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Social Construction and Acting "Gendered" Networks in Science Communication

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ABSTRACT

This article presents a research focus on key theories concerning the concept of social construction within the context of Science and Technology, with a particular focus on the relationship between gender and science. Our aim, through qualitative research that combines a literature review with the analysis of Science and Technology Museum reports, non-participant observation of educational programmes and interviews with professionals and parents, is to explore whether Science and Technology; as socially constructed domains; contribute to the formation and/or reinforcement of concepts that are shaped more by social than by cognitive or technical factors, and which inherently carry gender stereotypes. It was therefore observed that Science and Technology are socially constructed concepts, whose meanings are shaped by the networks and contexts within which they are framed. These networks; whether originating within the scientific community or involved in the communication of scientific concepts; shape both the production and the consumption of scientific knowledge. They interact with, interpret, and integrate scientific data into society through the lens of the social stereotypes they embody, both as individual units and as interconnected systems. In doing so, they contribute to the maintenance of a gendered culture that normalises the absence of the female gender from scientific discourse and information.

1. Introduction

Science and technology are often presented in public discourse as neutral, objective fields, free from social influences. Yet, sociological and feminist studies have demonstrated that scientific knowledge is socially constructed within networks of institutions, practices, and symbolic frameworks (Latour & Woolgar, 1979; Keller, 1978). Gender, plays a central role in this construction: societal inequalities and stereotypes are embedded in scientific discourse and

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practice, often marginalising women and framing science as predominantly male (Longino, 1990; Cameron, 2023; Collet & Dillon, 2019; Davila et al., 2021).

Science and technology museums exemplify this dynamic. While presented as neutral spaces for public education, they actively shape social norms and identities through exhibitions, educational programmes, and public engagement (Armstrong & Lock, 2023). Curatorial choices often reinforce women's absence from science, reproducing gendered narratives and shaping public perceptions of scientific authority and participation (Dawson et al., 2020; Sismondo, 2016).

This study investigates how science and technology are communicated and perceived through gendered networks, positioning museums as sites where collective consciousness and social norms are formed and reproduced (Durkheim, 1949; Boyer, 2024). Drawing on the social construction of science, Actor-Network Theory (Latour, 1983), and feminist critique, the study introduces the concept of gender networks, through which norms, roles, and exclusions in science organised and legitimised.

Using qualitative methods, including non-participatory observation, interviews, and focus group, the research documents how museum practices contribute to reinforcing or challenging gender stereotypes in science communication (Yang et al., 2024; Martin-Gamez et al., 2022). Museums, as informal educational spaces, play a key role in shaping perceptions of STEM participation, highlighting the ongoing persistence of male-centred narratives and the need for more equitable science communication (Rieger, 2016; Dawson et al., 2020)

1.1 Social Construction of Science and Technology

The idea that science and technology are socially constructed fields was introduced dynamically in the 1970s with studies in the sociology of science (Latour & Woolgar, 1979). The authors argued that the "production of scientific facts" involves negotiations, conventions and social practices rather than purely objective observation. Knowledge is therefore not absolute or independent of context but is constructed within networks of scientists, institutions, funding mechanisms and cultural perceptions.

In the same vein, Sismondo (2016) emphasises that science must be understood as a social system, in which rules and practices shape what is considered "valid" or "legitimate" knowledge. Objectivity is collectively constructed by these networks, rather than inherently given. This perspective does not relativise science but highlights how social and cultural forces shape its production and communication. Consequently, science communication in museums and science centres conveys meanings that reflect societal hierarchies, rather than neutral knowledge.

1.2 Gender and Science: From Neutrality to Bias

Since the 1970s, feminist critiques have shown that science, despite claims of neutrality (Bowler & Morus, 2012), has historically been male-centred, institutionally and symbolically excluding women (Keller, 1978; Merchant, 1982; Longino, 1990, 2002). Gendered assumptions persist in scientific theories and methods, as seen in the portrayal of fertilisation (Sismondo, 2016) or the marginalisation of figures like Rosalind Franklin (Perez, 2019). Longino (2002) argues that objectivity arises from pluralism and critical dialogue rather than context-free neutrality.

Technology studies similarly reveal that women are positioned primarily as consumers and excluded from knowledge production (Cowan, 1983; Wajcman, 2010; Haraway, 1985).

Contemporary evidence confirms ongoing gender biases in AI systems, specifically the incorporation of gender stereotypes into objects that are ostensibly considered neutral. (Collet & Dillon, 2019; Zhou et al., 2024). Also, the "Matilda effect" in science, that is the attribution of women's scientific achievements to male colleagues (Goyanes et al., 2025; Cameron, 2023), and male-biased biomedical research (Martin-Gamez et al., 2022). Perez (2019) identifies the "gender data gap," where the absence of female-focused data shapes scientific practices and technological design, reinforcing structural inequities.

Science communication plays a key role: unequal gender representation in museums, media, and education reproduces stereotypes, whereas inclusive communication fosters equitable knowledge production (Bucchi & Trench, 2021; Vickery et al., 2023; Bennet et al., 2022). Persistent associations of science with male qualities influence societal expectations and girls' self-perceptions. Overcoming these biases requires diverse epistemic communities that interrogate the social and gendered conditions shaping scientific knowledge (Longino, 2002; Fausto-Sterling, 1985, 2021). Neutrality remains problematic when built on exclusionary norms, highlighting that the creation and dissemination of scientific knowledge is embedded in broader social dynamics (Perez, 2019).

1.3 Actor – Network Theory

Actor-Network Theory (ANT), as originally developed by Bruno Latour (1983) and his colleagues, is an analytical tool for understanding science as a network of multidimensional interactions among human and non-human actors, including scientists, institutions, exhibits, technologies, and the public (Latour, 1983; Law, 1992; Elder-Vass, 2020). In science communication, museums, science and technology centres serve as central hubs where knowledge is not only transmitted but co-constructed through relationships among exhibits, interpretations, and diverse user groups (Hetland, 2019; Verbeek, 2015).

Technoscience, embedded in its social context, is actively shaped through interactions within these networks (Sismondo, 2016). Scientific claims emerge from networks of people and machines, which are in turn connected to structures of power, economy, and institutionalised knowledge production (Latour & Woolgar, 1979; Latour 2005; Sismondo, 2016; Jasanoff, 2016). Coexisting actors with divergent values can produce theories reflecting both natural phenomena and social or regulatory function (Sismondo, 2016; Popper, 1979; Stergiopoulos, 2013). A characteristic example is the history of hysteria, which illustrates how socially constructed scientific categories can persist over centuries, regulating behavior, particularly of women (Perez, 2019; Paulon, 2022).

Technoscience also shapes broader cultural norms and social classifications (Keller, 1978; Haraway, 2016), though its language often remains inaccessible to wider publics (Feminist Critical Policy Analysis II, 2020). In conclusion, ANT and contemporary approaches to Science and Technology Studies highlight the importance of networks of actors as key units of production and distribution of scientific knowledge, with the coexistence of social, cultural, and technological factors shaping the field of technoscience (Christensen & Conradi, 2020; Jasanoff, 2016; Sismondo, 2016), but also society itself.

1.4 Collective Consciousness as a Foundation

In this study, collective consciousness is a central analytical tool, encompassing the shared values, rules, and perceptions that shape societal networks. As Durkheim (1949) noted, it explains how societies generate and perpetuate norms and stereotypes. The communication of scientific knowledge through museums and similar institutions not only informs but also shapes

identities, legitimises specific social relationships, and defines what is considered valid and important (Boyer, 2024). Gendered networks operate within this collective consciousness (Carvalho, 2021), influencing visibility, voice, and exclusion. Science is often represented as a "male" pursuit, a mechanism that sustains gender gaps in education, the workforce, and public life (Eren, 2022). Collective consciousness is dynamic, continuously reproduced through institutions, such as education, politics, and culture (Boyer, 2024), incorporating gendered perceptions of objectivity and ability that affect how science is legitimised and communicated (Carvalho, 2021; Eren, 2022). Thus, museums and science centres do not simply function as networks that convey information; they function as spaces of collective consciousness, where values and norms about gender and science are reinforced or challenged.

1.5 Acting “Gendered” Networks

The contribution of this research is the introduction of the concept of gender networks. Instead of treating scientific networks as neutral, we approach them as structures shaped by collective gendered consciousness. Within these networks, male presence is constructed as the normative form of scientific authority, while women’s contributions are systematically marginalised or rendered invisible.

Gender networks operate as complex systems of language, symbols, institutional practices, and collective memory, normalising women’s absence even in the absence of deliberate exclusion. From this perspective, museum practices, such as exhibit selection, presentation, and interpretive strategies, function not only educational activities but as mechanisms for reproducing collective gender consciousness in science.

1.6 Reproduction of Gender Inequalities

The combination of social construction, active networks, and collective consciousness, when transferred to the level of gender, shows how inequalities are systematically reproduced. Collective consciousness produces value systems about who belongs in science. These frameworks are incorporated into the gendered networks of museums and science centres and ultimately gender inequalities are legitimised as "natural" or "self-evident." Thus, the originality of the study lies in highlighting science and technology museums and centres not only as places of education, but as mechanisms of social construction, where collective consciousness shapes gender networks that in turn reproduce gender inequalities.

1.7 Science and Technology Museums and Centres as Political and Cultural Actors

The literature now recognises science museums not as neutral learning spaces, but as cultural and political agents (Armstrong & Lock, 2023). Their exhibitions, educational programmes, and activities constitute mechanisms of governance, insofar as they convey values, ideas, and social norms. Dawson and her colleagues (2020) showed that girls often face narratives limiting their identity; even when actively engaging, exhibits remain focused on male scientists, requiring girls to assert their presence in spaces not designed for them. Through virtual representations and educational programmes, they mediate reality, reinforce hierarchies, including gender divisions, and guide public understanding and action, while also functioning as sites for learning, recreation, and non-formal education.

2. Methodology

The study was guided by three research questions:

1. How are Science and Technology socially constructed?
2. How do networks reinforce gendered perceptions?
3. What role do museum play in shaping these narratives?

2.1 Research Approach

This study adopts a qualitative research approach in order to examine the social and cultural processes that shape the production and communication of techno-scientific knowledge in science and technology museums. Qualitative methods were selected for their capacity to explore both the phenomena under study and the meanings attributed to them by participants within specific social and cultural contexts (Creswell, 2013).

The research design combined multiple qualitative techniques, non-participant observation of exhibitions and educational programmes, interviews and a focus group. This multi-method design enabled data triangulation and strengthening the interpretive validity of the findings.

The choice of this approach reflects the need to understand science as a socially constructed practice and to explore the role of gender within science communication. For this study, "power" refers to how networks influence others, such as families shaping behaviours based on their beliefs and science centres acting according to sponsors, scientific communities, and employee ideologies, often shaping outcomes regardless of objective knowledge. By drawing on multiple sources of data, the study captures both institutional practices and lived experiences, offering a understanding of how gendered assumptions are reproduced or challenged within museum-based science communication.

2.2 Sample and Research Instruments

Our case study centred on Science and Technology Museums in Greece, with emphasis on the periodic exhibition "Life in Space", as a case study. The research included three categories of participants. Museum professionals (curators, museum educators, programme managers), who help shape the narrative of science. Visitors – parents, who perceive and interpret the content through the lens of their family experiences. Groups of children/students, 4 to 7 years of age, who experience the exhibition directly as part of their educational curriculum.

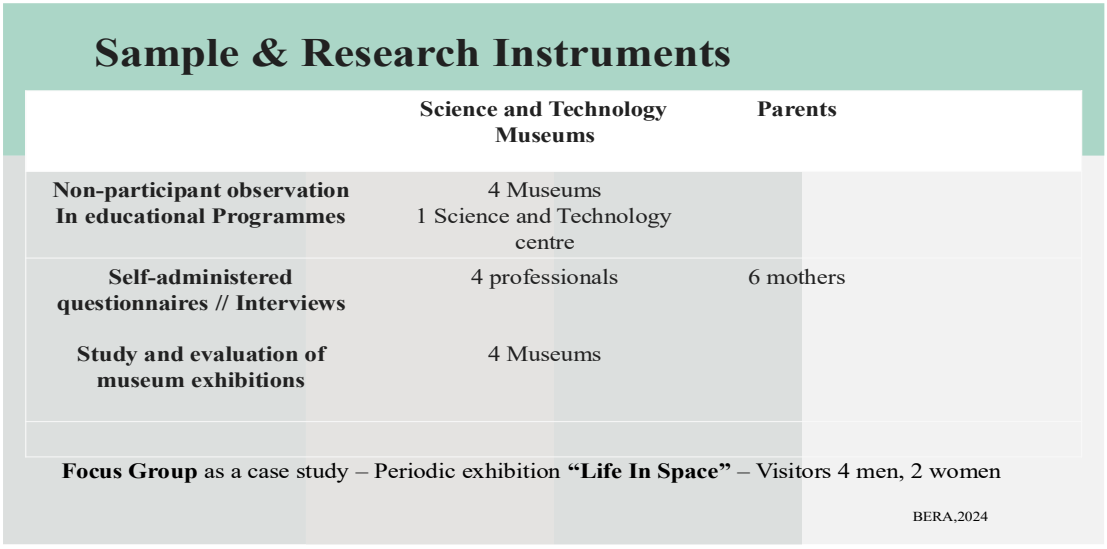

Figure 1. Sample & Research Instruments

The study employed three research instruments. A non-participatory observation of exhibitions and educational programmes documented narrative strategies (Li, 2024), gender visibility, linguistic and visual representations, the presence or absence of female figures and patterns of visitor engagement. Semi-structured interviews with museum professionals and parents investigated material selection, the implicit or explicit integration of gendered elements, the pedagogical role of educators and anticipated visitor interpretations. Finally, a focus group conducted during the "Life in Space" exhibition examined participants' perceptions of scientific representation, recognition of female presences, and interpretations of the exhibition's broader scientific and technological messages.

2.3 Data Analysis

The data analysis was based on thematic analysis, with the aim of identifying and categorising issues related to the social construction of science and gender representations in the process of communicating science and technology through science and technology museums. Thematic analysis of interviews and focus group revealed the following key themes: science communication through science and technology museums; the gender gap in science and technology; collective consciousness and inclusion; and acting networks.

The triangulation of data, strengthened the validity of the findings and allowed for more reliable conclusions to be drawn. In addition, the research was conducted in accordance with the ethical principles of educational and social research (BERA, 2024). All participants were informed of the purpose of the research, gave their consent, and their anonymity was ensured. The data were used exclusively for research purposes.

3. Findings

The findings presented below draw on data from non-participant observations of exhibitions and educational programmes, semi-structured interviews with museum professionals and parents, and a focus group conducted during the "Life in Space" exhibition. This multi-method approach enabled data triangulation, capturing both institutional practices and participants' perspectives.

3.1 Science Communication through Science and Technology Museums

Science communication is a multifaceted concept with fluid boundaries, often defined either in terms of objectives or in terms of outcomes (Dimopoulos, 2021; Christidou et al., 2019). For this reason, one of the central questions posed to museum professionals and parents was how they themselves define science communication and how they perceive its implementation through museum exhibitions and activities. This question aimed to explore the extent to which contemporary understandings of science communication align with visitor's scientific literacy and with institutional practice. Both professionals and parents highlighted, based on interviews and observations, that science communication involves making technoscientific knowledge accessible, meaningful, and engaging for diverse audiences. They emphasised the importance of popularisation, interaction, and moving beyond linear exhibition formats, using all available means, exhibits, images, digital tools, and audiovisual productions, to ensure that scientific information is comprehensible and captivating for the public.

Although responses shared common ground, notable differences emerged, particularly in the interpretations offered by parents, who demonstrated a sophisticated understanding of the broader aims of science communication. They highlighted the development of new skills, scientific literacy, and the relevance of science to everyday life. Science communication was

seen as encompassing the teaching of children about the necessity of science for societal development, spanning areas from medicine to agriculture, communications, and manufacturing.

In terms of how science communication is achieved through museums, participants, as observed during visits and reported in interviews, emphasised a combination of exhibitions, educational programmes, workshops, lectures, and organised events. The pivotal role of the museum educator was repeatedly noted, particularly in guiding visitors' understanding through technical means and the incorporation of historical contexts of scientific and technological artefacts. Parents reinforced the importance of the educator's engagement, noting that interactive elements and encouragement significantly enhanced children's learning experiences. Early and repeated exposure to museums, especially in cooperation with primary school teachers, was also highlighted as essential for cultivating familiarity and interest in science from a young age.

Finally, the selection of exhibits was discussed, with participants stressing that exhibits should engage with contemporary environmental and societal issues, fostering awareness and promoting active learning. On the contrary some professionals noted that the exhibit selection is determined by the museum's director who "reconstructs" exhibits. Although this may suggest a more object-centred and hierarchical model, the term "reconstruction" also implies the potential for contextualising objects historically and socially. We would say that following the above interpretation comes the response of professional B, which emphasises that exhibits:

"...serve concepts that need emphasis..."

In short, for an exhibition to be created must be based on a specific theme and the selection of exhibits provides a lens to critically assess the assumed neutrality of previous displays. Exhibits are not merely objects but carriers of messages shaped by their social, political, and cultural contexts (Kokkou et al., 2009). While an individual exhibit may not convey a fixed meaning, its inclusion allows the overall narrative to emerge, enabling visitors to interpret both the objects and their context.

Although participants responses vary, museum and science centre professionals generally emphasise object meanings and an anthropocentric approach, aligned with modern museum learning theories. Parents, as part of contemporary society, can understand concepts and integrate new information into science communication, highlighting the need for further research on their scientific literacy and role in this process. Understanding curatorial decision-making, prioritised concepts, and institutional influences on exhibited meanings remains a key challenge, to be addressed in the following section.

3.2 Collective Consciousness and Acting "Gendered" Networks

This section investigates how the interactions and norms within different networks affect science communication and the perception of gender in science. Because science communication is closely tied to museum and science centre exhibitions, the discussion focused on who determines the concepts emphasised, the objects selected, and the relationships among those involved. Across responses, cooperation between members and networks emerged as a key theme. At the same time, some participants acknowledged that, depending on the context, hierarchical power relations may be present and may partially shape science communication, noting that relationships are generally harmonious and aligned with institutional goals, alternative viewpoints are discussed, yet final decisions ultimately rest with the exhibition curator.

However, regarding the extent to which science communication is influenced by elements of hierarchy/power, professional B observed that:

> *"…even the selection of one topic over another, the over, or under, exposure of an aspect constitute expressions that reflect power relations."*

This reference highlights how the relationship of a network, or even an individual, can influence the functional role of objects. These are not the exhibits themselves, but the objects behind the scenes that shape how science is communicated. We interpret this observation as an indication that technological and representational tools used in exhibitions, lighting, positioning, emphasis, narrative sequencing, function as instruments of science communication whose effects depend on the intentions and values of the actors controlling them. Even subtle curatorial decisions structure visitors' interpretive pathways and consequently, shape the epistemic hierarchy of the exhibition.

Therefore, drawing on Durkheim's (1949) theoretical framework, in which collective consciousness serves as the foundation through which values, perceptions, beliefs, and rules shape how individuals see, think, and act, it can be argued that these sets also influence the communication of science. This influence occurs wherever communication takes place, as long as the bearers of these sets remain active forces in the process of creating out such communication. In consequence, any active force, whether a network or an individual, that employs tools to carry out the communication of techno-science inevitably influences the outcome of that communication. This is because their involvement introduces specific values and beliefs into the process, which operate, often subconsciously, with a subjective character. At the same time, these actors may hold the conviction that they are acting under the umbrella of scientific objectivity, even as their choices and interventions subtly shape the meaning, reception, and direction of the communication itself.

This discussion then turned to participants' understandings of inclusion within museums and science centres. The aim was to assess (a) whether professionals recognise inclusion as a core institutional value, (b) whether inclusion coexists hierarchical or exclusionary structures, and (c) whether current practices explicitly acknowledge or seek to address gender divisions. Participants consistently defined inclusion as the non-exclusion of social groups, with a strong emphasis on religion, language, and mobility. Notably, no participant explicitly mentioned gender. Although their definitions could implicitly accommodate gender, exclusion in museum practice. When asked whether they observe gendered differences in children's engagement with exhibits, responses diverged. Most participants recognised behavioural differences, attributing them to familiar and educational socialisation rather than innate tendencies.

Aç professional A mentioned:

> *"There is a difference in behaviour between the two genders [….]it is due to the lack of feminist education and the dominance of patriarchy."*

These reflections, based on interviews and observations, indicate that children's patterns of engagement with scientific content are shaped by early socialisation processes and by entrenched societal expectations. Parents similarly described gendered behaviours as "normal", indicating a naturalisation (Pearce, 2002) of segregation in both every day and museum settings. Such comments highlight how gendered expectations shape not only behavioural norms but also group formation and interpretive practices in museum environments. These findings align with scholars emphasising that gender identity and gendered patterns of engagement with knowledge, is formed through intertwined biological and social processes in early childhood (Dierking & Falk, 1992; King et al., 2022; Li, 2024). Families and schools often reproduce long-standing gender norms, legitimising particular behaviours as appropriate

for boys and girls. Consequently, the science-related preferences and interpretive frameworks of children and adults alike are conditioned by these networks of socialisation. These observations raise important concerns about the type of knowledge disseminated during early socialisation and education, particularly through the formal educational institutions responsible for empowering critical thinking and neutral behaviours.

In reality, childhood is considered particularly important both in terms of how knowledge is approached, and in relation to children's general behaviour towards issues related to society, such as gender (Elsayed, 2024). Childhood shapes the type of education an individual receives, as societal expectations determine what is considered typical or expected for a child. Both family and school follow long-established social norms, where male dominance, in general, is normalised and often treating children as immature and justifying mandatory participation in the education system. This system typically prioritises disciplinary knowledge through a linear approach, while the development of social skills is often secondary. Such neglect is rationalised by entrenched perceptions that individuals behave in certain ways according to their gender, which are deemed acceptable or justified. In practice, children depend on their parents and school communities, adopting behaviours shaped by the power of these social networks. The way children approach scientific knowledge is influenced by the educational approach, their age, and their individual interests.

Age plays an important role in the formation of the individual, in gender identity which does not only refer to biological characteristics but includes the characteristics of the individual's personality, interests and self-categorisation. The child understands his own identity (Dierking & Falk, 1992; King et al., 2022; Li, 2024) and that of those around him through a biological and social process especially during early age. From the moment they understand gender, they also associate the type of behaviour that suits their gender according to the stereotypes and expectations of the society in which they live (Maccoby, 1998; Li, 2024).

Participants reflected, through both interviews and focus group discussions, on the broader relationship between gender and science, highlighting that science and technology are not neutral domains. Persistent stereotypes, such as the association of scientific expertise with men or the disproportionate attention given to female infertility over male infertility, demonstrate that gendered assumptions remain embedded in scientific practice and its public communication. Scientific findings themselves can inadvertently reinforce these expectations when communicated without reflection. At the same time, they may lead to the search for knowledge from unreliable sources, potentially undermining trust in scientific institutions. Participants also emphasised that these biases affect men as well as women, illustrating that gendered perceptions permeate scientific knowledge production and dissemination. As one parent noted, scientists have historically focused on female infertility, while the male body is still often considered “perfect,” reflecting how societal ideas of gender continue to shape scientific narratives and public understanding (Perez, 2019).

Finally, participants observed that although science ostensibly addresses all members of society, public imagery continues to privilege male scientists, often reflecting historical patterns rather than contemporary realities. Evidence from participants highlights that science and technology are socially constructed, shaped by institutional, educational, and cultural networks that intersect with gendered assumptions, influencing both the production and consumption of knowledge. Scientific outputs can become tools for reinforcing stereotypes. This reproduction of biased knowledge involves not only socialisation from childhood but also experts whose personal beliefs shape public perceptions of scientific objectivity. These reflections point that Science and Technology are socially constructed. Their meanings are

framed by networks, institutional, educational, that influence both production and consumption of knowledge. These networks shape what is considered valid, relevant, or even "scientific".

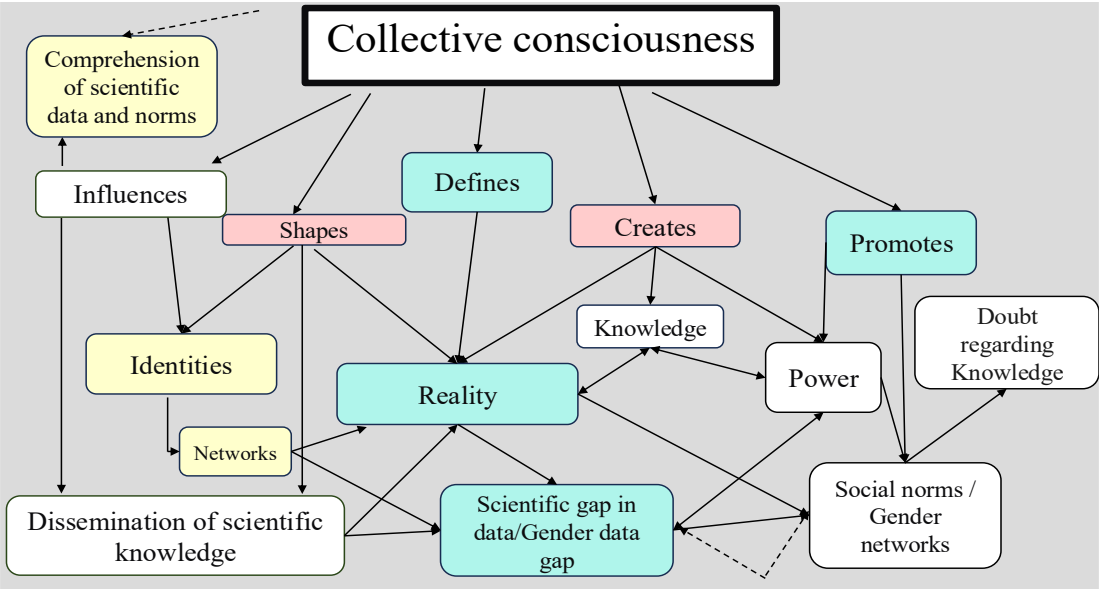

Figure 2. Collective Consciousness

For this reason, science and technology museums, as non-formal education providers, should offer everyone the opportunity for choice and free expression, presenting scientific knowledge objectively and inclusively. This approach helps prevent a scientific data gap and allows individuals to engage with a complete, unbiased picture of science, rather than fragmented views shaped by beliefs or gender divisions.

3.3 Gender Gap in Science Communication through Science and Technology Museums

Gender stereotypes are present at every level, in visuals and language used in exhibitions, in the roles of educators and experts, in who is encouraged, or discouraged, to participate. Observations indicated that even the design elements of a museum such as lighting play a role in meaning-making (Gobbato, 2022).

Therefore, within the context of inclusion and collective consciousness regarding their influence on the individual and consequently on the communication and understanding of scientific knowledge, questions were raised regarding the equal representation of the two sexes by museums/science centres, as well as the participation of the general public in this equal representation. Responses varied depending on the aspect discussed. Regarding staff, some participants noted a higher proportion of female employees, while regarding exhibitions and actions, questions arose about the naturalisation of unequal gender representation. When asked if gender equality is reflected in the museum's inclusive practices, most participants limited their responses to staff composition and the established belief that primary education is mainly dealt with by women and not men. For many decades, the prevailing view was that women have an affinity for specific forms of knowledge (Martin, 1991; Retentzi, 2003; Almeling, 2023), such as primary education. The perceptions reflect longstanding stereotypes reinforced from early childhood through formal and informal education (Martin, 1991; Korlat et al., 2021). These perceptions shape behaviours, expectations, and professional development, influencing which professions are considered appropriate for each gender (Babercheck, 2001; Orenstein, 1994; De Gioannis, 2022).

Indeed, considering what is most commonly observed, especially in Greek society, then we will conclude that we rarely hear about a male early years educator. It seems as the profession is culturally associated with femininity, motherhood, and care. Such views limit both genders, steering children away from "non-traditional" careers like teaching for boys or science and mathematics for girls, while perpetuating outdated assumptions about women's sensitivity and caregiving roles (Rossiter, 2001). These patterns demonstrate how the power of familiar knowledge shapes societal behaviours, interests, and expectations.

As professional B observed:

> *"In many cases, it is considered necessary to display some of the exhibits[...]so that they serve the concepts that need to be emphasised."*

This highlights the influence of networks and individuals on the functional role of objects within exhibitions. Decisions such as lighting and emphasis can unconsciously highlight male-centered achievements, creating a "scientific data gap" in the interpretation of exhibits. This response refers to the use of technological products for the communication of techno-scientific knowledge itself, and how these means, when controlled by specific people or networks, can influence or not the communication of science. For instance, more illuminated exhibits naturally attract more attention, leaving others in the shadows. Educators further influence this narrative, as each has the freedom, as professional C noted, to add personal touches that shape the visitor's experience.

In this light, the participants were asked the question of what they believe is the reason why actions/exhibitions on women in science are held mostly for a specific amount of time. The purpose of the question was to investigate to what extent the tradition of gender division has invaded the functions and the "reasoning" of museums/centres of science and technology. Professionals A and D noted that there is a wider lack of awareness of gender inequality, enabling isolated initiatives while constraining ongoing engagement and deeper critical discussion. Professional D argued that the restriction of exhibitions or actions related to women in science to specific days of the year is attributed, first, to the perceived absence of publicly recognised historical sources linking women to concrete techno-scientific achievements, and second, to the limited visibility of relevant initiatives, noting that few, if any, such actions are effectively communicated to the wider public.

These responses illustrate the persistence of the gender data gap (Perez, 2019), whereby women's contributions to science and technology have been historically underrepresented, affecting both scientific objectivity and public knowledge. As professional D noted the actions related to women in science are mot many but they are more than the days dedicated to men in science. Although the actions concerning men are related to the highlighting of specific figures each time, the contribution of, for example, a specific person to science, while the actions for women mainly concern the need to highlight all women in Techno-science or their approach to engaging in Techno-science.

The point is not to compare genders by the number of dedicated days, but to show that the nature of the actions differs: men are recognized for individual achievements, whereas women are highlighted collectively. This grouping does not address the deeper issue, which, as professional A mentioned, prevents serious discussion. True equality requires representing individuals based on abilities rather than gender, ideally eliminating gendered distinctions or special days. The goal is to close both scientific and gender data gaps, ensuring an objective understanding of science and society. Participants agreed that museums have the capacity to promote equal representation through institutional resources and societal collaboration. Nevertheless, as Parent I noted:

"…the museum needs to dig deeper into history and bring to the surface all the important forms of science regardless of gender."

Museums, through their multifaceted role, can provide a foundation for gender equality and have contributed to improving women's involvement in science. However, this alone is insufficient; a broader deconstruction of societal gender culture is necessary. This responsibility extends beyond museums to all actors involved in education and social institutions. As participant T noted, achieving gender equality requires considerable effort from society. These findings indicate that museums alone ensure gender equality; broader societal change involving families, schools, and state institutions is needed, as persistent stereotypes continue to shape public perceptions of science and reinforce gendered barriers.

3.4 Focus Group – Periodic Exhibition "Life in Space" as a Case Study

In the context of this research, and in order to evaluate visitors' views on science communication by museums and gender representation six visitors to the *LIFE IN SPACE* (2023) periodic exhibition were asked about the methods used to communicate techno-scientific achievements. Although researchers did not introduce gender topics, participants independently raised concerns regarding gender visibility, informational gaps, and missing key contributors, while also reflecting on child-friendliness, accessibility and communicative effectiveness.

Participants were randomly selected to balance gender representation ad reduce researcher bias. Discussions focused on impressions of organisation, clarity, and standout elements. While the theme received positive feedback, visitors noted limitations including a small number of exhibits, limited interactivity, and difficulty accessing or understanding supplementary information. Similarly, technological features such as QR codes did not always enhance understanding. During focus group discussions, participant OE2 remarked that audio descriptions were ineffective when the exhibition was crowded, while OE4 reported that he tried twice to scan the barcode to access the audio instructions, but it did not work, so he gave up. Some of participants emphasised the need for a mediator or guided group narrative to contextualise the exhibits and explain their scientific and technological significance. These observations highlight that technological enhancements alone do not guarantee successful communication; on the contrary, when not fully functional, they may confuse or even discourage visitors. As noted by participants, visitors often prioritise the visual impact of objects—such as a space capsule—over written or digital information, especially when access to such information is inconsistent.

Concerns regarding gender representation emerged repeatedly. Participants OE2 and OE3 stated that:

"…there was no mention of women […] We didn't see the female presence."

Although the absence of distinct female spacesuits reflects historical realities, NASA only recently produced suits tailored to women[1], the exhibition failed to contextualise this, leaving visitors with the impression of omission. As participant O2 noted:

"*We should have had this information."*

[1] https://spacecenter.org/artemis-astronaut-feature-anne-mcclain/

Participants also demonstrated awareness of women's contributions to space science, referencing (even if not by name) Valentina Tereshkova, as well as the "NASA Rocket Girls,"[2] whose computational work underpinned early space missions. OE3 stressed that representation should not be limited to astronauts. The absence, or minimal presence, of such information created uncertainty among visitors as to whether women were entirely omitted or merely underrepresented in the exhibition materials. This gap illustrates how gender data omission shapes the nature of scientific knowledge communicated to the public. As Pedretti and Iannini (2020) argue, contemporary museum practice must examine scientific processes rather than present science solely as an outcome. When exhibitions highlight predominantly male contributions, they risk reinforcing cultural rather than scientific narratives, contributing to what Perez (2019) calls both a gender data gap and, consequently, a scientific data gap. Participants proposed explanations for this omission. Specifically Participant OE5 attributed it to women's historically lower participation in missions, while OE1 emphasised that even a minority presence should still be adequately represented. On the other hand, Participant OE2 advocated for balanced representation, grounded in the idea that from the perspective of space, that we are all equal.

Ultimately, determining what and who is highlighted in techno-scientific narratives reflects broader power structures and cultural assumptions. Incomplete information not only silences specific contributors but also shapes public understanding of techno-science itself. As participants OE1 – OE5 revealed, contemporary visitors, far from being uninformed, actively follow scientific and technological developments and seek exhibitions that connect with, expand, and validate their existing knowledge.

4. Conclusions

The purpose of this research was to examine the extent to which the production and communication of techno-scientific knowledge within museums and science and technology centres rely on gender stereotypes and contribute to the maintenance of gender divisions, thereby shaping the knowledge disseminated to the public. Drawing on the bibliographic review, the study investigated science communication practices through the perspectives of professionals and visitors, focusing on the presence of gender dimensions in science and on the processes of knowledge production and dissemination, particularly in relation to the influence of gendered networks operating within a collective consciousness.

For the purposes of this research, an assessment tool was developed to examine science communication practices and the understanding of scientific ideas. The tool included non-participatory observation through visits to museums and science and technology centres, visits of permanent and temporary exhibitions, and attendance at educational programmes. It was complemented by a focus group interview and individual open-ended questionnaires, with the aim of obtaining a comprehensive view of participants' perspectives and enhancing the validity of the findings.

Regarding the results on science communication in museums and science and technology centres, the majority of participants, irrespective of their background, demonstrated a clear understanding of "Science Communication" and emphasised an anthropocentric approach. Interaction and visitor engagement were highlighted as key for fostering comprehension of basic techno-scientific concepts and supporting personal interpretation. Non-specialist participants displayed a relatively high level of scientific literacy, underscoring the need for

[2] https://www.nasa.gov/image-article/rocket-girls-advent-of-space-age/

further research into the public's role in science communication. Participants also stressed the importance of developing new skills and tools to effectively convey current and future techno-scientific developments and their societal relevance.

Perspectives on gender in science and the existence of segregation in museums were diverse. Some claimed that gender segregation no longer exists, often invoking the "modern era" without evidence, raising questions about the deep-rooted influence of collective consciousness and social stereotypes. Others, drawing on personal experience, acknowledged persistent gender segregation, noting that it affects both men and women rather than being solely a feminist concern (Perez, 2019). Regarding equal representation, participants recognised a higher proportion of female employees but rarely discussed exhibition content, suggesting either the absence of gender-focused initiatives or limited recognition due to normalised stereotypes. Analysing museum exhibitions through the lens of author, text, and reader (Porter, 2012) reveals a cycle in which gendered beliefs and stereotypes are embedded in socio-cultural and technoscientific practices, reproduced through exhibitions and educational programmes and internalised by visitors, even when actively engaged in learning. In essence, since science shapes society (Sismondo, 2016), meaning and interpretation are constructed within exhibitions and educational programmes and filtered through pre-existing societal knowledge.

Age was highlighted as crucial in shaping gender identity, which encompasses biological characteristics as well as personality, interests, and self-categorisation. From early age, individuals associate gender with behaviours deemed appropriate according to societal expectations (Maccoby, 1998; Leaper, 2022), which influence educational planning, daily behaviour, and future career choices. Participants noted that stereotypes are reinforced both by family and school, maintaining social norms that limit children's ability to pursue interests and skills freely. The rarity of male early years educators in Greece reflects entrenched associations of women with caregiving and motherhood, reinforced by cultural and educational systems. Even when some participants suggested gender divisions might not exist, contradictions in their observations indicate that the naturalisation of stereotypes continues to hinder an accurate understanding of gender dynamics.

In essence, the majority of responses underline the significant influence of family and school, which, however, carry entrenched perceptions that impose restrictions on both genders. The power of these networks' shapes children's behaviours and choices, as they adopt social norms dictated by their immediate environment. This transmission of values, beliefs, and rules imposes on children a structured way of seeing, thinking, and acting, perpetuated through the repetition of social behaviours (Pechtelidis, 2015). From birth, children are categorised as boys or girls and treated differently, a pattern consistent with research showing that gender expectations are internalised early via family, school, and cultural norms (Solbes-Canales et al., 2020).

However, the way children are treated influences their subsequent perception of the world and society (Cameron, 2023). Thus, a kind of social reality is created as a result of the actions and attitudes of people in power, which can have both positive and negative consequences. On the one hand, it can set rules of behaviour that promote harmonious and respectful coexistence among people. On the other hand, however, it can promote socially constructed concepts, such as gender.

Regarding the extent to which power/hierarchy relations affect the communication of science in museums/science and technology centres, it is particularly important that the participants' responses promote cooperation between members or networks (Cameron, 2023). However, participants highlighted that power and hierarchy in museums and science centres influence both interpersonal relationships and functional aspects of exhibitions, lighting, positioning, and

emphasis on objects, guide visitors' interpretation of scientific concepts (Durkheim, 1949; Boyer, 2024). While cooperation between networks remains important, the final authority often rests with museum heads or educators, whose personal beliefs may shape the presentation of content, contributing to scientific and gender data gaps, as seen in the *Life in Space* (2023) exhibition where female figures were absent. Overall, power dynamics, structural and interpersonal, affect how science is produced, communicated, and understood, including the representation of gender. Scientific communication is thus inevitably shaped by societal networks and frequently reflects male/female dualisms, reinforcing stereotypes and social inequalities. Participants emphasised that collaboration among museums, schools, and families provides a framework for educational programs that foster children's understanding of gender in science, promote reciprocal learning, and support learner-centred approaches, contributing to the reduction of gender-based divisions.

In conclusion, an anthropocentric approach to science communication was observed, placing the individual at the centre. However, the activist tendencies of museums, shaped by impermanent factors such as tools or personal beliefs, can compromise the objectivity of scientific communication. Incomplete scientific information, influenced by gendered networks, not only alters perceptions of science but also reinforces a gender data gap, perpetuating societal limitations and stereotypes. Social networks, including family and school, further shape perceptions of gender and individual freedom, highlighting the importance of critical thinking in reshaping collective consciousness. Techno-science is inevitably influenced by social norms, and institutions such as Science and Technology Museums risk transmitting knowledge whose objectivity is compromised. As Armstrong & Lock (2023) note, the representation of scientific knowledge in museums constructs science itself; when these representations predominantly focus on males, they reinforce the cultural assumption that male equals universal, deepening both gender and scientific data gaps (Perez, 2019).

The cooperation of museums, families, and schools is both essential and promising: it fosters interaction and education while improving gender equity in science and society. Given that this study is small-scale and qualitative, its findings cannot be generalised. Further research with a broader range of institutions and participants of all genders is needed to strengthen conclusions. This work lays a foundation for national and international development, aiming not only to contribute to research on gender in science and society but also to illuminate gender stereotypes in science communication. Effective science communication relies on the collaboration of these networks to challenge established knowledge, counter stereotypical perceptions, and make science engaging and accessible to the public.

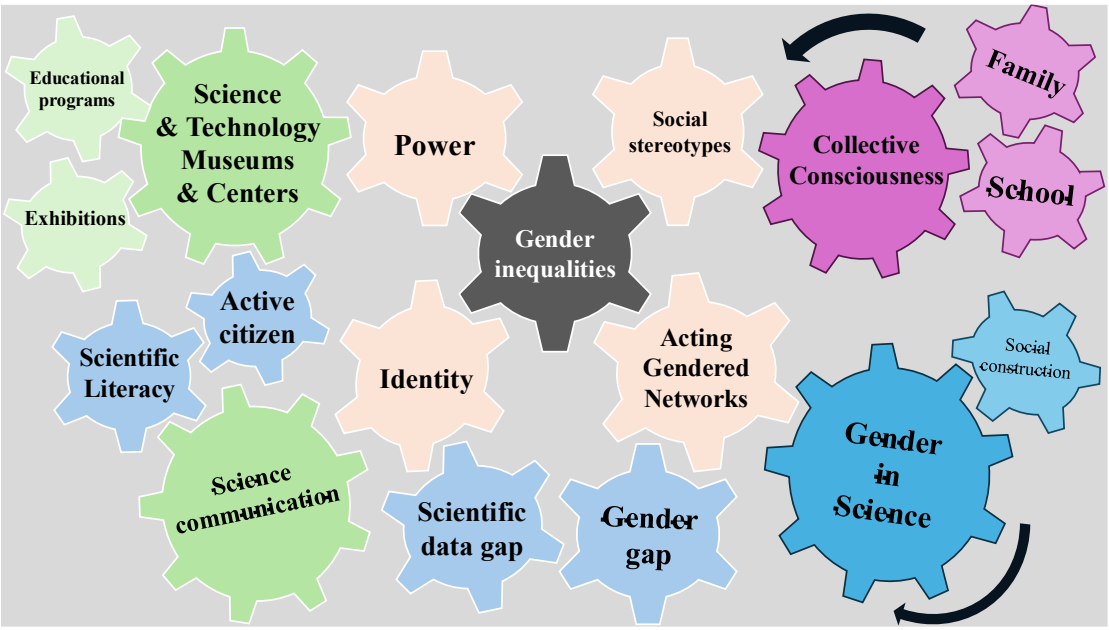

Figure 3. Acting Gendered Networks

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