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Bridging STEAM and Cultural Heritage Through Inclusive Inquiry: The SciArt Professional Development Program

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Abstract

This study presents a professional development (PD) program designed within the “SciArt—Promoting 21st-century skills through an inclusive STEAM approach to Cultural Heritage” project, which aims to prepare teachers to implement an inclusive, inquiry-based STEAM approach in their classrooms. The approach, developed collaboratively by academics from the arts, sciences, and cultural sectors across Cyprus, Greece, and Portugal, integrates archaeometric methods with cultural heritage to support identity exploration and inclusive pedagogy. The study explores how participating teachers evaluated the PD program, how it influenced their self-efficacy in applying inclusive, inquiry-based STEAM approaches, and how teacher trainers experienced its implementation across different national contexts. The study utilizes both qualitative and quantitative methods of data collection, comprising questionnaires and a focus group. Results show high teacher satisfaction and increased self-efficacy across four thematic areas: inquiry-based learning, science-heritage integration, cultural identity exploration, and use of multimodality for inclusion. Teacher trainers described the process as demanding but professionally enriching, emphasizing the role of interdisciplinary collaboration. These findings highlight the potential of well-supported, theoretically grounded PD programs to build capacity for inclusive STEAM education, while also revealing structural barriers that must be addressed for wider implementation.

Keywords: STEAM; cultural heritage; science education; inquiry; inclusive education; identity; archaeometry; professional development



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1. Introduction

STEAM education—an interdisciplinary approach that interweaves Science, Technology, Engineering Arts and Mathematics—has redefined conventional barriers between

disciplines, offering a vehicle for cultivating creativity, criticality and collaboration, and supporting future citizens in adapting well to rapid change. Indeed, a growing literature supports the notion that engaging learners in activities that integrate sciences, technologies and the arts enhances their creativity, innovation, and problem solving skills, while it offers several other cognitive benefits that are necessary for the demands of our increasingly challenging and complex societies (Liao, 2016). Project-based initiatives promoted by STEAM education narrow achievement gaps between girls and boys, and nurture perseverance and curiosity among students from diverse backgrounds (Sigit et al., 2022). Such evidence confirms that STEAM is more than a fashionable acronym: it is a mechanism for realizing the transformative aspirations of “Quality Education”.

1.1. For a Discipline-Balanced and Inclusive STEAM Education

The United Nations 2030 Agenda situates “Quality Education” (SDG 4) at the heart of a just and sustainable future, urging us to design learning that is both inclusive and culturally resonant. However, while a balanced STEAM approach demands dialogic exchange between disciplines rather than a one-way transfer of creativity from arts to sciences (Colucci-Gray et al., 2021), often the (visual) arts are used “from merely a utility perspective, as a tool for STEM learning, rather than for equally developing arts related skills and competencies” (A. Leavy et al., 2023). Other scholars similarly warn that art components are often reduced to decorative props or motivational hooks, and their capacity for aesthetic reasoning and ethical critique tends to be displaced by narrow performance metrics (M. A. Graham, 2021).

Aiming, thus, for a balanced STEAM approach, where the “A” attains genuine epistemic parity with STEM, and acknowledging both the rarity of opportunities for collaborative work between disciplines, and the significance of accessible opportunities for open-ended and long-term collaborations (A. Leavy et al., 2023), an interdisciplinary Erasmus+ partnership was formed. The funded project “SciArt—Promoting 21st-century skills through an inclusive STEAM approach to Cultural Heritage” (SciArt: 2022-1-CY01-KA220-SCH-000086608), aimed to develop an inclusive STEAM approach with particular emphasis to cultural heritage (the ‘SciArt’ approach), connecting scientific methods and techniques from archaeometry with the critical exploration of cultural heritage narratives, artifacts, and their influence on identity formation processes. Using this approach, a professional development program for primary- and secondary-education teachers was designed and piloted in three European countries—Cyprus, Greece, and Portugal. This paper specifically describes and discusses the SciArt approach to cultural heritage and its potential contribution to an inclusive STEAM education based on results from pilot implementation.

The SciArt approach to cultural heritage aligns with Critical Heritage scholars, understanding heritage not as a static collection of artifacts but as a social process through which communities negotiate identity, memory and power structures (Charalambous, 2019; Deacon & Smeets, 2013). It is also driven by the “material turn” in contemporary theory that acknowledges the active role of materiality in shaping meaning, while also situating it within networks of social, affective, and political relations (Appadurai, 1988; Bennet, 2010; Latour, 2005). Within such an approach, an amphora, a coin or a patch of fresco are seen as both material specimens that are subject to archaeometric analysis and parts of a larger network of narratives linking trade and rituals with well-known myths, circulating discourses and representations. Exploring the multifaceted dimensions of heritage artifacts encourages interdisciplinary engagement, prompting learners to develop diverse skills and draw connections across fields, such as linking physics and chemistry with iconography, mathematics with proportion, and engineering with conservation, while critically addressing themes of history and identity.

Beyond its interdisciplinary potential, the study of cultural heritage also provides a fertile ground for inclusive education. Cultural heritage artifacts embody multiple voices, traditions, and narratives, allowing learners to recognize and value diversity in knowledge, histories, and experience. STEAM approaches to cultural heritage, designed based on Universal Design for Learning (UDL, (“CAST. Universal Design for Learning Guidelines version 3.0,” [CAST, 2024](#)) or other inclusive frameworks, can become a space where varied modes of engagement, representation, and expression are intentionally fostered, enabling all learners—regardless of ability, background, or prior knowledge—to access, connect with, and contribute to the learning process ([Boyle et al., 2023](#)), p. 43). By incorporating multisensory exploration, flexible pathways for meaning-making, dialogic exchange between disciplines, and collaborative inquiry that foregrounds learners’ identities and cultural capital, educators can transform cultural heritage from a static content domain into a dynamic, inclusive STEAM practice of shared understanding and co-creation. Through this lens, a STEAM approach to cultural heritage becomes not only an academic pursuit but also a pedagogical commitment to inclusion.

Realizing this potential, however, hinges on teacher readiness. International surveys reveal that many educators feel under-prepared to develop interdisciplinary, object-based inquiries and to differentiate within them ([Margot & Kettler, 2019](#); [Wu & Zhou, 2025](#)). Professional-development research converges on several design principles: sustained participation in Professional Learning Communities builds collective expertise ([Prenger et al., 2019](#)); hands-on workshops boost self-efficacy for integrating arts and STEM ([Jiang et al., 2024](#)); and programs that foreground inclusion—through UDL checkpoints or equity-driven design studios—correlate with greater adoption of multimodal strategies ([Sofianidis et al., 2024](#); [Thoma et al., 2023](#)). Such findings indicate that robust, context-specific professional development is not an optional add-on but the linchpin of systemic change. These were the main principles on which the professional development program of the SciArt project was designed. The following sections provide a brief overview of the theoretical framework underpinning the study, followed by a detailed presentation of the professional development program based on the SciArt approach, and the results from the pilot implementation. In the end, we discuss these findings in relation to the literature to draw conclusions that could inform future professional development programs in inclusive STEAM education.

1.2. STEAM Education—Inquiry-Based Learning

STEAM education has developed largely due to the rise of new technologies and the rapid development of sciences, which underline the need for engaged citizens and critical thinkers who possess the capacity to respond to social, economic and political challenges ([Meletiou-Mavrotheris et al., 2022](#)). Often, following technological advancements also means being able to engage in scientific reasoning and to effectively manage the increasing flow of information. In this context, one of the priorities of STEAM education is to cultivate scientific and technological literacy, preparing students to contribute to a world transformed by innovation and complex challenges as responsible citizens ([Holbrook & Rannikmae, 2007](#)).

The integration of modern science topics and technology in teaching, along with the familiarization of students with fundamental aspects of scientific methodology, enhances students’ scientific literacy ([Kallery et al., 2022](#); [Kousloglou et al., 2023](#)). Scientific literacy encompasses not only the acquisition of scientific knowledge but also the development of skills and attitudes that enable individuals to engage critically and constructively with not only science-related issues, but more general social concerns. The Organization for Economic Co-operation and Development ([OECD, 2025](#)) emphasizes the importance of equipping students with the competencies to explain phenomena scientifically, construct

and evaluate designs for scientific inquiry, critically interpret scientific data and evidence, research, evaluate, and apply scientific information to inform decision-making and action. This approach aligns with the concept of functional scientific literacy, which emphasizes the application of scientific understanding in real-world contexts, enabling individuals to manage complex social challenges.

Within the context of STEAM education and contemporary pedagogical frameworks, inquiry-based approaches play a pivotal role in fostering scientific literacy, as they provide a reasonable background that helps students understand how scientific innovations are generated, while simultaneously introducing them to both disciplinary content and scientific methodologies (Tsaliki et al., 2022). Inquiry-based teaching is widely acknowledged as essential in STEAM education, as it emphasizes active learning and the construction of knowledge through engagement with authentic scientific practices (Vorholzer & von Aufschneider, 2019). Engaging students in advanced inquiry practices contributes to effective learning, motivation, critical thinking, communication and collaboration, and an increased interest in science content (Kousloglou et al., 2022; Schwartz, 2017), part of which are also identified as 21st-century skills (Partnership For 21st Century Skills, 2009). Considering the above, inquiry approaches are regarded as supportive for education of sustainable development as they offer to teachers and students alike, the appropriate tools for ongoing learning and the understanding of science (Aldahmash et al., 2019).

Archaeometry provides a rich field of study that inherently supports inquiry-based and interdisciplinary learning, allowing students to meaningfully engage with both scientific methodology and technological innovation. As a contemporary area of scientific inquiry, archaeometry provides authentic contexts for students to explore the interplay between science, technology, and cultural heritage, thereby fostering a deeper understanding of science as a dynamic human endeavor.

1.3. STEAM Education—The Case of Archaeometry

Archaeometry is the application of scientific methods and techniques to the study of cultural heritage, and archaeological materials and monuments (Liritzis et al., 2020). Archaeometry is a scientific field that originates from interdisciplinarity, as it integrates approaches from the natural sciences, engineering, social sciences, data science, and the humanities (Vandenabeele, 2007). Disciplines such as anthropology, medical sciences, and medicine also contribute to archaeometric research, in close collaboration with archaeology, the history of art, and restoration and conservation science (Karapanagiotis, 2019).

Artifacts and monuments are strongly connected to the materials from which they are composed of; from the original materials used in their creation, to those that emerged through the processes of ageing and degradation, and finally to those introduced during restoration and conservation. Although the first recorded material characterization analyses of artifacts date back to the 18th century (Doménech-Carbó & Osete-Cortina, 2016; Nadolny, 2003), the term “archaeometry” was introduced in the mid-20th century and it is closely associated with the Archaeometry Journal of the University of Oxford (Doménech-Carbó & Osete-Cortina, 2016). It has been defined as the application of physical techniques and concepts to answer archaeological questions, particularly in areas such as dating and artifact analysis (Aitken, 1961; Olin, 1982).

Archaeometric applications initially emerged as a specialized field to support archaeological findings, primarily through dating and material identification (Jones, 2004). In the decades that followed, archaeometric studies became an inseparable part of archaeological research, as well as of the restoration and conservation of monuments and artifacts. Today, archaeometry is widely applied in universities, research centers, museums, antiqui-

ties ephorates, and specialized laboratories, contributing to the study of monuments and materials of all types, from valuable artifacts to everyday utilitarian objects.

Archaeometric studies are employed to address a wide range of questions connected to cultural heritage (Malletzidou et al., 2018): What is the artifact made of? When was it manufactured? Is it authentic or counterfeit? What is its degradation state? What materials should be used for its restoration? To answer such questions, a variety of analytical methods are applied, including microscopic, spectroscopic, and X-ray-based techniques (Doménech-Carbó, 2008). The choice of the appropriate method of analysis -or methods- depends on the nature of the artifact and the research questions being posed, acknowledging that no single scientific method or technique can provide all the answers. In every case, the integrity of the artifact under study should be preserved. This is achieved either by using non-invasive methods through portable infrastructure that can be applied directly to the artifact, or minimally through micro-invasive methods, where small samples are collected in minimal quantity and only from already damaged areas.

The primary aim of archaeometry is not simply the study of artifacts themselves, but the generation of scientific data that contributes to broader interpretive procedures, guided by archaeological and anthropological frameworks, which are situated within a defined archaeological and historical context. For example, the identification of a specific pigment used in a painting not only informs us about the materials used by the artisan(s), but it also contributes to knowledge about the pigment's provenance and trade routes, its period of use, the technological processes for its production, and the applied techniques. This comprehensive archaeometric approach requires the collaboration of experts across multiple fields (including natural sciences, history of art, geology, archaeology, and restoration), to reconstruct the technological, social and economic background of the artifact.

Today, archaeometry is no longer limited to traditional analytical methods, as it increasingly incorporates emerging and advanced technologies (Boyatzis, 2022; Madariaga, 2015; Vandenabeele, 2007). Medical imaging techniques, such as CT scanning and MRI, are employed in studying mummies and skeletal remains, while isotopic analyses are used for the study of genetics, migration and paleopathological conditions (Doménech-Carbó, 2008; Stantis & Kendall, 2022). In addition, computational tools are also employed, such as statistical analysis, machine learning algorithms, and geographic information systems (GIS), all of which broaden the range of questions that can be addressed with accuracy and reliability (Bellat et al., 2025; Evangelidis et al., 2024). As a result, archaeometry provides a coherent and reliable framework for the study of materiality, technology, and the preservation state of cultural heritage objects and monuments. It connects material evidence with historical and archaeological interpretation, contributing both to the understanding and the conservation of the past. Today, archaeometry is a mature and technologically advanced discipline, attracting growing interest in archaeological research, cultural heritage management, and the broader expansion of scientific knowledge.

Archaeometric methods such as optical microscopy (OM), scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS), Fourier transform infrared (FTIR) spectroscopy, and X-rays diffraction (XRD) contribute significantly to the study of cultural heritage objects, providing valuable information on their dating, composition, and origin (Malletzidou et al., 2021). Barosso-Solares et al. (Barroso-Solares et al., 2021) designed and implemented an interdisciplinary intervention with high school students, aiming to highlight archaeometric methods in understanding cultural histories. The use of archaeometric methods for studying objects contributes to an interdisciplinary approach that deepens students' understanding of cultural heritage issues, familiarizing them with aspects of scientific methodology and enhancing their scientific literacy. Students' engagement with archaeometry equally encourages them to think critically about evidence,

draw connections across disciplines, and appreciate the impact of science on gaining information about cultural heritage issues in the past and the present. Archaeometry, thus, offers students a unique opportunity to engage with authentic scientific inquiry while exploring cultural heritage, diverse histories, and identity politics within the context of STEAM education.

1.4. STEAM Education—Cultural Heritage and Identity Politics

The importance of heritage in identity politics and in fostering a sense of belonging has been widely discussed in the literature (see (Charalambous, 2019) for a review) and is evident in policy contexts, such as the EU's 2018 recognition of cultural heritage. According to UNESCO, heritage can refer to tangible physical objects from the past—such as buildings, artifacts, or landscapes—as well as intangible elements like traditions, languages, and cultural practices. However, defining heritage can be a complex and contested process and, as Tunbridge and Ashworth note (Tunbridge & Ashworth, 1996), it can often involve disagreements over what counts as 'heritage', its significance, and its political or socioeconomic uses.

Drawing from Critical Heritage studies, heritage is understood as a social and cultural construct, deeply embedded in power relations and contemporary politics (B. Graham, 2002). So heritage is not merely seen as an object of the past, but it contributes to collective memory and the cultural framing of the past—what Van de Putte calls the 'culturalization of memory' (Van de Putte, 2024)—which is directly linked to identity processes (see also (Charalambous & Ioannidou, 2025) forthcoming). As Pearce argues (Pearce, 1994), heritage artifacts contribute to narratives about the past and play a crucial role in shaping contemporary understandings of history.

This understanding of heritage as a social, cultural, and political practice places identity politics at the core of discourses around heritage. The term "heritage" itself implies ownership and identity—suggesting inheritors, legatees, and processes of disinheritance (Tunbridge & Ashworth, 1996). These tensions are particularly visible in Europe, which has been described as a "memoryland" (Macdonald, 2013), reflecting its growing preoccupation with preserving collective memory and cultivating a common European identity based on common symbols, narratives, and material culture. However, as Macdonald cautions (Macdonald, 2013), this identity is often imagined, built on sanitized or selective historical representations that risk marginalizing diverse communities and histories.

B. Graham (2002) outline how heritage constructs coherent narratives of identity, continuity, and change; yet, heritage is never neutral (B. Graham, 2002). It may unite, but it can also provoke conflict, especially when dominant historical narratives marginalize certain groups. While international bodies often promote heritage as a tool for reconciliation, critics (e.g., (Giblin, 2014)) warn that heritage can also perpetuate divisions or silence traumatic pasts. Concepts such as 'dissonant', 'conflicted', or 'dark heritage' capture these tensions, raising questions of ownership, authenticity, and representation (Charalambous, 2019). These dynamics become more acute in postcolonial and post-conflict contexts and the notion of 'conflicted heritage' (Charalambous, 2019) underscores struggles over visibility, memory, and recognition.

In educational settings, engaging with conflicted heritage is crucial for inclusive pedagogies. Teachers must navigate multiple and often uncomfortable narratives, acknowledging differing experiences and perspectives (Charalambous, 2025). As Porto and Zembylas argue (Porto & Zembylas, 2022), art offers alternative ways to engage with trauma, memory, and silenced histories, not as restorations of the past, but as critical re-imaginings of it. The SciArt project bridges material and representational approaches by combining archaeometric analysis of museum artifacts with investigations into their

social and emotional significance. This forms the basis for the development of the SciArt approach, which, through an interdisciplinary STEAM approach, explores how objects carry layered meanings that can contribute to new, shared narratives of memory and identity at both local and European levels.

2. The SciArt Approach

The project “SciArt—Promoting 21st-century skills through an inclusive STEAM approach to Cultural Heritage” was interdisciplinary and brought together academics from the arts, the sciences and the cultural sector, researchers in STEAM education, museum experts and professionals, as well as educators and students¹ from three different countries: Cyprus, Greece and Portugal. The main objectives of the SciArt project were the development of an innovative, inclusive STEAM approach to Cultural Heritage, combining inquiry-based methods across sciences and arts education, digital technologies, and cultural heritage studies. These integrated elements constitute the SciArt approach which then informed the design of all SciArt activities, including the educational resources and a professional development (PD) Program. Of equal significance was the building of capacities among all members—researchers, museum experts, professionals, educators—on the various aspects of the SciArt approach, as well as the dissemination of the approach by sharing the results with relevant stakeholders, such as educators, schools, educational organizations and museums. Finally, the project placed particular emphasis on the use of accessible instruments with Augmented Reality affordances aiming to empower educators and students alike, to use multimodal tools for the documentation, communication and dissemination of their ideas and research processes during the implementation of the SciArt approach in their school settings.

The SciArt project developed its own approach before the design of any materials and of the PD Program; what we call the “SciArt Approach”. This was based mainly on the adoption of a critical approach to heritage, drawing on the field of Critical Heritage Studies (Smith, 2012; Waterton & Smith, 2010), which reframes heritage not as a fixed legacy from the past but as a dynamic, socially constructed process. This perspective emphasizes how heritage is continuously produced, interpreted, and mobilized by various communities and people across different temporalities. In this project we focused on specific stakeholders, such as educators and museums, and on the ways in which they use heritage objects to shape and promote certain narratives of the past, present, and future. In doing so, the social, economic, cultural and political functions of heritage are emphasized, especially in struggles for collective identifications.

Within this approach, the project focused on artifacts from collections in the three partner countries—Cyprus, Greece, and Portugal—examining them not as static relics but as dynamic elements in sociopolitical meaning-making and as tools for shaping relations between people, objects, and spaces. More specifically, nine artifacts from three different museums representing the three partner countries and their diverse cultures were chosen to be studied. Selected artifacts either archaeological, historic or more recent, included religious icons, coins, pottery, glass or wood objects, and paintings.

Whilst materiality remains central in our approach of heritage, and archaeometry was adopted for the material investigation of these objects, we began by acknowledging that these are only partial representations of the past, highlighting both presence and absence. They do not offer a complete historical account and instead reveal the fragmentary, discontinuous nature of history (Wasserman, 2007). The SciArt project builds on this understanding, recognizing that heritage objects can expose both what is remembered and what is forgotten in historical narratives. Our perspective, thus, aligns with the material

turn in the humanities and social sciences, which foregrounds the materiality and affective resonance of objects (Edwards, 2012).

This understanding informs the project's broader aim: to explore how heritage functions socially, economically, culturally, and politically—particularly in contested contexts of collective identification. By recognizing how objects are used, displayed, and interpreted to promote specific visions of identity, the SciArt project foregrounds the critical potential of heritage in fostering reflective and inclusive engagements with the past. Ultimately, it does so, by taking into account the multiple ways in which inquiries can inform our knowledge of heritage, especially when these are done through a transdisciplinary STEAM approach.

3. Methodology

3.1. *The Purpose and the Context of the Study*

Based on the SciArt approach as described above, several materials were produced during the project. These include the publication of the methodological guidelines that provided the framework for the development of the rest of the activities and of the SciArt e-book that offers a theoretical overview of the various aspects of the project, including notions of identity in cultural politics, the analysis of inquiry based models in education, a detailed overview of the archaeometric methods adopted in the study of artifacts, and a brief analysis of the principles of Universal Design of Learning². Further material produced includes the development of STEAM activities and resources on selected museum artifacts; the SciArt PD Program for educators; the SciArt educational e-platform that makes accessible all the material produced including the SciArt PD Program; as well as multimodal and/or AR-enhanced books, based on the activities created by students in schools after the implementation.

The present study particularly focuses on the pilot implementation of the teacher PD Program developed within the framework of the SciArt project. More specifically, this study seeks to explore the following research questions:

1. How do participating teachers evaluate the structure, content, and relevance of the SciArt PD Program?
2. In what ways does participation in the PD Program influence teachers' self-efficacy in implementing inclusive, interdisciplinary, and inquiry-based STEAM teaching approaches?
3. How do teacher trainers perceive their roles and experiences in facilitating the pilot implementation across different national contexts?

3.2. *The SciArt PD Program*

Building on the theoretical foundations of Critical Heritage Studies and interdisciplinary pedagogy, the SciArt project developed an innovative, inclusive, and inquiry-based STEAM approach to the study and teaching of Cultural Heritage. This initiative centers on culturally situated learning through material artifacts from Cyprus, Greece, and Portugal, whose analysis via archaeometric methods reveals their materiality in ways that enrich and connect with the historical narratives and concerns of local communities. The educational material created was designed to support teachers in guiding students through inquiry-based learning, introducing them to scientific methodologies drawn from archaeometry while fostering critical engagement with heritage artifacts.

The PD program, targeted at Primary and Secondary Education teachers in the three countries, aimed to implement the SciArt approach in schools and extend its reach through partnerships with local museums. The PD Program enhanced teachers' capacity to engage students with Cultural Heritage from an interdisciplinary perspective. The approach encouraged learners to explore how cultural meanings, histories, and narratives are con-

structured through material objects, beginning with tangible investigations into the artifacts' material, properties, using archaeometric methods, as well as their historical contexts. Scientific inquiry was key in connecting these material aspects with broader socio-cultural narratives, thus transcending traditional disciplinary boundaries.

The learning materials were organized around thematic axes that linked artifacts across the three countries, emphasizing mobility, interconnectedness, and solidarity—highlighting common threads such as migration, trade, travel routes, and motherhood. Designed for adaptability, the material allowed educators to tailor implementation to their students' diverse backgrounds, prior knowledge, and experiences.

To prepare for national-level training, a “Training of Trainers” phase was conducted via a Master Training Event. During this event, partner staff were introduced to the SciArt methodology and resources, enabling them to lead teacher PD Programs in their respective countries.

Following this, an open call invited teachers to participate in the pilot phase. Seventy-five primary and secondary school teachers voluntarily enrolled, completed the 30-h hybrid-format PD program (delivered collaboratively by teacher trainers and academic partners), and subsequently implemented the SciArt approach in their classrooms over a period of approximately two months (March–April 2025). The PD program combined face-to-face sessions, online learning, and access to digital materials through an e-platform.

3.3. Data Collection and Analysis

To investigate the three research questions relating to the implementation of the PD Programs, a mixed-methods approach was employed, combining quantitative and qualitative data collection tools (Table 1).

Specifically, to address the first research question, which focused on how the participating teachers evaluated the PD program and its content, a structured post-questionnaire was developed and administered after the SciArt PD program implementation. The questionnaire included closed-ended questions, aiming to capture participants' evaluations across a range of dimensions. The closed-ended items were constructed using a 5-point Likert scale, ranging from “completely” to “not at all”, allowing for the quantitative measurement of participants' perceptions. These items examined the extent to which the PD program fulfilled its stated aims and objectives, met the teachers' expectations, and the content provided was relevant and useful to their professional practice. Teachers were also asked to evaluate the quality and relevance of each of the six online modules of the program. These modules addressed a range of topics, including an introduction to the SciArt approach and its aims; the connection between science and cultural heritage artifacts; the exploration of national and European identity through artifacts; the promotion of inclusive education through multimodality and augmented reality; the implementation of inquiry-based learning activities; and the overall evaluation of the PD program. Additional questions focused on participants' satisfaction with the quality of the PD program resources, including videos, reports, Augmented Laboratory Instruments (ALIs), and art-related activities. These items examined the extent to which the resources supported the PD program activities, their usefulness for classroom implementation, the suitability of the video lengths for the students' age group, their contribution to students' understanding of the relationship between science and the arts, and the usefulness of the provided instructions in enabling students to critically explore connections between artifacts and identity narratives. Cronbach's alpha was calculated at 0.93, demonstrating high reliability of the instrument (Field, 2009). To enhance transparency and to provide a comprehensive overview, all descriptive statistics, including means and standard deviations, are presented in Appendix A.

Table 1. The table provides an overview of the data collection and analysis for each research question.

Research Questions	Data Collection	Data Analysis	Participants
Q1: How do participating teachers evaluate the structure, content, and relevance of the SciArt PD Program?	Post hoc 5-point Likert scale Survey	Descriptive statistics	75 Teachers participating in the PD in all countries
Q2: In what ways does participation in the PD Program influence teachers' self-efficacy in implementing inclusive, interdisciplinary, and inquiry-based STEAM teaching approaches?	Pre-Post questionnaire	Descriptive and non-parametric statistics	75 Teachers participating in the PD in all countries
Q3: How do teacher trainers perceive their roles and experiences in facilitating the pilot implementation across different national contexts?	Focus groups	Thematic analysis	6 Teacher trainers from all countries (2 from each country)

Regarding the second research question, which focused on the participating teachers' self-efficacy development in implementing the inclusive, interdisciplinary, inquiry-based STEAM teaching approach, a questionnaire was developed and administered before and after the program. The purpose was to capture any changes in teachers' perceived confidence before and after their participation in the SciArt PD Program. Both questionnaires included a series of closed-ended items formulated using a 5-point Likert scale, ranging from "strongly agree" to "strongly disagree". These items measured self-efficacy across several thematic areas central to the PD program content. Specifically, participants were asked to assess their confidence in engaging students in inquiry-based STEAM activities, their familiarity with learning tools and strategies related to inquiry-based learning, and their ability to manage potential challenges associated with implementing such approaches in practice. Several items focused on interdisciplinary integration, exploring how confident teachers felt in creating connections between science and cultural heritage, and in using technological tools to support students in making meaningful links between science and cultural heritage.

Another set of questions examined teachers' self-efficacy in guiding students to explore the relationship between cultural heritage and identity. These included their confidence in using diverse methods and tools to facilitate this exploration and in addressing potential challenges that might emerge in their teaching. The final section of the closed-ended items addressed inclusive practices, particularly the integration of multimodal technologies. Teachers were asked to indicate their confidence in applying inclusive teaching strategies, incorporating multimodal tools, and overcoming potential difficulties when implementing such practices in diverse classroom settings.

The data were analyzed using descriptive statistics (mean scores, standard deviations, and frequency distributions) to identify trends in participant responses. All mean values and their corresponding standard deviations (SDs) are presented in Appendix A. Due to the anonymity of the questionnaires, pre- and post-test responses could not be matched at the individual level. Additionally, the data violated normality assumptions. Therefore, responses were treated as independent samples and analyzed using non-parametric methods, with the Mann–Whitney U test employed to assess statistically significant differences between pre- and post-test responses. The reliability of the instrument was assessed using Cronbach's alpha, which yielded a coefficient of 0.94 (pre-test) and 0.94 (post-test), indicating excellent internal consistency (Field, 2009).

As the instrument was specifically developed for the purposes of the present study, the validation process primarily emphasized the establishment of content validity rather

than construct validation. Item formulation and refinement were informed by expert review from three scholars specializing in science education, cultural heritage education and inclusion, ensuring conceptual relevance and clarity. In view of the exploratory and pilot nature of the research, as well as the limited sample size, factor analytic procedures were not deemed appropriate at this stage. Comprehensive construct validation is planned for subsequent large-scale implementations of the instrument.

To address the third research question, which explores teacher trainers' perceptions of their experience in facilitating the pilot implementation of the PD program in their respective countries, qualitative data were collected through a focus group. The aim was to gain insight into the trainers' reflections on both the implementation process and the effectiveness of the PD program content and materials. The interview was designed to cover two main thematic areas. The first set of questions focused on the educational materials developed and used during the SciArt PD program. Trainers were asked to comment on the clarity and usability of the content, any difficulties they encountered while preparing or delivering the PD program, and whether they needed to adapt or supplement any parts of the provided materials to meet the needs of the participating teachers. Additionally, they were invited to evaluate the overall quality and usefulness of the materials from their perspective as facilitators.

The second part of the interview aimed to capture broader reflections on their experience in the PD program delivery process. Trainers were encouraged to describe what worked well, what challenges they faced, and how participating teachers responded to the PD program content and activities. Further questions explored their views on the suitability and impact of the PD program in promoting inclusive, interdisciplinary, inquiry-based STEAM teaching practices, as well as their suggestions for improving future implementations. The interviews concluded with questions about the kind of support or preparation trainers would find beneficial for enhancing their role in similar PD contexts.

The focus group was conducted in person, and was audio-recorded with the participants' consent. The focus group lasted approximately 60–75 min and was moderated by the first author, who facilitated discussion using a semi-structured interview guide aligned with the study objectives. The qualitative data were analyzed using reflexive thematic analysis (Braun & Clarke, 2019, 2012), focusing on identifying recurring patterns, perceived challenges, and recommendations for improving the structure and delivery of the SciArt PD program from the perspective of those facilitating it. The focus group transcription was independently analyzed by two researchers, who subsequently discussed their findings and reached a consensus on the final coding and interpretation. To enhance trustworthiness, we maintained an audit trail, applied researcher triangulation during coding, and conducted peer debriefing sessions.

4. Results

4.1. Teachers' Perceptions Concerning the PD Program and the Material Developed

After the PD Program implementation, teachers assessed the PD Program through a questionnaire. Responses indicated a high level of satisfaction in various aspects of the PD program.

Concerning the relevance and usefulness of the PD program content, 45.3% of participants rated it as very relevant and useful, and an additional 41.3% found it sufficiently relevant and useful, with only 1.3% expressing dissatisfaction. Similarly, 32% and 53.3% of the participants stated that their personal expectations were completely met or met to a great extent, respectively. Only 12% and 2.7% reported that their expectations were met somewhat or to a small extent. Additionally, the vast majority of teachers felt that the PD program completely or to a great extent (29.3% and 62.7%, respectively) achieved its stated

aims and objectives, while only 6.7% and 1.3% of the participants responded that it did so somewhat or to a small extent. These responses yielded consistently high mean scores (Figure 1), reflecting a strong overall consensus among participants regarding the relevance and usefulness of the PD Program, as well as its success in meeting both its stated objectives and their professional expectations.

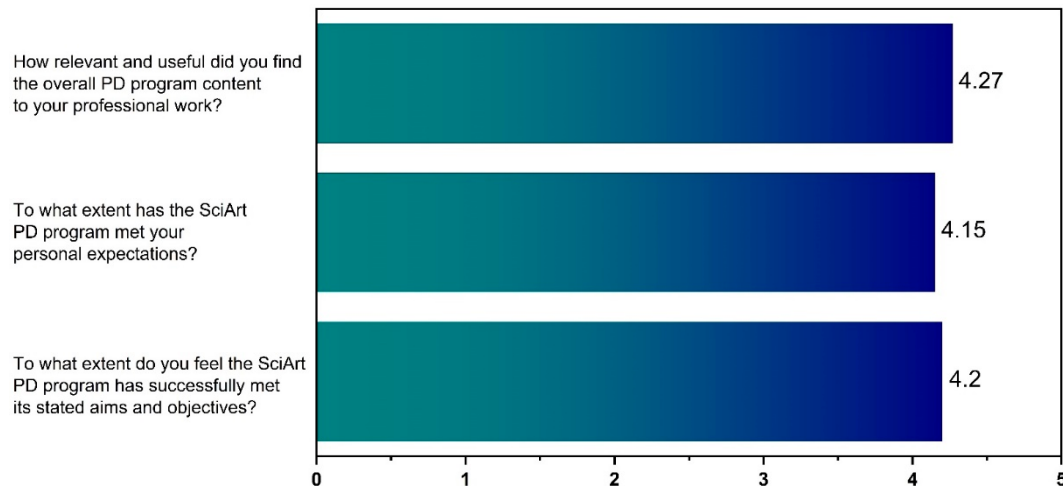


Figure 1. Teachers' perceptions in relevance and usefulness of the SciArt PD Program content.

Participants were also asked to evaluate the modules of the PD Program concerning their quality and relevance. All modules received favorable evaluations, with mean scores ranging from 4.33 to 4.55 on a 5-point scale (Figure 2). The results suggest a consistent level of satisfaction across all content areas, with particular appreciation for the conceptual framing and interdisciplinary integration offered in the first three modules.

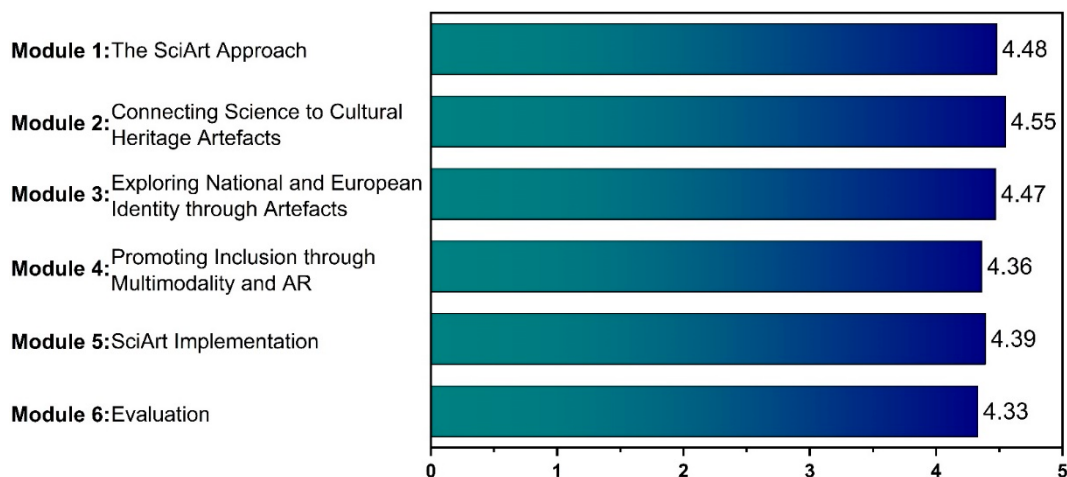


Figure 2. Teachers' evaluation of the SciArt project's modules.

Participants who implemented the activities in their classrooms were asked to evaluate the design, clarity, and classroom feasibility of the SciArt activities and supporting instructions (Figure 3). The highest ratings were given to the structure of the activities ($M = 4.38$, $SD = 0.587$) and their ability to encourage exploration of artifacts' material aspects ($M = 4.30$, $SD = 0.654$). Slightly lower evaluations were reported for the clarity of implementation guidance ($M = 4.24$, $SD = 0.733$) and the support provided by the instructions in fostering critical connections between artifacts and identity narratives ($M = 4.25$, $SD = 0.667$). The lowest, though favorable, mean score ($M = 4.10$, $SD = 0.810$) pertained to the feasibility of implementing the activities in classroom settings. The results indicate generally positive

perceptions with a potential variability in perceived practical applicability depending on participants' specific teaching contexts.

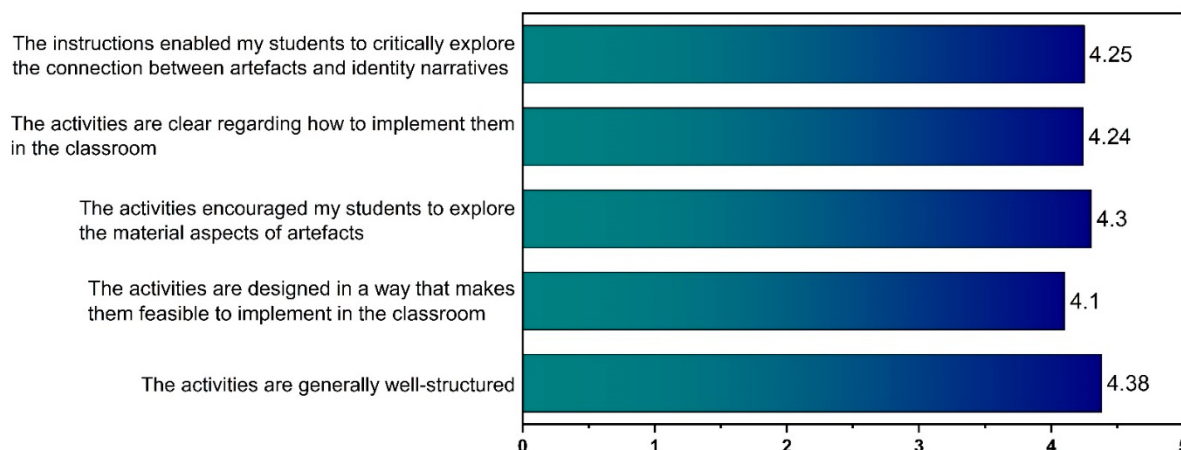


Figure 3. Participants' evaluation of the SciArt activities.

The same participants also assessed the quality and effectiveness of the PD program resources, including videos, reports, Augmented Laboratory Instruments (ALIs), and art-related activities. Overall, participants expressed high levels of satisfaction (Figure 4) with the quality and pedagogical value of the SciArt program resources, highlighting their usefulness in supporting classroom implementation and fostering students' understanding of the interdisciplinary links between arts and science. The lowest score was recorded for the appropriateness of video length for students' age, suggesting that while video content was generally well-received, its length may warrant further adjustment to better align with classroom needs.

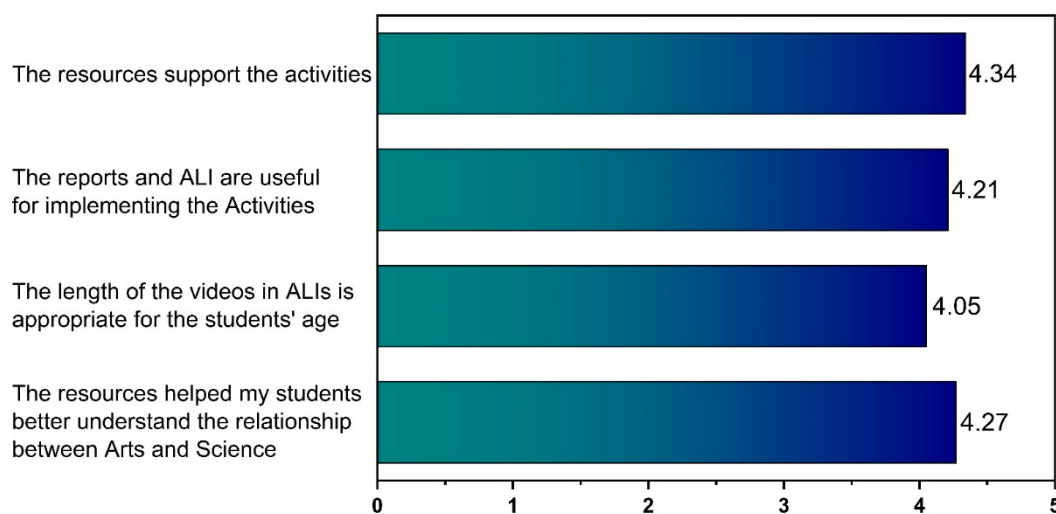


Figure 4. Teachers' evaluation of the SciArt project's quality and effectiveness.

4.2. Teachers' Self-Confidence in Inclusive Inquiry-Based STEAM for Cultural Heritage

To examine the potential impact of the professional development program on teachers' self-confidence in applying inclusive, inquiry-based STEAM approaches to cultural heritage, a pre-post questionnaire was administered.

Figure 5 presents the first three questions of the questionnaire focusing on teachers' self-reported confidence in applying inquiry-based approaches within STEAM education. The results reveal a statistically significant improvement across all three items. More specifically, teachers reported increased confidence in their ability to engage their students effectively

in inquiry-based STEAM activities (Q1: $U = 2957.5$, $Z = -3.380$, $p < 0.001$, $r = 0.25$, small to moderate effect), use learning tools and strategies of inquiry-based learning (Q2: $U = 2451.5$, $Z = -4.914$, $p < 0.001$, $r = 0.36$, moderate effect), and addressing potential challenges when implementing inquiry-based STEAM activities (Q3: $U = 3159$, $Z = -2.761$, $p < 0.05$, $r = 0.20$, small effect).

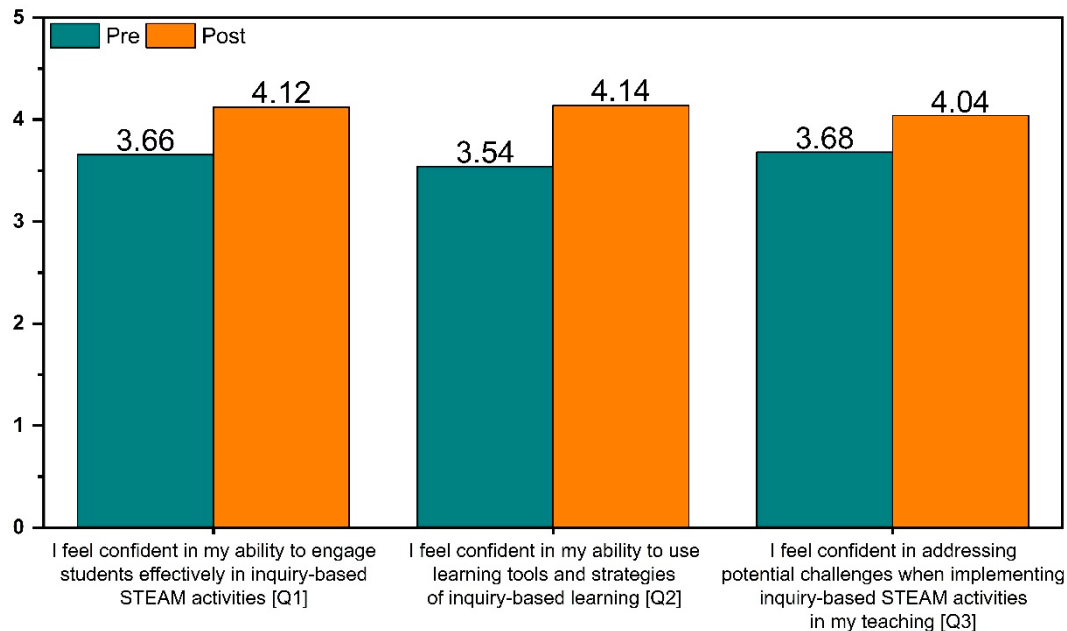


Figure 5. Teachers' perceptions in applying inquiry-based approaches in STEAM education before (pre) and after (post) the SciArt Approach.

The results presented in Figure 6 show a statistically significant improvement in teachers' confidence to connect Science and Cultural Heritage. Teachers reported improved self-confidence in creating interdisciplinary connections between Science and Cultural Heritage (Q4: $U = 2695.5$, $Z = -4.132$, $p < 0.001$, $r = 0.30$, moderate effect), in using technological tools to help students explore the relationships between science and cultural heritage (Q5: $U = 3001$, $Z = -3.267$, $p < 0.001$, $r = 0.24$, small to moderate effect), and addressing potential challenges while encouraging their students to make meaningful connections between science and cultural heritage (Q6: $U = 2757$, $Z = -3.945$, $p < 0.001$, $r = 0.29$, moderate effect).

Similarly, teachers reported a statistically significant increase in their confidence to explore the relationship between cultural heritage and identity (Figure 7). Based on the results, teachers felt more confident after the professional development program in guiding their students to critically explore the connections between cultural heritage and identity (Q7: $U = 2831.5$, $Z = -3.808$, $p < 0.001$, $r = 0.28$, small to moderate effect). They also reported greater confidence in using diverse methods and tools to help students explore how cultural heritage influences identities (Q8: $U = 2897.5$, $Z = -3.607$, $p < 0.001$, $r = 0.27$, small to moderate effect), as well as in addressing potential challenges when examining the relationship between cultural heritage and identity (Q9: $U = 2904$, $Z = -3.581$, $p < 0.001$, $r = 0.26$, small to moderate effect).

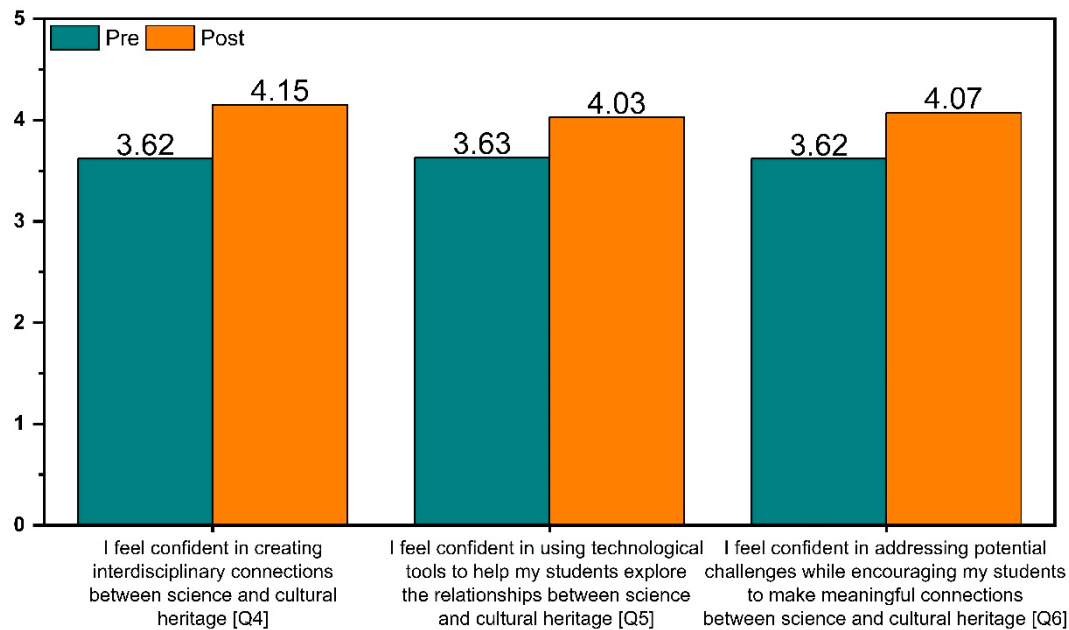


Figure 6. Teachers' perceptions in connecting science and cultural heritage before (pre) and after (post) the SciArt Approach.

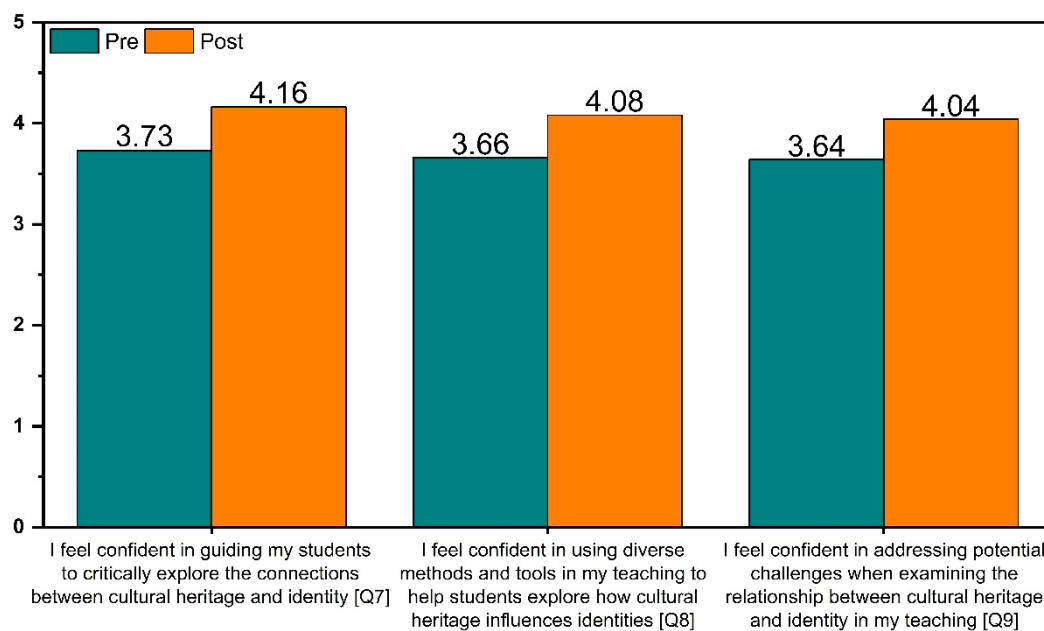


Figure 7. Teachers' perceptions in cultural heritage and identity before (pre) and after (post) the SciArt Approach.

Teachers' self-reported confidence showed a statistically significant improvement in the questionnaires focusing on the use of multimodal technologies to incorporate or promote inclusive practices (Figure 8). In more detail, teachers reported that they feel more confident in including inclusive practices in their teaching through the use of multimodal technologies (Q10: $U = 3127$, $Z = -2.887$, $p < 0.05$, $r = 0.21$, small effect), in applying different strategies to promote inclusive practices in their teaching through the use of multimodal technologies (Q11: $U = 3127$, $Z = -2.887$, $p < 0.05$, $r = 0.21$, small effect), and in overcoming potential challenges in implementing more inclusive practices using multimodal technologies with their students (Q12: $U = 3127$, $Z = -2.887$, $p < 0.05$, $r = 0.21$, small effect).

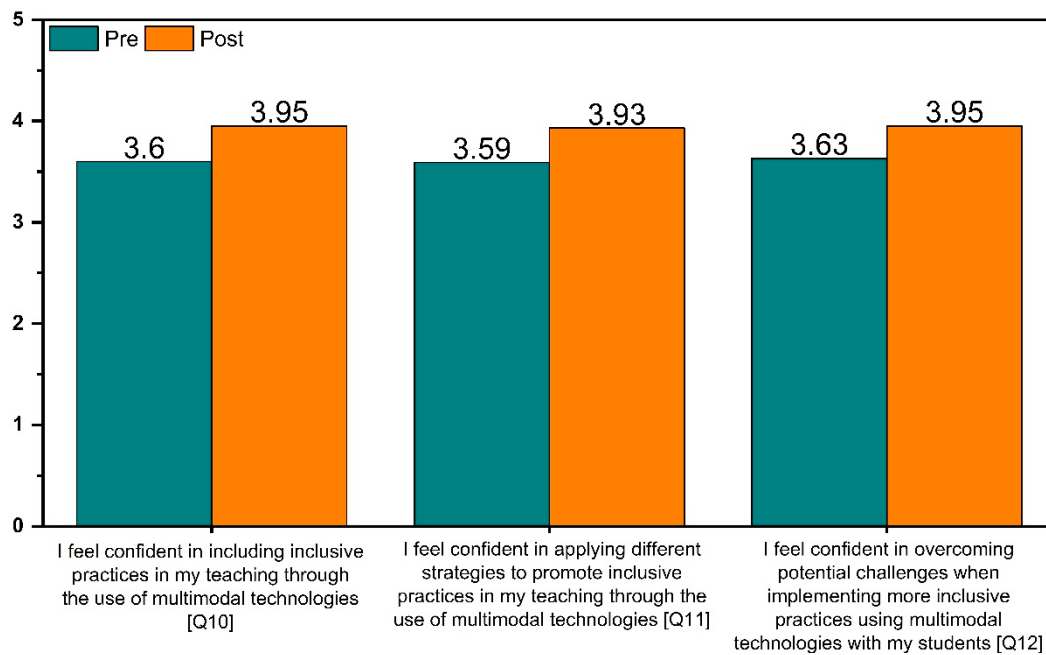


Figure 8. Teachers' perceptions in inclusive practices and multimodality before (pre) and after (post) the SciArt Approach.

As presented above, the questionnaire results revealed a statistically significant increase in mean scores across all items, with effect sizes ranging from small to moderate ($r = 0.20$ – 0.36). While none of the observed effects reached a large magnitude, their consistency across diverse thematic areas—ranging from inquiry-based learning and interdisciplinary connections to identity exploration and inclusive technology use—suggests a meaningful improvement in teachers' self-confidence. These findings highlight the potential practical impact of the professional development program in supporting teachers' readiness to adopt inclusive, inquiry-driven STEAM practices on cultural heritage.

4.3. Teacher Trainers' Perceptions on the Training of Their Peers

Thematic analysis of the focus group conducted with teacher trainers from the implementation countries revealed four major themes, as presented in Table 2. These highlight the challenges, reflections, and perceived impact of the SciArt pilot implementation.

Table 2. The challenges, reflections and impact of the SciArt pilot implementation.

Themes	Subthemes
Navigating Complexity in Interdisciplinary Facilitation	Initial Confusion and Progressive Familiarization
Tensions and Synergies Between Science and Art	Supporting Role of Materials and Structure
Catalysts for Engagement and Professional Growth	Perceived Imbalance and Readiness of Science Materials
Structural Constraints and Transformative Value	Striving for Balance through Adaptation
	Collaborative Design as Turning Point
	Role of Videos, PowerPoints, and Hands-On Activities
	Need for Curricular Alignment
	Time Pressure Across All Phases
	Perceived Educational Value and Motivation

4.3.1. Navigating Complexity in Interdisciplinary Facilitation

Teacher trainers described a variety of difficulties in understanding and delivering the interdisciplinary content, particularly in the early stages. Many of them felt an initial uncertainty due to their limited background in either science or the arts. However, that

initial insecurity was transformed into confidence through the collaboration with and the support from the fellow trainers. Teacher trainer 1 describes:

“At the very beginning, it was quite difficult for me to understand.”

Others echoed this, noting that discussions with colleagues, particularly those from different disciplinary backgrounds, enabled them to better interpret and convey the materials:

Teacher trainer 2: *“With all the worksheets and talking to an actual science teacher, everything was much clearer.”*

The resources and the materials (worksheets, e-book, PowerPoint slides) were repeatedly praised for their clarity and structure. Their role as helpful scaffolds for trainers' preparation and delivery was highlighted.

Teacher trainer 3: *“The worksheets were of excellent quality in every term, in every meaning.”*

Teacher trainer 5: *“The material we had was really helpful in our preparation as trainers.”*

4.3.2. Tensions and Synergies Between Science and Art

Teacher trainers also underlined an imbalance between science and art content. The majority of the trainers agreed that the science components (see archaeometric methods) were more structured and ready to implement, while arts segments required greater improvisation and creativity by the end users (teachers participating in the PD program).

Teacher trainer 2: *“The science worksheets were 100% ready to be implemented in the classroom.”*

Teacher trainer 4: *“The language teachers had more difficult work and they had to imagine and design the activities themselves.”*

Despite the imbalance in the material designed by the project staff members, trainers identified a range of strategies to address it. They suggested that providing concrete, pre-designed examples would serve as an important support mechanism. Such examples were prepared and used by the teacher trainers during the implementation of the PD program as additional material they created. Trainers expressed that having complete sample activities would aid teachers better understand how to integrate the two domains:

Teacher trainer 5: *“I would create one or two examples with a complete story from the beginning to the end with specific connections.”*

4.3.3. Catalysts for Engagement and Professional Growth

Engagement among participating teachers increased notably when they moved from passive reception to active collaboration and design. Trainers described these moments of co-construction as pivotal, both for understanding the approach and for fostering teacher motivation.

Teacher trainer 2: *“As soon as they started designing. . . it started feeling more possible.”*

Multimodal resources—such as videos, activity books, and augmented tools—played a vital role in enhancing understanding and sparking creativity.

Teacher trainer 4: *“The video definitely shows them how to do exactly what they need to do.”*

Teacher trainer 3: *“We gave them the 100 activities and the activity book. . . they started having ideas.”*

4.3.4. Structural Constraints and Transformative Value

While teacher trainers recognized the approach as well-received, they emphasized structural challenges that hindered its full implementation. The most significant of these were time constraints. Teacher trainers underlined the extensive amount of time required both for the initial PD program and for lesson planning and classroom delivery.

Teacher trainer 1: *“The greatest challenge was time. Before, during, and after implementation.”*

Teacher trainers also noted that the existing school curriculum creates obstacles for an interdisciplinary approach like SciArt, highlighting concerns about the institutional alignment.

Teacher trainer 5: *“Teachers needed to align all that we gave them with the contents they need to teach based on their curricula.”*

Despite these barriers, teacher trainers expressed enthusiasm for the SciArt approach, describing it as motivating, inclusive, and pedagogically sound.

Teacher trainer 2: *“It’s one of the few times that I’m attending something that I really like and enjoy.”*

Teacher trainer 3: *“This is how teaching should be done in our everyday life in schools.”*

These findings suggest that while the pilot PD program and classroom implementation presented practical challenges, it also held transformative potential for teacher development and inclusive, interdisciplinary practice.

5. Discussion

The results mentioned in detail in Section 3 provide clear answers to the three research questions initially posed. In addressing the first research question, the findings show that participating teachers evaluated the SciArt PD Program very positively, particularly in terms of its structure, content, and relevance to their professional needs. Over 86% of teachers found the content either “very relevant” or “sufficiently relevant,” while a similarly high percentage, reported that the PD program met their expectations either completely or to a great extent. The thematic modules were consistently rated favorably, with mean scores indicating high satisfaction with the clarity, quality, and educational value of the PD program materials. Teachers particularly appreciated the interdisciplinary integration of science and cultural heritage and the PD program’s practical resources (e.g., worksheets, videos, AR tools), which supported classroom implementation and engaged students in meaningful inquiry. Darling-Hammond et al. ([Darling-Hammond et al., 2017](#)), in their review of several studies on the effectiveness of professional development programs, summarized seven common characteristics of successful PD programs. Among them, they mention that meeting teachers’ needs and focusing on specific content, as in the SciArt program, ensures that participants can effectively use the suggested practical resources to support teacher learning within the same context in which they will apply them ([Tsaliki et al., 2024](#)).

Moreover, results provide strong indications about the issue raised by the second research question. SciArt PD Program significantly improved teachers’ self-efficacy across four thematic areas: inquiry-based learning, science-heritage integration, cultural identity exploration, and multimodal inclusion. Teachers reported feeling more capable of designing and delivering inquiry-based STEAM activities, creating interdisciplinary links between science and cultural heritage, and using diverse tools to help students critically explore themes of identity and cultural narratives. Relative literature highlights the importance of hands-on workshops to boost teachers’ self-efficacy for integrating arts and STEM ([Jiang et al., 2024](#)). Furthermore, the increase in confidence regarding the use of multimodal and

inclusive strategies supports previous research suggesting that professional development programs grounded in Universal Design for Learning (UDL) principles are more likely to foster equity-driven instructional change (Boyle et al., 2023). In this respect, SciArt's integration of Augmented Reality (AR), visual artifacts, and interdisciplinary resources created conditions for reflective, culturally responsive pedagogy, particularly relevant in multicultural contexts like those of Cyprus and parts of Europe (Charalambous, 2019; Porto & Zembylas, 2022). These findings align with previous research which emphasizes the importance of robust, context-based professional development to enable lasting pedagogical transformation and effectively face other research findings pointing out teachers' insecurity about their readiness to develop interdisciplinary, object-based inquiries (Margot & Kettler, 2019; Wu & Zhou, 2025).

As far as the third research question is concerned, teacher trainers across the three countries described their experience as both challenging and transformative. Initially, many trainers faced difficulty navigating the interdisciplinary nature of the content, especially when they lacked expertise in either science or the arts. However, this initial uncertainty gave way to greater confidence through creative collaboration with colleagues, a crucial and supporting factor recorded in other PD research (Darling-Hammond et al., 2017; Doyle et al., 2020). Despite imbalances in content readiness, possibly echoing concerns raised in the literature about the instrumentalization of the arts in STEAM (Colucci-Gray et al., 2021; P. Leavy, 2022), trainers responded creatively by designing additional example activities concerning art and cultural identity components and fostering collaborative design among participants. They identified these moments of co-construction as critical for teacher engagement and professional growth. Indeed, promoting peer collaboration and encouraging sharing ideas is a core element of many effective PD programs (Tsaliki et al., 2024). Research has shown that when participants are actively engaged in designing and implementing new teaching approaches, they feel more confident and develop appropriate skills to guide their students effectively through suggested activities while at the same times empowers students learning (Zhang et al., 2024). While some improvements reached statistical significance, the practical implications are equally noteworthy. Beyond numerical changes, teachers reported enhanced confidence in applying inclusive inquiry strategies, suggesting meaningful pedagogical impact that extends beyond statistical outcomes.

Findings also revealed that systemic barriers, especially time constraints and curriculum alignment, were considered important by both teachers and trainers. These findings resonate with past studies indicating that without institutional support, time, and curricular flexibility, interdisciplinary approaches are often difficult to sustain (Doyle et al., 2020; Margot & Kettler, 2019). However, the enthusiasm and increased motivation reported by participants also reflects the transformative potential of such initiatives when accompanied by thoughtful, scaffolded design. Moreover, programs that promote inclusion through UDL checkpoints or equity-driven design studios, may correlate with greater adoption of multimodal strategies (Thoma et al., 2023). The collaborative nature of the SciArt PD program, involving educators, academics, and museum professionals, appears to have been a catalyst for professional growth and a model for peer collaborations and community-based professional learning relating to effective in PD (Darling-Hammond et al., 2017; Doyle et al., 2020; Tsaliki et al., 2024) boosting teachers' self-efficacy for integrating arts and STEM (Jiang et al., 2024; Prenger et al., 2019).

6. Conclusions

SciArt findings demonstrate the potential of interdisciplinary, inclusive, and inquiry-based approaches to transform teaching practices related to STEAM and cultural heritage. The study revealed that structured, theoretically grounded PD programs, supported by

multimodal and digital tools can enhance teachers' competence and self-efficacy in addressing identity narratives, while engaging in inclusive, multimodal practices. Teacher trainers emphasized both the benefits and the challenges of implementing such an innovative model. While initial confusion and imbalances between science and art content were noted, collaboration and high-quality materials helped overcome these barriers, underscoring the importance of interdisciplinary cooperation among teachers of different disciplines in fostering confidence and professional growth. Nevertheless, structural limitations, time constraints, and curriculum alignment are indicative of the need to support that such interdisciplinary approaches can be widely adopted.

The SciArt project also highlights the potential of integrating archaeometric methods into cultural heritage education as a means of fostering critical inquiry, identity exploration, and more inclusive pedagogical approaches. It further illustrates the importance of fostering cross-sector collaboration and designing professional development programs that are not only content-rich but also innovative, promote peer collaboration and make suggested resources applicable in real teaching conditions. Future research should focus on the long-term impact of inclusive STEAM programs on teachers' professional development and possible learning outcomes, particularly regarding identity formation, critical thinking, and engagement with science and heritage across formal education systems.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Appendix A

The tables below present the mean and standard deviation (SD) of responses for all questionnaire items presented in the main manuscript, supplementing the graphical data.

Table A1. Descriptive Statistics (Mean and Standard Deviation) of Teachers' Self-Efficacy Scores in the Pre- and Post-Test.

Question	Mean (Pre-Test)	SD	Mean (Post-Test)	SD
Q1	3.66	0.84401	4.12	0.64375
Q2	3.54	0.79852	4.14	0.64375
Q3	3.68	0.78893	4.04	0.69697
Q4	3.62	0.83557	4.15	0.61600
Q5	3.63	0.81286	4.03	0.66658
Q6	3.62	0.73573	4.07	0.64375
Q7	3.73	0.75787	4.16	0.71735
Q8	3.66	0.74917	4.08	0.68128
Q9	3.64	0.74122	4.04	0.66658
Q10	3.6	0.76438	3.95	0.74132
Q11	3.59	0.76764	3.93	0.78431
Q12	3.63	0.75202	3.95	0.74132

Table A2. Descriptive Statistics (Mean and Standard Deviation) of Participants' Evaluations of the SciArt Professional Development Program.

Question	M	SD
To what extent do you feel the SciArt Training Course has successfully met its stated aims and objectives?	4.20	0.615
To what extent has the SciArt Training Course met your personal expectations?	4.15	0.730
How relevant and useful did you find the overall training course content to your professional work?	4.27	0.844
Module 1: The SciArt Approach	4.48	0.554
Module 2: Connecting Science to Cultural Heritage Artefacts	4.55	0.599
Module 3: Exploring National and European Identity through Artefacts	4.47	0.644
Module 4: Promoting Inclusion through Multimodality and AR	4.36	0.629
Module 5: SciArt Implementation	4.39	0.695
Module 6: Evaluation	4.33	0.664
The activities are generally well-structured.	4.38	0.587
The activities are designed in a way that makes them feasible to implement in the classroom.	4.10	0.810
The activities encouraged my students to explore the material aspects of artefacts.	4.30	0.654
The activities are clear regarding how to implement them in the classroom.	4.24	0.733
The instructions enabled my students to critically explore the connection between artefacts and identity narratives.	4.25	0.667
The resources helped my students better understand the relationship between arts and science	4.27	0.820
The length of the videos in ALIs is appropriate for the students' age.	4.05	0.686
The reports and ALI are useful for implementing the Activities.	4.21	0.669
The resources support the activities.	4.34	0.664

Notes

- ¹ The partners of the SciArt project include the European University of Cyprus, the Anastasios G. Leventis Foundation, and the Falcon School, in Cyprus; the Aristotle University of Thessaloniki, the University of Western Macedonia, and the Experimental

School of the University of Thessaloniki, in Greece; the Polytechnic Institute of Porto, the Municipal Museum of Esposende and the Eugénio de Andrade School, in Portugal. The Museum of Byzantine Culture of Thessaloniki is an associate partner of SciArt.

² <https://sci-art.eu/resources/> (accessed on 10 November 2025).

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