against the dominant ideology, especially in STEM, character and gender representation.

The STEM area of expertise is (almost) clearly outlined in the films analysed. However, as mentioned above, the presence or absence of diversity in STEM role models in popular films reinforces and/or destroys stereotypes and suppresses STEM identity in underrepresented groups. Increasing the diversity of STEM characters, in particular, can positively affect society. In addition, contemporary popular films provide much-needed role models for people who do not see others like themselves in STEM roles. *Hidden Figures*, for example, is built around three STEM fields – technology, engineering and maths. The three women at the film's centre (Dorothy, Katherine and Mary) deliver a positive message with their perseverance and diversity. On the other hand, in *The Martian*, Mark Watney builds a positive image for the audience in the field of science with his determination and common-sense features. In *Arrival*, within a narrative equipped with science such as linguistic relativity, gravitational shifts and optical image analysis, intense depth is given to a female linguist character who works in an organised manner with naturalists and is defined as a "mathematician". This is not a frequent occurrence in popular film narratives.

Interpreting These Popular Narratives

An interpretation scheme was developed following the literature review. First, attention should be paid to the fact that the films included in the sample are: a) popular films, b) high-budget, commercial and entertaining films accessible to large audiences; and c) works that show the close relationship their narratives and characters have with STEM. Then, the general categorisation of the films was determined by determining 4 categories as follows:

1. "Science is the hero."
2. "Science is still male dominated, however, promising for women."
3. "These are not male narratives."
4. "Science may be fun too."

While the characters in these films come to the fore with their intelligence and scientific knowledge, they are far from the usual depictions of scientists, such as nerdy/geeky and alone in the scene. These characters are also far from the typical gender coding. In the analysed film narratives, the following can be listed regarding the prominent topics related to the construction and depiction of STEM characters.

"Science Is the Hero"

While these films emphasise the importance of scientific problem solving, they also show that science cannot proceed with the strict rules that it should have. The characters of the films examined reveal the idea of making space and science research more accessible shortly, with proper study and creative thinking. The understanding that modernism focuses on a single truth and a single meaning that can be reached follows

43   See also: DE LAURETIS, T.: Aesthetic and Feminist Theory: Rethinking Women's Cinema. In *New German Critique*, 1985, Vol. 34, p. 154; MULVEY, L.: Visual Pleasure and Narrative Cinema. IN BRAUDY, L., COHEN, M. (eds.): *Film Theory and Criticism*. New York : Oxford University Press, 2009, p. 262-272; KAPLAN, A.: *Women & Film: Both Sides of the Camera*. New York, London : Routledge, 1983.

the philosophy of multiple realities and implications instead of a single concept in postmodernism. These films deconstruct the postmodern understanding, criticising positivism's acceptance of empirical knowledge and objective scientific actions through characters. On the other hand, science is a long process that rarely comes up with clear solutions and is always a field brimming with caveats and qualifications. However, the film 'normalises' science and the protagonist deals with science, portraying it as does everyone else and allowing the audience to identify with the character.

For example, the hero of *The Martian* survives with intelligence, determination, genius and stubbornness. The hero is aware of the conditions he is in and is sensitive to these conditions, responsible, produces solutions, radiates positive energy, exhibits a patient, tolerant, consistent, determined attitude, and is described as a scientist with a high level of emotional intelligence.

On the other hand, *Arrival* can be defined as a more understandable and 'for the public' narrative. In the film, a linguist needs to talk about communication and how important language is in her first meeting with a natural science scientist and to explain how important science is. These scholars think that the official language of mathematics and science will be a form of communication, and the film opposes this idea.

With this feature, the film is different from other similar ones. In the film *Hidden Figures*, the scientific knowledge and vision behind every step of Dorothy, Katherine and Mary become the hero of both them and humanity. Dorothy's discovery of the newly established IBM system being able to perform tens of thousands of calculations per second, Katherine's relationship with numbers as a mathematical genius and her calculations, and her ability to predict when and in which coordinates the spacecraft might be, and Mary's engineering education at the university, which is her determination to step into the engineering field, which is suitable for Anglo-Saxon men, is a depiction of the heroization of science through these characters.

In these narratives, science is portrayed not as an enemy but as a trusted companion, a secret weapon, and a force for good.

"Science Is Male-Dominated Field, But Promising for Women"

While these films break down gender stereotypes, they also challenge the masculine perception of the STEM field. Considering that men dominate the scientific world, sexism and harassment continue in the STEM field, as many professionals in the industry show daily. Popular films break this perception. Contrary to the usual, these popular STEM-themed films feature female role models – even a little (*Hidden Figures* is based entirely on the story of black women). On the other hand, when it comes to science, technology, engineering and mathematics, it is a known fact that the references that women have to follow are built within the framework of masculine principles. The high-budget popular films examined show women's contribution to the field of technology. In addition, although men are portrayed as directors and heroes in these films (as in *The Martian, Hidden Figures, Arrival* films), the message is given to the audience that they cannot achieve this success without the support and cooperation of women.

In the film *Hidden Figures*, three STEM fields – technology, engineering and mathematics – are narrated through three black women. Entrepreneur Dorothy discovers the IBM system's capacity to perform tens of thousands of calculations per second and teaches her and her team to prepare for this digital disruption, advancing her team and making careers sustainable when 'human computers' wear out. The mathematician Katherine Johnson, principal Dorothy Vaughan and engineer Mary Jackson in the film can exist as subjects in the male and white-dominated NASA, albeit of different colours and genders, in 1960s America. On the other hand, in the film *Arrival*, Louise is portrayed as a strong woman. She takes out the flawed, short-sighted men who run the First Contact programme. She exhibits multiple identities like all humans, is depicted as a keen linguist, a loving mother, and a grieving woman.

"These Are Not Male Narratives"

Popular narratives appear to praise and foreground masculinity. The fact that masculinity is problematised in popular narratives and becomes a leading theme or that masculinity expresses its inner logic is due to universal rather than local reasons.[44] On the other hand, there exists a masculinity crisis caused by the rise of women's movements in the world and their taking their rights step by step, the loss of power of the middle class and the mainstream male head of the family, and the fact that capitalism transitioned to a different phase and the rise of poverty and insecurity intertwined.

Furthermore, the fact that women work like men has been a factor that weakens the power of men and accelerates the transition to the nuclear family instead of the extended family. As a result of this development, patriarchy based on blood or lineage, that is, masculine domination based on the undisputed authority of the older man is disappearing in most parts of the world. In summary, a situation where a biological, cultural, economic or ideological reason that would legitimise men being superior and before women is in question in daily life; a similar situation is in question in popular texts.

Feminist critics claim that what is universal in every field is not the male subject but the gendered subject. The idea that different issues can have different understandings and stories has begun to settle. With this thought, some of the men who received criticism about women began to rethink men and women by questioning themselves. For example, we see an exhilarating gender role reversal where Louise Banks' science partner, Ian Donnelly, is a less complex character used as a tool to deepen her own story. *Hidden Figures* puts women, even African American women, at the centre and showcases their STEM adventure. The film documents the gender imbalance in the STEM fields.

"Science May Be Fun Too"

These films surround science with its top ideology, 'entertainment', to popularise science. Recent popular films eliminate the seriousness of science and create a perception of science in the audience by adding entertaining and pleasurable tools and activating and motivating thinking with narrative. These productions are blended with entertainment and presented to the audience. In the words of Postman, entertainment is the upper ideology of any discourse in the narrative. The criticism brought to entertainment as the top doctrine is not the emphasis in entertainment-themed programmes; it is the imposition of entertainment on the viewer as a natural framework. The main point of criticism is that all narratives are presented as entertainment and pleasure, regardless of the genre or theme. Popular narratives aim to keep the audience on screen for as long as possible. At this point, these popular narratives portray science as an entertainment element. This vital mission of popular narratives presents the pursuit of pleasure as the source of happiness. The audience quickly consumes the pleasure without any effort. Emotional contentment is an ideal goal.[45]

'Intellectual' activities such as questioning and criticising are never mixed into this purpose. In this respect, these films present science and science-related things by incorporating an entertainment element, apart from the narrative format of classical Hollywood cinema. In addition, the characters in these narratives are also portrayed as entertaining. For example, in *The Martian*, Mark Watney can make jokes about bad food and music, even when he is in trouble. *Arrival*'s Louise Banks is introduced while teaching at a university. She has a calm yet confident and charismatic demeanour, and while she is entirely satisfied with her abilities, she is not portrayed as being smug or overconfident. In these films, the scientists are the problem-solvers, survivors and doers; they grow gardens and create codes. These narratives, which show science as magic, lead the audience to expect more from science than it should.

44   See also: HOLLINGER, K.: *Feminist Film Studies*. New York : Routledge, 2012; GÜRKAN, H., EGE, Ö.: Gendering Turkish Action Films in the Post-2010 Period: "Hey Boy, Protect Me and Don't Cry!" In *Studies in European Cinema*, 2023, Vol. 20, No. 1, p. 4-7.
45   See: POSTMAN, N.: *Amusing Ourselves to Death*. New York : Penguin Books, 2005.

5 Conclusion

This study claims that recent high-concept popular films include alternative characters other than existing STEM identities, which builds a positive perception in the audience. This study supports the development of an interdisciplinary research agenda by examining the problematisation of STEM fields in popular texts based on a mismatch of the 'STEM problem'. The STEM issue crystallises around issues where gender and sexuality intersect – and clearly around masculinity – and have political, socio-economic, criminological, ethical, even racial and cultural dimensions. The multidimensionality of the STEM problem requires interdisciplinary research, especially in Western societies.

This study argues that the inclusion of diversity in popular texts from a gendered, sexualised and even racialised perspective due to the nature of globalisation and neoliberal processes, instead of seeing the STEM issue as a means of erasing existing boundaries and differences, would make the audience more reconciled with these texts. Moreover, this study demonstrates that, with the increasing popularity of science, female scientists are represented 'as they are' and how they portray their femininity in this field. However, this study shows that stereotypes in STEM are changing, and more visible female role models are being represented. Today, STEM studies must break out of the restrictive framework of the nation-state and critically reposition gender and cinema in an innovative and diverse configuration that enables the study of power and knowledge relations between and within cultures and nation-states. Frankly, given that women and others still make up a tiny percentage of the STEM workforce, there need to be better role models for aspiring girls and multi-ethnics in the audience, and these popular texts do just that. Moreover, these popular films deconstruct the dominant STEM ideology and its depictions and stereotypes.

These narratives break down the male and female stereotypes constructed by their predecessors. Instead, they project more positive images as innovative, social and harmonious scientists who do not place science at the centre of life. In these narratives, the STEM world goes beyond traditional representational patterns. For example, scientists are more flexible and understandable characters, and science is portrayed as a hero that saves lives and solves problems, not isolates people. Recent popular films do not build their narratives around men like the previous ones. Still, these are films in which men and women are depicted in solidarity, and both genders are independent subjects, even though they show masculine narrative features. In these films, the audience identifies with the characters, and these films differ from their previous counterparts with their independent and strong male and female STEM characters. These films can be coded as films that produce ideology against the dominant ideology and patriarchy, especially regarding STEM, character and gender representation. There is a positive change in the hierarchical order in the STEM field and the representation of women and Others. And these representations do not have any marginalisation.

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