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MUSEUM AS A SPACE FOR INTERDISCIPLINARY DIALOGUE BETWEEN SCIENCE, HISTORY, AND ART

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ABSTRACT

The article presents a comprehensive theoretical and analytical examination of the museum as a space for interdisciplinary dialogue between science, history, and art in the context of contemporary sociocultural transformations. It substantiates the argument that the modern museum transcends its traditional function of preserving cultural heritage and emerges as a dynamic cultural and educational platform in which

different types of knowledge and forms of communication are integrated. Particular attention is paid to the concepts of new museology and the participatory museum, within which the museum is conceptualized as a dialogical, inclusive, and socially oriented space that enables visitor participation in the process of meaning-making. Based on the analysis of international and Ukrainian scholarly research, as well as contemporary museum practices, the study identifies the key dimensions of interdisciplinary interaction within the museum environment—scientific, historical, and artistic—and reveals the specific features of their functioning and integration. The article proposes original conceptual models that illustrate: the interaction of these dimensions within the structure of the museum space; the interconnected dimensions of museum-content interpretation (cognitive, emotional, aesthetic, and critical); and the main mechanisms of interdisciplinary integration, including problem-oriented thematic exhibition design, the use of interactive and immersive technologies, artistic interpretation of knowledge, and dialogical communication with visitors. The analysis suggests that an interdisciplinary approach may enhance the educational and sociocultural potential of museums by fostering critical reflection, emotional engagement, an integrated understanding of complex phenomena, and public dialogue. The proposed conceptual models constitute a heuristic analytical framework that may inform further empirical research and the development of museum exhibitions and educational programs. However, their practical applicability and use as assessment instruments require further empirical testing.

Keywords: museum; interdisciplinarity; museum pedagogy; museum communication; science; history; art.

INTRODUCTION

In the contemporary world, the museum is evolving from a traditional institution focused on preserving artifacts into a dynamic cultural and educational space. Within this space, science, history, art, technology, and the social sciences interact and shape new forms of knowledge production and communication. This transformation is driven by changes in information dissemination, global cultural processes, and the reconsideration of the museum's role as a platform for public communication. Contemporary museums are increasingly integrated into the educational sphere and perform important functions in non-formal and informal education, particularly:

- in the historical and cultural dimension — as centers for preserving and shaping identity;
- in the sociological dimension — as platforms for civic dialogue;
- in the psychological dimension — through their influence on the emotional, cognitive, and reflective development of individuals, including aspects of art therapy and empathic practices.

There is a growing expansion of the museum's interaction with management, marketing, economic, and legal dimensions, which highlights its emerging role as an active participant in socio-economic processes and public discourse. A particular niche is occupied by environmental and climate-related issues, which position the museum as a space for fostering ecological awareness and a critical approach to sustainable development challenges.

Digital transformation also expands the possibilities of interdisciplinary museum communication. Virtual tours, multimedia installations, interactive educational platforms, and immersive environments move exhibitions beyond static visual presentation toward visitor-centred, multisensory participation (Yang et al., 2025). These formats bring scientific inquiry, cultural content, and aesthetic experience together within a shared communicative environment.

In international museum studies, the emergence of new museology marked a shift from treating museums primarily as technical institutions concerned with collection care toward critically examining their purposes, modes of representation, and social responsibilities. Vergo's edited volume (1989) framed new museology as a reconsideration of established museum theory and practice. Hooper-Greenhill (1992) subsequently demonstrated that museums participate in the production and organization of knowledge rather than merely transmitting neutral information. Bennett (1995) examined museums as public cultural institutions embedded in relations of governance, education, and power, while Macdonald's edited volume (1998) emphasized the socially and politically situated character of exhibitionary representations and the changing relationship between displays and their audiences.

Building on this theoretical reorientation, Simon (2010) conceptualizes the participatory museum as an institution in which visitors contribute to the creation, interpretation, and circulation of museum content. Participation, collaboration, and co-creation transform the visitor from a passive recipient of information into an active participant in museum communication and meaning-making. This approach supports an understanding of the museum as a dialogical and socially oriented environment in which different experiences, perspectives, and forms of knowledge may interact. A significant contribution to the theoretical understanding of interdisciplinary exhibitions has been made by Pleiger in the study *«Interdisciplinary Exhibitions and the Production of Knowledge: Perspectives from Curatorial Practice»* (Pleiger, 2024), where the necessity of a precise methodological definition of the concept of "interdisciplinarity" is emphasized, along with the development of conceptual models capable of describing the mechanisms of interaction among different disciplines within the museum context.

Ukrainian scholarly discourse is currently in an active phase of development in the field of interdisciplinary museum practices. Research by Ukrainian authors emphasizes that museum pedagogy, as one of the key areas of museum activity, has not yet established a consistent conceptual framework, and existing approaches are often fragmented in nature.

For instance, Olena Nevmerzhytska, in the article «Museum Pedagogy: Towards the Definition of the Concept» (Nevmerzhytska, 2023), highlights the lack of consistency in the interpretation of fundamental concepts in museum pedagogy and emphasizes the interdisciplinary nature of this phenomenon.

Similarly, Oksana Zuievych, in the work «Elements of Museum Pedagogy in the Educational and Methodological Support of the Educational Process» (Zuievych, 2024), draws attention to the insufficient methodological development of museum education and the need for comprehensive studies of the mechanisms underlying its implementation.

A significant contribution has been made by Oleksii Karamanov, who, in his doctoral research «Theory and Practice of Pedagogical Activity of Museums in the Contemporary

Educational Space of Ukraine» (Karamanov, 2020), conceptualizes the museum as an interdisciplinary educational environment where knowledge from history, pedagogy, cultural studies, art, and psychology intersects.

The collective monograph «Museum Pedagogy in Science Education» (Dovhyi, 2020) outlines directions for integrating science and museum communication within the framework of contemporary STEAM approaches, while simultaneously identifying the need for further theoretical rethinking of these processes.

In this context, the position of Nataliia Filipchuk is particularly noteworthy. She conceptualizes museum pedagogy as a theoretical foundation for the pedagogical and educational activities of educational and cultural institutions and emphasizes the necessity of systematic communication within the «museum–educational institution» model. In her work «Museum Pedagogy as a Theoretical Basis for the Pedagogical and Educational Activities of Educational and Cultural Institutions» (Filipchuk, 2020), the researcher argues that the implementation of the social mission of museums, as well as their educational and formative objectives, is ensured through the continuous renewal of content, forms, and methods of interaction with audiences. She further emphasizes that the effectiveness of museum communication is largely determined by the professional competence of the educator or museum practitioner, who is capable of organizing dialogical, subject–subject learning practices.

At the same time, Nataliia Filipchuk argues for the necessity of scientifically grounded training of museum educators within higher pedagogical education. This position aligns with current efforts to systematize and standardize the conceptual framework of museum pedagogy and to enhance its interdisciplinary potential.

Recent empirical visitor studies complement these conceptual approaches by demonstrating that museum engagement and learning are shaped not only by exhibition content but also by spatial organization, emotional and interpretative experiences, technological design, and social interaction. Using mobile eye tracking and recognition–memory testing, Krukar & Dalton (2020) found that the spatial arrangement of artworks influenced how visitors distributed their visual attention: more prominently visible works attracted greater attention, while the simultaneous visibility of several works affected the way attention was allocated among them. Artworks viewed for longer were subsequently more likely to be recognized. In an *in situ* study of Olafur Eliasson's installation art, Pelowski et al. (2018) identified differentiated emotional, evaluative, and meaning-making responses, showing that the interaction between an artwork and its spatial environment contributed to the character and depth of visitor engagement. An experimental study of an augmented-reality exhibit further demonstrated that meaningful learner control and multimodal interaction can support active engagement, inquiry, and knowledge acquisition (Lin et al., 2022). In a large naturalistic study involving 4,835 visitors across 47 science-centre exhibits, Machado Corral et al. (2021) found that interaction with facilitators significantly increased the proportion of visitors displaying deeper learning-associated engagement and identified comfort, information, reflection, and exhibit use as key dimensions of facilitation. These findings provide empirical support primarily for the cognitive, emotional, interactive, and social dimensions of museum experience, while the critical dimension requires further targeted validation.

Despite these contributions, museum interdisciplinarity still lacks a coherent analytical framework: the concept is used inconsistently, typologies of disciplinary interaction remain underdeveloped, and the communicative mechanisms of knowledge synthesis are insufficiently systematized. This gap has become more significant under conditions of digitalization and growing demand for museum formats that foster critical thinking, civic awareness, and active interpretation of historical and cultural content. A framework capable of describing the interaction of science, history, and art and the mechanisms through which visitors engage with such integration is therefore needed.

The aim of this article is to conceptualize the museum as an interdisciplinary cultural and educational space, to identify the key directions of integration between science, history, and art, and to outline methodological approaches that enable the systematization of mechanisms of interaction among different domains of knowledge. The proposed approach involves an analysis of existing theoretical interpretations and the development of a coherent model of interdisciplinary dialogue in the museum as a contemporary historical, cultural, and communicative environment.

In light of this objective, the subsequent presentation focuses on a systematic analysis of the museum as a space for interdisciplinary dialogue between science, history, and art. First, the theoretical foundations of this understanding of the museum are examined, followed by an exploration of the scientific, historical, and artistic dimensions of the museum environment and the specific features of their integration in interdisciplinary practices. This enables the delineation of the sociocultural significance of interdisciplinary museum experience and clarifies the role of the museum in the contemporary cultural and educational landscape.

METHODOLOGY AND RESEARCH DESIGN

The study is theoretical and analytical and combines conceptual analysis, a qualitative review of scholarly literature, and case-based analysis of contemporary museum practices. The proposed models synthesize approaches from new museology, the participatory museum, museum pedagogy, and interdisciplinary exhibition research. They are not empirically validated; their practical applicability requires comparative case studies and visitor research.

The case-based analytical material consists of a principal set of selected examples from European and international museums representing scientific, historical, artistic, and explicitly interdisciplinary institutional profiles. The cases were selected purposively to provide a range of institutional contexts relevant to the three analytical questions addressed in the study: the interaction of knowledge domains, the dimensions of visitor interpretation, and the mechanisms of interdisciplinary integration. Additional considerations included the use of interactive, digital, immersive, participatory, or problem-oriented exhibition formats; identifiable educational and communicative objectives; variation in institutional profile; and the availability of institutional or scholarly materials sufficient for contextual analysis. The selection was not intended to constitute a statistically representative sample or to support a systematic comparison of the institutions.

Three institutions from the principal case set—the Copernicus Science Centre, the POLIN Museum of the History of Polish Jews, and the Science Museum of the National Center “Junior Academy of Sciences of Ukraine”—were also visited in person by one of

the authors. These visits provided direct contextual familiarity with the spatial organization of exhibitions, interactive elements, artistic and scenographic solutions, and modes of communication with visitors. However, the observations were not conducted as a formal ethnographic or visitor study and were therefore not treated as an independent empirical dataset. Instead, they were used to contextualize and critically interpret information obtained from scholarly publications and official institutional sources.

The principal case set comprised the Copernicus Science Centre, the Deutsches Museum, the Science Museum of the National Center “Junior Academy of Sciences of Ukraine,” the POLIN Museum of the History of Polish Jews, Tate Modern, the ArtScience Museum, the Wellcome Collection, and the Ars Electronica Center. For the purposes of the conceptual analysis, the science-oriented institutions were considered primarily in relation to interactive science communication; the POLIN Museum in relation to historical narrative and exhibition scenography; Tate Modern and the ArtScience Museum in relation to artistic interpretation; and the Wellcome Collection and the Ars Electronica Center in relation to explicitly interdisciplinary formats. These analytical associations were used to organize the discussion and should not be interpreted as a standardized evaluation of the institutions or their effects on visitors.

Other museums discussed in the article—including the Museum für Naturkunde, the Science Museum in London, the Exploratorium, the MIT Museum, the Cambridge Museum of Archaeology and Anthropology, the House of European History, and the Imperial War Museums—are used as supplementary examples of particular exhibition or communication practices. They are not part of the principal case set used in the conceptual development of Figures 1–3. Both groups serve illustrative and contextual functions and are not used as a basis for statistical or universal generalization.

The construction of Figures 1–3 followed a three-stage conceptual synthesis procedure. First, recurring and theoretically significant categories were identified through a close reading of scholarly literature on new museology, the participatory museum, museum pedagogy, and interdisciplinary exhibition practices. The analysis focused on three interrelated questions: which domains of knowledge interact within the museum environment; which dimensions characterize visitors’ interpretation of museum content; and which exhibition and communicative mechanisms support an interdisciplinary museum experience. Second, the identified categories were compared with the selected museum cases in order to examine how they were manifested in different institutional, exhibition, and educational contexts. Third, conceptually related categories were grouped into analytical blocks, and the relationships among them were represented schematically.

Accordingly, Figure 1 was developed as a structural model representing the interaction between scientific, historical, and artistic domains of knowledge. Figure 2 was constructed as an interpretative model systematizing the cognitive, emotional, aesthetic, and critical dimensions of museum-content interpretation. Figure 3 was developed as a practice-oriented conceptual model that brings together the principal mechanisms through which interdisciplinary integration is implemented in museum practice: thematic integration, interactive and immersive technologies, artistic interpretation of knowledge, and dialogical communication with visitors. The empirical visitor studies discussed in the literature review were used as a secondary point of

comparison to assess the correspondence between selected components of the models and existing evidence concerning visitor attention, emotional and interpretative responses, engagement, and learning. They were not treated as the primary basis for constructing the models or as evidence of their full empirical validation. The three figures should therefore be understood as complementary heuristic models proposed for further empirical examination rather than as validated measurement instruments.

THE MUSEUM AS AN INTERDISCIPLINARY CULTURAL AND COMMUNICATIVE SPACE

Contemporary museums operate as communicative environments in which scientific concepts, historical narratives, and artistic forms are connected through exhibitions, educational practices, and digital media. This transformation reflects the expansion of museum education and the wider use of interactive, audiovisual, and multimedia tools for representing knowledge.

In her study, Denysiuk (2021) examined the role of digital technologies in this transformation, arguing that they reshape museum communication across several interconnected levels. Their influence extends to the representation of museum content, patterns of interaction with visitors, and the positioning of museums within the broader information environment. Visual communication is particularly important in this process because it structures the digital presentation of collections and contributes to constructing the museum's semantic field in virtual space. Digital tools also support musealization by providing new methods for adapting objects to exhibition and communication purposes.

Science, history, and art constitute three key semantic vectors within the museum environment, the combination of which enables a comprehensive, multilayered interpretation of reality. Science foregrounds a rational and empirical dimension, making it possible to demonstrate natural, physical, or technical phenomena through experiments, digital simulations, or interactive installations. History ensures the continuity of cultural memory, providing a framework for understanding the past, its relationship with the present, and its influence on the future. Art, in turn, opens access to emotional, axiological, and symbolic dimensions of knowledge, offers a visual language of communication, and generates imagery that makes complex ideas accessible to broad audiences.

The three domains included in Figure 1 were identified because they recur across the theoretical literature and the selected museum cases as distinct but interacting modes of representing and interpreting knowledge. The scientific dimension is associated with explanation, experimentation, and modelling; the historical dimension with contextualization, memory, and narrative; and the artistic dimension with symbolic, emotional, and value-based interpretation. Their intersections are illustrated by the Copernicus Science Centre and the Deutsches Museum, where scientific explanation is linked to historical and educational contexts; by the POLIN Museum, where historical narrative is combined with scholarly interpretation and artistic scenography; and by Tate Modern and the ArtScience Museum, where scientific and technological phenomena are interpreted through artistic forms. Figure 1 therefore presents a structural synthesis of recurring relationships rather than an exhaustive classification of museum practices.

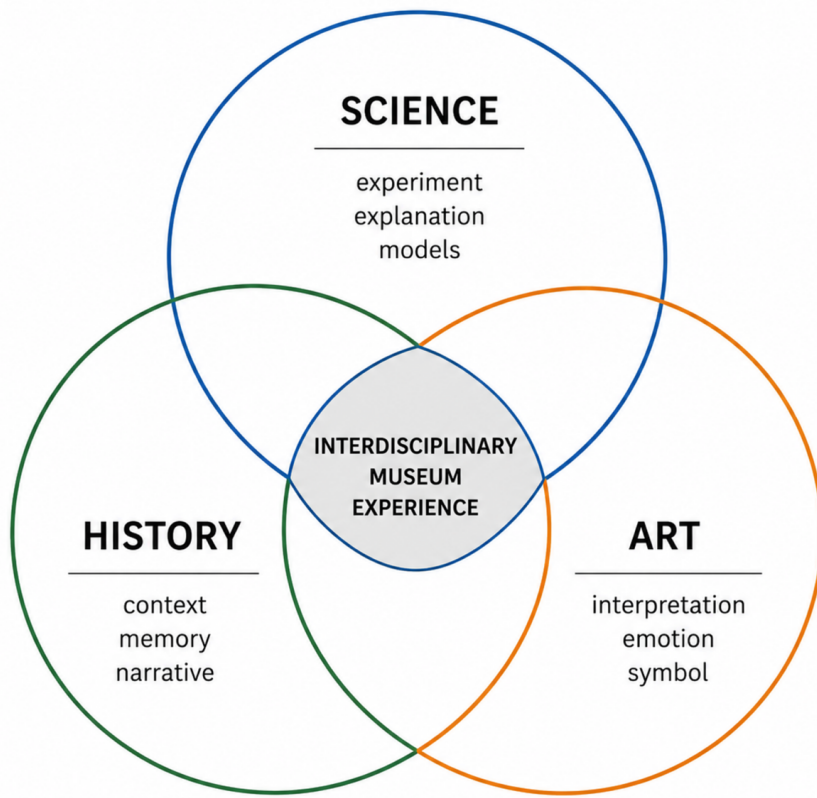


Figure 1. Conceptual model of the interaction between the scientific, historical, and artistic dimensions within the museum space

Source: Developed by the authors

Figure 1 presents science, history, and art as autonomous but interconnected dimensions. Science contributes explanation and modelling, history provides temporal and cultural context, and art enables symbolic, emotional, and value-based interpretation. Their intersection forms an interdisciplinary museum experience in which visitors can connect facts, narratives, and representations through cognitive, emotional, aesthetic, and critical engagement.

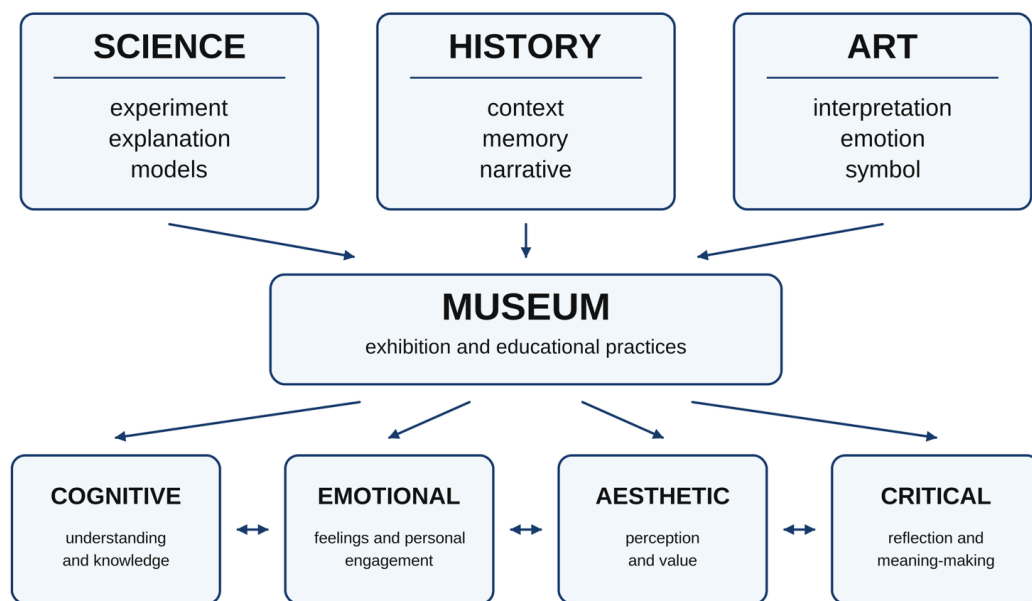
Such a multilayered exhibition structure may offer visitors opportunities to engage with information through cognitive, emotional, aesthetic, and critical forms of interpretation, while direct interaction with exhibition materials may contribute to the broader museum experience.

The interpretative potential of such a structure may also be influenced by the communicative model adopted by the museum.

This communicative aspect of museum learning is further examined by Filipchuk (2019), who emphasizes that the educational function of the museum should be based on a subject–subject model of communication that recognizes visitors as active participants in the learning process.

These relationships raise the question of how visitors may interpret interdisciplinary museum content. Figure 2 therefore proposes a heuristic arrangement of four interconnected dimensions—cognitive, emotional, aesthetic, and critical. These

dimensions are used in the present study as analytical categories for organizing different aspects of engagement discussed in the literature and case material; they are not presented as a validated typology or a universal sequence of visitor responses.



*Figure 2. Conceptual model of interconnected interpretative dimensions of museum experience
Source: Developed by the authors*

The model presented in Figure 2 organizes four analytically distinguishable but potentially overlapping dimensions of museum experience. Within this conceptual arrangement, scientific, historical, and artistic domains are treated as semantic sources, while exhibition and educational practices may create conditions in which understanding, emotional response, aesthetic perception, and critical reflection become relevant to the interpretation of museum content. The model is therefore intended as a heuristic scheme for examining possible aspects of interpretation rather than as a predictive model of actual visitor behavior.

For the purposes of the model, the cognitive dimension refers to the comprehension and organization of information. The emotional dimension encompasses personal involvement, affective response, and connections between museum content and the visitor's experience. The aesthetic dimension refers to sensory, figurative, evaluative, and value-based perception, particularly when content is communicated through artistic forms, spatial design, and visual imagery. The critical dimension concerns reflection, comparison of perspectives, interpretation of meanings, and independent meaning-making. These definitions delineate analytical categories rather than empirically fixed stages; during an actual museum visit, the dimensions may overlap, reinforce one another, or emerge in different combinations.

The visitor studies reviewed above provide only partial points of comparison with selected components of Figure 2 rather than evidence for the four-part structure as a whole. Krukar & Dalton (2020) address attention and recognition in relation to exhibition

visibility, Pelowski et al. (2018) examine emotional and evaluative responses to installation art, and Lin et al. (2022) consider learner control and engagement in an augmented-reality exhibit. Their findings are compatible with selected cognitive, emotional, and aesthetic aspects of the proposed scheme and with the role of exhibition conditions in shaping engagement, but they do not validate Figure 2. The critical dimension, in particular, remains conceptually proposed and requires targeted empirical investigation.

These studies address selected aspects of visitor experience. The organization of research, collections, exhibitions, and public communication represents a related but analytically distinct institutional level of museum interdisciplinarity.

This institutional perspective is further developed in the study by Trischler (2024), who presents the Leibniz Research Museums as a model of interdisciplinary knowledge production in which scientific research, collections, exhibition practices, and public communication are closely interconnected.

These observations provide a basis for examining how scientific, historical, and artistic components operate and combine in contemporary museum practice.

SCIENTIFIC, HISTORICAL AND ARTISTIC INTEGRATION IN THE CONTEMPORARY MUSEUM SPACE: INTERACTIVITY, DIGITALIZATION AND INTERDISCIPLINARY PRACTICES

The scientific component of the museum space today is among the most dynamic, innovative, and in-demand areas in terms of maintaining historical traditions and cultural-educational activity. Many contemporary museums, particularly science-oriented institutions, are increasingly adopting strategies of science popularization, employing interactive, experimental, multimedia, and visualization-based formats for presenting information. This approach expands target audiences, makes complex historical, natural, and technical concepts accessible to visitors of different ages and educational backgrounds, and integrates science into the everyday cultural experience of society.

In the traditional model of museum education, scientific exhibits primarily functioned as objects of observation, presenting historical and technical artifacts, mineral samples, biological specimens, or research instruments. Such exhibitions performed an informative but non-interactive function. In contrast, the contemporary museum moves away from passive display and adopts a format of full visitor engagement in the process of knowledge acquisition. Interactive exhibitions, science shows, live demonstrations, virtual models, sensor-based interfaces, and digital laboratories create conditions for active immersion in scientific phenomena. Museum science today operates within a “hands-on” and “minds-on” paradigm, which involves not only observation but also practical activity, critical thinking, process modeling, and independent experimentation.

In this context, “hands-on” refers to the visitor’s direct physical interaction with an exhibit or experiment, while “minds-on” emphasizes the cognitive dimension of learning, associated with reflecting on what has been observed, formulating questions, analyzing results, and drawing independent conclusions.

Examples of such innovative approaches include the Deutsches Museum in Munich, one of the largest science and technology museums in the world, which enables visitors to engage with physical phenomena through demonstration laboratories. The Museum

für Naturkunde in Berlin develops integrative practices that combine biology, geology, anthropology, archaeology, and digital technologies. Similar models are implemented by other leading science museums, including the Science Museum in London, the Exploratorium in San Francisco, as well as the Copernicus Science Centre, which promotes STEAM-oriented practices and actively works on scientific visualization.

In the Ukrainian context, examples of contemporary science-oriented museums are also becoming increasingly prominent. In particular, the Science Museum of the Junior Academy of Sciences of Ukraine represents a model of an interactive educational space focused on the popularization of STEM education and the development of scientific thinking among young people. According to information published on the institution's official website, its exhibition includes more than 120 interactive exhibits that allow visitors not only to observe but also to experiment, model physical processes, and test hypotheses through direct interaction (National Center "Junior Academy of Sciences of Ukraine", n.d.). This approach corresponds to contemporary trends in museum science, within which the museum emerges as an active environment of knowledge production that combines scientific content, educational objectives, and elements of playful and research-based learning.

The popularization of science within the museum environment has a multifaceted effect. On the one hand, it ensures the accessibility of complex natural, technical, and mathematical phenomena through visualization, digital modeling, and interactive demonstration. On the other hand, it fosters cognitive motivation, stimulates interest in research, and supports the development of scientific literacy and competencies aligned with contemporary educational challenges: critical thinking, information analysis, data literacy, hypothesis formulation, and evidence-based reasoning.

The communicative function of scientific exhibitions is also of particular importance. Through interactivity, openness, and mediatization, the museum enables visitors not only to receive information but also to engage in dialogue with it: to ask questions, discuss, test scientific hypotheses, and participate in the modeling of natural or technical processes. This format differs from traditional formal education in that it is based on voluntariness, curiosity, and active participation, and may therefore be particularly effective in fostering intrinsic motivation for learning.

Particular importance is gained by the integration of the scientific component with historical and artistic dimensions. For example, the presentation of scientific discoveries in a historical context makes it possible to trace the evolution of technologies, the social consequences of inventions, and transformations of scientific paradigms. Artistic interpretations of scientific phenomena—such as light installations, audiovisual projections, or media art—form an additional emotional and value-based layer of perception, making science more accessible, symbolic, and emotionally engaging. An example of such synthesis can be found in numerous projects in contemporary art museums, in particular the installations of Olafur Eliasson, which combine the physics of light with artistic interpretations of natural processes.

Such integrative approaches are not limited to science-oriented institutions but are also evident in leading museums worldwide that explicitly combine scientific and artistic interpretation. For example:

- Tate Modern in London integrates natural phenomena with artistic interpretations in its projects, notably in the well-known installation "The Weather

Project”, which engages with the physics of light as well as historical perceptions of nature.

- ArtScience Museum in Singapore implements models of synthesis between art, science, and historical narrative through interactive digital installations by the teamLab collective, which present physical and biological processes in an artistic form (ArtScience Museum, n.d.).

- At the Museum of Archaeology and Anthropology of the University of Cambridge, the exhibition *Colour: Art, Science & Power* integrates the physics of colour, cultural history, and artistic practices, demonstrating how natural phenomena acquire social and symbolic meanings (Museum of Archaeology and Anthropology, University of Cambridge, n.d.).

- MIT Museum in the United States integrates engineering, the history of technology, and media art, creating exhibitions that simultaneously explain scientific discoveries and their cultural implications.

Taken together, these cases illustrate how museums can extend science communication beyond the presentation of scientific achievements by situating knowledge within broader cultural and public contexts. When scientific phenomena are contextualized historically and interpreted through artistic forms, science is presented as a culturally embedded practice rather than an isolated collection of facts. This contextual function leads directly to the historical dimension of interdisciplinary museum communication.

The historical dimension of the museum space is one of the key components, as museums have long performed the function of preserving, representing, and interpreting cultural and historical heritage. In the classical understanding, the museum primarily served as a repository of artifacts and documents intended to record and transmit representations of the past. In contemporary conditions, this function is not only preserved but also significantly reinterpreted, a shift associated with the development of historical scholarship, the expansion of interpretative approaches, the increasing use of digital technologies, and the growing interdisciplinarity of museum practices.

History in a museum is represented through a wide range of sources and formats: material artifacts, written documents, archaeological finds, visual and audiovisual materials, oral testimonies, multimedia installations, and interactive models. At the same time, the contemporary history museum is increasingly moving away from the passive display of the past as a set of completed facts. Instead, it offers a conceptual reading of historical processes that takes into account multiple perspectives, contexts, and narratives.

Such an approach enables visitors to engage in an active dialogue with the past, to relate historical events to contemporary issues, and to develop their own critically informed understanding of history.

The interdisciplinary nature of historical exhibitions is manifested in the combination of historical knowledge with scientific and artistic approaches. The explanation of technological processes, natural conditions, or material characteristics of artifacts draws on scientific methods of analysis, while visual reconstructions, artistic installations, and creative interpretations of historical narratives shape an emotional and value-based level of perception. Through such synthesis, history in the museum

space is presented not as a static past, but as a living and dynamic reality that continues to influence contemporary cultural, social, and political processes.

Representative in this context are the practices of leading European museums. For example, the House of European History in Brussels structures its exhibition not according to a national or strictly chronological principle, but through problem-oriented thematic sections that combine historical documents, multimedia interpretations, and scholarly explanations of social and political processes (House of European History, n.d.).

Imperial War Museums in the United Kingdom integrates archival materials, technical exhibits, personal testimonies, and artistic approaches, thereby constructing a complex narrative of war as a historical, technological, and humanitarian phenomenon (Imperial War Museums, n.d.).

Particularly illustrative in this context is the POLIN Museum of the History of Polish Jews in Warsaw, whose exhibition is constructed as a spatial and narrative reconstruction of the thousand-year history of Jewish presence on the territory of Poland. The museum combines authentic sources, academically verified historical reconstructions, multimedia technologies, and artistic scenography, creating an immersive environment in which historical knowledge is experienced as a holistic form of engagement.

Spatial solutions and artistic imagery in the POLIN Museum of the History of Polish Jews do not replace scientific content but perform an interpretative function, helping visitors to understand complex social, cultural, and political processes. Such an approach presents the museum not only as an institution of memory preservation but also as an active platform for public historical dialogue, where scholarly reflection, cultural memory, and contemporary forms of communication converge.

Digital transformation has significantly expanded the capabilities of history museums. The use of 3D reconstructions, augmented and virtual reality, interactive screens, and projection installations makes it possible not only to present historical events but also to model their development, immerse visitors in the spatial and temporal context of specific eras, and reconstruct lost or fragmentarily preserved elements of cultural heritage. These tools enhance the educational potential of museums, foster empathy, strengthen skills in working with sources, and encourage a critical attitude toward historical narratives—an especially important competence in conditions of information overload and the manipulation of interpretations of the past.

Li et al. (2024) similarly observe that the integration of VR, AR, artificial intelligence, and 3D technologies into museum exhibitions may deepen visitor engagement by enabling immersive exploration of reconstructed historical environments and direct interaction with museum objects. Such technologies can support a more detailed examination and interpretation of historical events, cultures, and exhibition content.

The historical dimension therefore extends beyond the preservation of evidence by connecting interpretations of the past with contemporary questions of identity, memory, responsibility, and shared values. Filipchuk (2020) relates this changing sociocultural mission to the expansion of museums' communicative and educational functions across formal, non-formal, and informal settings. Within this framework, artistic forms provide one means of translating complex historical relationships into visually, symbolically, and emotionally accessible interpretations.

Within interdisciplinary museum environments, art functions not only aesthetically but also as an interpretative medium. Installations, scenographic solutions, photography, video, and media art translate scientific data and historical narratives into visual, sensory, and symbolic forms, making complex content more accessible to diverse audiences. By mediating between objective knowledge and subjective cultural experience, artistic forms can reveal the axiological, ethical, and human dimensions of scientific and historical phenomena while creating space for reflection and personal interpretation.

Representative in this context are the practices of leading contemporary art museums and interdisciplinary institutions. At Tate Modern in London, Olafur Eliasson's projects, in particular *The Weather Project*, combine the physics of light, historical perceptions of nature, and the artistic experience of space, transforming a scientific phenomenon into an object of emotional and social reflection. ArtScience Museum in Singapore implements a model of integrating art, science, and technology through interactive digital installations, where artistic imagery becomes a tool for understanding natural and biological processes. At the MIT Museum, art is employed to interpret engineering solutions and technological innovations, demonstrating their cultural and ethical dimensions.

Contemporary museums are increasingly using art as a means of creating interactive and immersive environments. Installations, performative practices, multimedia spaces, light and sound compositions transform the traditional model of interaction with exhibitions, turning the visitor from a passive observer into an active participant in the cultural experience. This approach corresponds to current trends in museum pedagogy, which emphasize immersion, co-participation, emotional engagement, and personalized learning experiences.

Karamanov (2025) emphasizes that museum pedagogy programs can be designed for audiences of different ages and organized through structured scenarios that support a holistic museum experience. Such programs may also be implemented in virtual environments using VR and AR technologies, thereby expanding opportunities for engagement with art and immersion in exhibition content.

The integration of art into the museum space also plays an important role in developing critical visual literacy. In the context of the dominance of visual culture and information overload, art helps to analyse symbols, media images, visual narratives, and social messages. This ability to critically read visual information is an essential component of humanistic education and cultural competence required for individuals to function effectively in contemporary society.

Taken together, these practices indicate that art functions in interdisciplinary exhibitions as an interpretative medium that translates scientific and historical content into visual, sensory, and symbolic forms while supporting critical visual literacy. This function provides a transition from the analysis of individual knowledge domains to the mechanisms through which their integration is organized in museum practice.

MECHANISMS AND PRACTICES OF INTERDISCIPLINARY INTEGRATION IN THE CONTEMPORARY MUSEUM: THEMATIC EXHIBITIONS, DIGITAL TECHNOLOGIES, STEAM AND PARTNERSHIPS

One of the most prominent manifestations of interdisciplinarity in museum exhibitions is the implementation of thematic displays built on the integration of scientific, historical, and artistic elements. Such exhibitions cover a wide range of issues—from the history of technology and the evolution of scientific thought to socio-cultural processes and contemporary global challenges. For example, exhibitions dedicated to climate change combine scientific data, historical evidence, artistic interpretations, and multimedia models, enabling visitors to gain a multidimensional understanding of the issue and to perceive it as a complex phenomenon shaped by natural, social, and cultural factors, as clearly demonstrated in the practices of contemporary museum institutions.

Across the selected cases, interdisciplinary practice takes different institutional forms: STEM-oriented experimentation at the Science Museum of the National Center “Junior Academy of Sciences of Ukraine”, digital art–science environments at the ArtScience Museum, and cross-sector approaches at the Wellcome Collection and the Ars Electronica Center. These cases are used not to establish a universal pattern but to identify recurring thematic, technological, artistic, and communicative mechanisms that are subsequently systematized in Figure 3.

Digital and multimedia technologies play a crucial role in the development of interdisciplinary practices, becoming one of the most effective tools for integrating different types of knowledge. Virtual and augmented reality, sensor systems, 3D reconstructions, interactive maps, and audiovisual installations create dynamic and adaptive museum environments. Such technologies not only enhance interaction with exhibition content but also enable the simultaneous combination of numerical data, archival sources, artistic imagery, and scientific models. In this sense, digital integration emerges as a form of interdisciplinary dialogue enacted directly within the exhibition space of the museum.

One of the key trends in recent years is the implementation of the STEAM approach (science, technology, engineering, art, mathematics), which integrates the natural and technical sciences with the arts. In the museum context, STEAM-oriented practices are realized through educational programs, interactive workshops, creative laboratories, and experimental spaces. Collectively, these formats enable visitors of different ages not only to engage with scientific phenomena or historical processes but also to apply creative thinking in their interpretation. As a result, a new learning model emerges, based on inquiry, creativity, and knowledge integration, corresponding to contemporary educational and cultural demands.

Particularly significant in the development of interdisciplinary museum practices are collaborations between museums, universities, research centers, artistic studios, and civil society organizations. Such partnerships create conditions for the implementation of projects that combine academic science, contemporary art, historical reconstruction, audiovisual technologies, and social innovation. Joint exhibitions, lecture programs, science communication events, science festivals, art residencies, and interdisciplinary workshops have become an essential component of contemporary museum activity, strengthening its communicative and educational potential.

Interdisciplinary practices also contribute to the development of inclusive forms of museum experience. The combination of artistic, scientific, and social approaches makes it possible to design exhibitions accessible to diverse audiences, including children, people with disabilities, elderly visitors, and non-native speakers. This expansion of the target audience strengthens the social role of the museum and positions it as an institution oriented toward diversity and social inclusion.

The four mechanisms presented in Figure 3 were identified by grouping recurring practices observed across the theoretical analysis and the selected museum cases. Thematic integration reflects the use of problem-oriented exhibitions and cross-disciplinary narratives that organize scientific, historical, and artistic material around a shared issue. Interactive and immersive technologies encompass hands-on exhibits, digital laboratories, multimedia environments, and AR/VR formats, as illustrated by the Copernicus Science Centre and the Science Museum of the National Center “Junior Academy of Sciences of Ukraine”. Artistic interpretation of knowledge derives from the use of installations, visual metaphors, media art, and scenographic solutions in institutions such as Tate Modern, the ArtScience Museum, and the POLIN Museum. Dialogical communication is grounded in the participatory museum approach and museum pedagogy practices that emphasize participation, co-creation, discussion, and reflection. Figure 3 brings these recurring mechanisms together as a practice-oriented conceptual model of how interdisciplinary integration may be organized in museum practice.

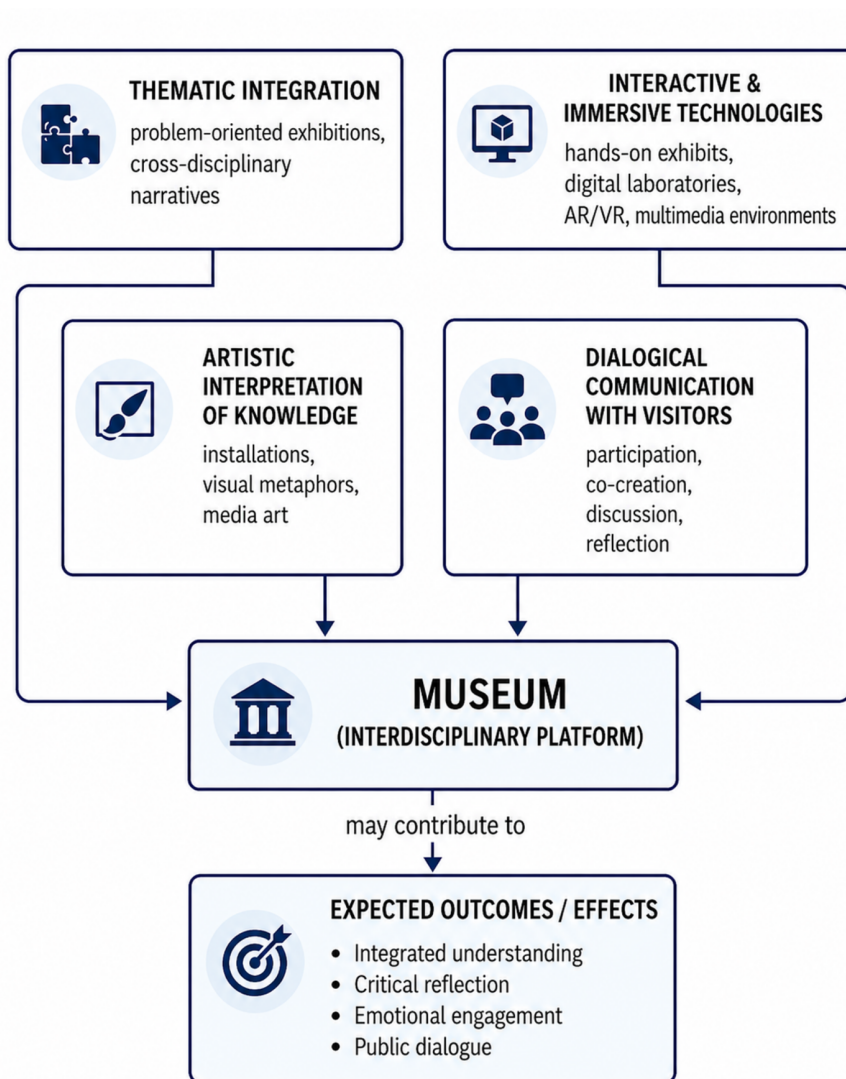


Figure 3. Mechanisms of interdisciplinary integration in the museum
Source: Developed by the authors

The model is conceptually derived from the recurring museum practices described above. Selected components are compatible with existing visitor studies addressing interactive and multimodal design (Lin et al., 2022), responses to installation art (Pelowski et al., 2018), and facilitated engagement (Machado Corral et al., 2021). These studies provide only partial points of comparison and do not validate the model as a whole.

Within the proposed model, these mechanisms are expected to contribute to an integrated understanding of complex historical, social, and cultural phenomena, critical reflection, emotional engagement, and the creation of conditions for public dialogue. Taken together, these relationships provide a conceptual basis for considering interdisciplinarity as a relevant foundation of contemporary museum practice, while their specific educational and sociocultural effects require further empirical examination.

At the sociocultural level, the proposed framework suggests that interdisciplinary museum practices may create conditions for visitors to relate scientific, historical, and artistic perspectives to contemporary public issues. Such engagement may support critical comparison, the interpretation of individual and collective memory, and discussion of questions including identity, environmental change, technological development, and historical responsibility. By bringing different audiences and perspectives into a shared interpretative space, museums may also contribute to civic dialogue and social inclusion. These outcomes remain hypothesized rather than empirically demonstrated in the present study and should therefore be examined through targeted visitor research.

These observations and the proposed conceptual models should, however, be interpreted in light of several limitations. The museum cases were selected purposively according to their theoretical relevance and the availability of institutional or scholarly materials sufficient for contextual analysis rather than as a representative sample of the museum sector. Moreover, a substantial proportion of the analyzed institutions are large, internationally recognized, and comparatively well-resourced museums with access to advanced technologies, specialized staff, and developed educational infrastructure. Consequently, the applicability of the proposed models to small, regional, and underfunded museums cannot be assumed without further examination. Future studies should investigate how the models may be adapted to institutions operating with limited financial, technological, spatial, and human resources.

In addition, the personal visits to three selected institutions were not conducted according to a formalized observation protocol and were used only to contextualize information obtained from scholarly and institutional sources. The study does not include original visitor data or a direct empirical assessment of audience responses; therefore, the relationships represented in Figures 1–3 should be understood as conceptually proposed rather than empirically validated. This limitation is particularly relevant to the critical dimension presented in Figure 2, which is supported primarily by theoretical argument and indirect comparison with existing visitor studies. Its manifestation in actual museum experience, as well as its relationship with the cognitive, emotional, and aesthetic dimensions, requires targeted empirical investigation.

CONCLUSIONS

The analysis indicates that museum interdisciplinarity is best understood not as the coexistence of separate disciplines but as the organized interaction of knowledge domains, interpretative dimensions, and exhibition practices. Across the selected cases, this interaction was most consistently expressed through problem-oriented thematic organization, interactive and immersive technologies, artistic interpretation of knowledge, and dialogical communication with visitors.

These recurring practices may support contextualized interpretation, critical reflection, emotional engagement, and non-formal learning. However, the nature and intensity of these potential effects may vary according to institutional resources, exhibition conditions, and audience characteristics and therefore require further empirical examination.

The models proposed in this study (Figures 1–3) constitute a central conceptual contribution of the research by translating the general idea of museum interdisciplinarity into a complementary heuristic analytical framework. Figure 1 offers a structural representation of the interaction between scientific, historical, and artistic domains within the museum environment. Figure 2 provides an interpretative scheme for systematizing the cognitive, emotional, aesthetic, and critical dimensions through which museum content may be experienced and interpreted. Figure 3 organizes the recurring mechanisms of interdisciplinary integration—thematic integration, interactive and immersive technologies, artistic interpretation, and dialogical communication—and connects them with expected outcomes of museum communication. Collectively, the models provide a preliminary framework that may inform exhibition design, comparative case studies, visitor research, and the future development of evaluation indicators. Their use as validated instruments for assessing educational or sociocultural effects, however, requires further empirical testing.

The analysis across the selected cases suggests that interdisciplinary integration does not follow a single institutional pattern and that its configuration may be shaped by the museum's profile, the nature of its collections, educational objectives, technological capacity, staffing, and available resources. In institutional contexts comparable to those examined in this study, the proposed models may serve as preliminary analytical reference points for examining the relationships among scientific, historical, and artistic content, forms of visitor participation and interpretation, and the thematic, technological, artistic, and dialogical components of exhibitions. Their applicability to small, regional, and resource-constrained museums, however, cannot be inferred from the present study. Further research is required to determine whether and how the models may be adapted to different collections, audiences, spatial conditions, and organizational capacities.

Overall, the study positions interdisciplinarity as a methodological principle for linking heritage preservation, knowledge interpretation, and public engagement, while providing a basis for future comparative and visitor-focused research involving museums of different types and resource levels.

Data Availability Statement

No new empirical data were generated or analysed in this study. The research is based on the analysis of publicly available scholarly literature, institutional materials, and illustrative museum case studies. Therefore, data sharing is not applicable to this article.

Ethics Statement

This study did not involve human participants, animals, personal data, interviews, surveys, or experimental procedures. Therefore, institutional ethics committee approval and informed consent were not required.

Author contributions

V.I.: Conceptualization, methodology, literature review, investigation, writing – original draft, visualization.

S.K.: Validation, supervision, writing – review and editing.

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