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UPSKILLING AND RESKILLING CULTURAL HERITAGE PROFESSIONALS: EVIDENCE FROM A WORKSHOP ON METAVERSE EXHIBITION DESIGN

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Abstract

This article supports the involvement of cultural heritage professionals (CHPs) in the design process for creating engaging exhibitions, emphasizing the importance of equipping them with the necessary digital skills and tools. To this end, it reports on an intensive workshop entitled "Platforms and Tools for Digital and Virtual Exhibitions," conducted for CHPs in the Apulia region, Italy. The workshop aimed at developing skills and knowledge in designing digital exhibition environments aligned with European recommendations for digitalizing cultural heritage. Over 16 hours, distributed into four online sessions, the workshop introduced theoretical frameworks, case studies, and hands-on practice using Spatial and Artsteps. Evaluation data collected from 21 participants assessed self-efficacy to measure how well-prepared participants feel, perceived learning to gauge their perceptions of learning, and usability to measure their familiarity with the platforms covered, indicating significant learning outcomes and positive user experiences.

Keywords

Digital Cultural Heritage, Metaverse, Cultural Heritage Professionals, Self-Efficacy, Perceived Learning, SUS.

1. Introduction and Research Aim

In recent years, cultural institutions such as museums, libraries, archives, archaeological sites and galleries have increasingly adopted digital transformation strategies to improve accessibility and audience engagement and to preserve cultural heritage (Gervasi et al., 2022; Botte et al., 2024; Anwar et al., 2025). Digital and virtual exhibition platforms offer innovative ways to engage with a broad international audience in line with contemporary digital practices (Angeloni, 2023; Pagliano & Ansaldi, 2023; Vital et al., 2023).

However, despite the European Union's recommendations to strengthen the digital skills of cultural heritage professionals (CHPs), particularly in relation to 3D digitisation, access to digital data, and professional training (European Commission, 2021), there is often a lack of digital literacy among professionals. This limits the concrete implementation of digital strategies within cultural institutions.

In this context, the concepts of upskilling and reskilling are particularly relevant as they support the adaptability of human capital in the face of ongoing technological transformation. Upskilling involves strengthening existing competencies to address technological developments within the same role, while reskilling involves acquiring new competencies to take on different roles, often in response to structural changes in the labour market (Orphanidou et al., 2024).

In response to this need, the research group at the Polytechnic University of Bari, as part of the Digital Cultural Heritage Puglia Skills Lab project and in line with the National Plan for the digitisation of cultural heritage, developed an inclusive training offer through co-design sessions (technical roundtables and focus groups) with cultural operators in response to the PNRR call.

This programme includes workshops, activities, and structured learning paths aimed at strengthening the competencies of CHPs and experimenting with innovative solutions for the promotion and enhancement of cultural heritage.

One such course is the workshop entitled “Platforms and Tools for Digital and Virtual Exhibitions”, which aims to provide professionals with the theoretical foundations and practical skills necessary to design engaging virtual

exhibition experiences. The course explored user-friendly platforms such as Spatial and Artsteps to create immersive and interactive environments in line with European digitalisation guidelines.

This article presents a case study from the Apulia region of Italy, in which CHPs operate museums, libraries, archives, parks, and galleries. Across the region, the study looks at how collaboration among local practitioners can be encouraged to build a scalable digital cultural ecosystem and support the broader European ecosystem.

Contributing to the literature on digital training in the cultural sector, the article proposes and evaluates a practice-oriented workshop model aimed at strengthening the capacity of CHPs to design digital and virtual exhibitions. It underscores the importance of equipping CHPs with the tools to engage with increasingly demanding, interconnected, and international audiences, ensuring sustainable digital growth and continuous intergenerational dialogue in line with EU guidelines.

Beyond merely reporting on the experience, the paper aims to: (i) formalise a replicable workshop design that is grounded in explicit pedagogical objectives; (ii) document the rationale behind the selection of accessible exhibition platforms; and (iii) provide initial evidence, through the use of validated evaluation instruments, of the model's potential to support the upskilling and reskilling of CHPs in institutional contexts where resources are limited.

More specifically, the workshop was designed to pursue four interconnected objectives: (i) enabling CHPs with limited technical backgrounds to design basic digital and virtual exhibitions autonomously using accessible platforms; (ii) fostering an operational understanding of the different types of digital exhibitions, ranging from static virtual galleries to immersive and collaborative environments; (iii) supporting the transfer of these competencies to the participants' institutional contexts by developing concrete exhibition prototypes; and (iv) stimulating peer exchange and networking among local professionals, which is a prerequisite for building a scalable, collaborative digital cultural ecosystem.

2. Background

Previous scientific literature highlights the still marginal participation of CHPs in the design processes of digital and interactive exhibitions, a condition often attributed to a lack of specific digital and design skills (Hornecker et al., 2013; Maye et al., 2014; Cesário et al., 2025). Despite the growing demand for immersive and technologically advanced museum experiences, many CHPs lack both the appropriate tools and the necessary training support to contribute actively and knowingly to the design of such experiences (Nikolaou, 2024).

The platforms currently available on the market are frequently geared toward expert users or those with a solid technical background, effectively excluding a large share of CHPs from creative processes. This situation has produced a significant gap between the potential offered by digital technologies and cultural institutions' actual ability to conceive, develop, and manage interactive and engaging exhibition environments.

Among the few contributions that concretely address this issue, the study by Cesário et al. (2025) is particularly noteworthy. The authors propose a training approach based on accessible authoring tools, aimed at strengthening museum curators' design autonomy and promoting their active inclusion in digital innovation processes. Specifically, they present EasyMuseumARCreator, a desktop content-management system that allows CHPs to easily create, update, test, and modify interactive exhibitions. Each piece of content generated is associated with a QR code, which can be read by the EasyMuseumARViewer mobile application, enabling visitors to experience the exhibitions in augmented reality (AR).

However, beyond this contribution, the current scholarly literature offers no significant examples of training strategies oriented toward the upskilling or reskilling of CHPs with regard to virtual-exhibition design.

This points to a clear research gap and, at the same time, an urgent need to develop and share effective pedagogical models to support cultural institutions' digital transition.

Against this backdrop, there is a need not only for new technological tools, but also for clearly structured training methodologies that translate accessible platforms into scalable professional practices for CHPs.

3. The workshop

The workshop entitled "Platforms and Tools for Digital and Virtual Exhibitions" was designed

within the operational phase of the training actions envisaged by the project and directly responds to the needs that emerged during the participatory analysis of the context, conducted through technical roundtables and focus groups (Di Roma et al., 2025).

The workshop was designed following a practice-oriented and learner-centered methodology, informed by the outcomes of preliminary co-design activities with CHs.

These activities contributed to calibrating the content and learning pace according to participants' heterogeneous professional profiles and prior digital expertise, with particular attention to the constraints of small and medium-sized institutions.

The workshop was structured as an intensive, professionalizing experience aimed at museum staff, librarians, archivists, and professionals from archaeological parks, with particular attention to small and medium-sized organizations, which are often excluded from institutional training circuits.

The goal was to foster an integrated process of upskilling and reskilling by providing operational tools for the design and management of digital exhibitions and virtual environments (Leon, 2023).

The intensive workshop included 16 hours divided into four interactive online sessions, each lasting four hours, conducted via Microsoft Teams on a flexible schedule (i.e., sessions on Tuesdays and Thursdays):

- Lesson 1: Introduction to digital exhibitions—concepts and structures of virtual reality (VR), AR, metaverse environments, and modes of digital visualization (Bekele et al., 2018; Anwar et al., 2025).
- Lesson 2: Analysis of international and national case studies, classification of digital and virtual exhibitions (from static displays to immersive interactive experiences), and criteria for selecting appropriate technological platforms (See *Table 1*).
- Lesson 3: Practical introduction to the Spatial (metaverse environment) and Artsteps platforms, followed by an in-depth exploration of their features, interfaces, and workflows for creating digital exhibitions.
- Lesson 4: Hands-on exercise with Artsteps, in which each participant created a prototype digital or virtual exhibition tailored to their professional context (See *Table 2* and *Figure 1*).

  The final project was individual and required creating an exhibition that either reproduced a real scenario belonging to their institution or was purely imaginary. The hands-on activities were designed to be adaptable to institutions with different levels of technological readiness, reflecting the heterogeneous digital infrastructures reported by participants.

  The hands-on exercise was conceived not as a technical tutorial, but as a design-oriented task aimed at simulating real institutional constraints, encouraging participants to make curatorial, spatial, and narrative decisions rather than focusing solely on technical execution.

The fully online format was adopted to ensure accessibility for participants distributed across geographically distant areas of the region and to accommodate work-shift constraints, which would have limited attendance in face-to-face sessions.

Each session combined short theoretical inputs with guided demonstrations, hands-on activities, and collective discussion.

This structure was intentionally adopted to balance knowledge transfer with experiential learning and peer interaction, allowing participants to reflect on different design approaches while progressively applying concepts to their own professional contexts.

During the sessions, participants explored the potential of two reference platforms for digital exhibit design: Artsteps and Spatial.

The selection of these technological solutions was guided by a set of predefined criteria, including ease of use for non-expert users, compatibility with low-cost or existing institutional infrastructures, flexibility in supporting different exhibition typologies, and potential scalability across different institutional contexts.

The platforms were analyzed not only from a technical standpoint but also in relation to fundamental implications such as accessibility, audience engagement, and personalization of the exhibition experience.

Tab.1. Overview of the case studies analysed in Lesson 2, categorised according to technology used, content type, and interaction mode. The selected examples span web-based platforms, virtual and augmented reality experiences, immersive installations, and metaverse environments, illustrating different approaches to digital and virtual heritage practices.

Case Study	Technology Used	Content Type	Interaction Mode
Google Arts & Culture (Google, international platform)	Web-based 2D platform	Static digital exhibitions and digitised collections	Browsing and consultation (low interactivity)
Vatican Library Digital Collections (Vatican City)	Web-based digital library (2D)	Digitised manuscripts and heritage collections	Browsing and consultation (low interactivity)
Egyptian Museum of Turin – Virtual Tour (Turin, Italy)	Browser-based 3D virtual tour	Virtual visit of museum galleries	Click-based navigation, zoom, spatial exploration
National Museum of Natural History – Virtual Tour (Washington, D.C., USA)	Browser-based 3D virtual tour	Virtual visit of museum galleries	Click-based navigation, zoom, spatial exploration
The Kremer Collection VR Museum (private collection, international)	Virtual Reality (VR)	VR-native virtual museum	Immersive VR navigation (high interactivity)
The VR Museum of Fine Art (online VR platform)	Virtual Reality (VR)	VR-native virtual art museum	Immersive VR navigation
Mona Lisa: Beyond the Glass – Louvre Museum (Paris, France)	Immersive VR / 3D experience	Virtual reconstruction of a single artwork	Immersive exploration and observation
Flying Scotsman VR – National Railway Museum (York, UK)	Virtual Reality (VR)	VR reconstruction of a museum environment	Immersive VR exploration
Archaeological Excavation – Somma Vesuviana Project, University of Tokyo (Japan)	Virtual Reality (VR)	VR reconstruction of an archaeological site	Immersive VR exploration
Acute Art Virtual Reality (Acute Art, international)	Virtual Reality (VR)	VR-based artistic performances	Immersive experiential interaction
CHROMA AR Experience – The Metropolitan Museum of Art (New York, USA)	Augmented Reality (AR)	On-site augmentation of artworks and narratives	On-site AR interaction via mobile devices
MedievalMe – National Library of the Netherlands (The Hague, Netherlands)	Augmented Reality (AR)	Cultural content augmentation	On-site AR interaction via mobile devices
Project Beyond – Carnegie Museum of Natural History (Pittsburgh, USA)	Augmented Reality (AR)	AR-based museum experience	On-site AR interaction via mobile devices
Ara as it was – Ara Pacis Museum (Rome, Italy)	Augmented Reality (AR)	Historical-artistic reconstruction of monument	On-site AR interaction
Museum from Home App (international, 2020)	Mobile AR application	Remote AR cultural experience	Remote interaction via smartphone or tablet
Story of the Forest – teamLab (Japan)	Immersive multimedia installation	Digital storytelling and video mapping	Sensory and environmental immersion
Imagine Van Gogh – Exhibition at La Rural (Buenos Aires, Argentina)	Immersive multimedia installation	Digital art exhibition	Sensory immersion
Metaverse-native museum prototype (various platforms)	Metaverse environments	Virtual museum/gallery	Avatar-based navigation and social interaction
The Met Replica – The Metropolitan Museum of Art on Roblox (New York City, USA)	Metaverse platform (Roblox)	Virtual replica of a physical museum	Avatar-based exploration and social interaction
Ai-Da – Aidan Meller Gallery (London, UK)	Artificial Intelligence (AI)	AI-generated art and NFT-related content	Digital observation and participation
NFT Gallery – Decentraland (virtual world)	Metaverse (Decentraland) + NFTs	NFT and crypto-art gallery	Avatar-based navigation and interaction

Fig.1. Two case studies of cultural experiences in the metaverse on ArtSteps:
On the left, a gallery; On the right, a library.

Tab. 2. Overview of the hands-on activities carried out in Lesson 4, illustrating the pedagogical phases, digital tools, and expected outputs involved in the design of a digital/virtual exhibition using ArtSteps.

Phase	Activity	Tool	Expected Output
Phase 1	Spatial planning and layout definition	Paper sketch + ArtSteps grid	Exhibition floor plan
Phase 2	Construction of walls and entrances	ArtSteps 3D editor	Virtual architectural space
Phase 3	Visual configuration (walls and floors)	ArtSteps material editor	Customised exhibition environment
Phase 4	Content integration (images, text, audio, video, 3D objects)	ArtSteps Content Management System	Digital artefacts placed in the virtual space
Phase 5	Visitor path and experience planning	ArtSteps viewer	Simulated visitor journey
Phase 6	Publication and sharing	Web link	Online virtual exhibition

Spatial, an immersive environment based on the metaverse, enables the creation of virtual spaces accessible via VR headsets, mobile devices, and desktops (Zhang et al., 2022). It emerged that this platform is particularly suited to real-time collaborative scenarios, offering high levels of customization, despite the presence of certain limitations associated with free resource access.

By contrast, Artsteps proved to be a more immediate and flexible solution for creating static yet effective virtual exhibitions, thanks to its intuitive interface, compatibility with a wide range of multimedia content, and the possibility of integration in educational and promotional contexts, including by non-expert users (Tasiouli et al., 2025).

The practical exercises allowed participants to conceive and develop exhibition projects based on content from their own institutions, experimenting with modes of interactive digital storytelling and strategies for accessing heritage that are decoupled from the physical constraints of traditional display. The teaching approach, centered on active learning, promoted critical reflection on different models of virtual exhibitions, supported by a review of national and international case studies selected for their design and technological merit.

Moreover, the experimental component of the activity provided a space for dialogue among participants, fostering the exchange of experiences and the co-creation of design solutions adaptable to different contexts. This workshop-based dimension proved strategic not only for enhancing digital skills but also for activating professional networks oriented toward the digital transformation of cultural heritage, in line with European recommendations on access, valorization, and sustainability.

4. Methodology

The workshop evaluation was conducted through a structured questionnaire administered at the end of the training activities via Google Forms.

4.1 Participants

Regarding institutional equipment, most participants (n = 18; 85.71%) reported access primarily to basic digital tools, such as institutional websites. A smaller proportion (n = 11; 52.34%) indicated the availability of intermediate solutions, including interactive screens, mobile applications, digital audioguides, or virtual tours. Only one institution out of 21 reported access to immersive technologies such as VR experiences with HMDs (e.g., Meta Quest 2).

4.2 Measures

The evaluation design incorporated three instruments, each designed to measure a key dimension of learning and the training experience: perceived self-efficacy, perceived learning, and the usability of the digital platform. This combination made it possible to obtain a multilayered view of the program's impact, going beyond mere subjective satisfaction to include aspects related to competence, engagement, and interaction with the proposed technological tools.

The construct of self-efficacy, introduced by Albert Bandura (1977), refers to the confidence an individual places in their ability to organize and execute the actions necessary to handle specific situations. In the context of the workshop, self-efficacy was measured through a set of statements adapted to tasks specific to the digital design of virtual exhibitions, with explicit reference to tools

such as ArtSteps. Participants rated their confidence in overcoming unforeseen obstacles, tackling complex tasks, and solving problems related to the use of the platforms. Responses were collected on a 7-point Likert scale, from 1 ("not at all true") to 7 ("completely true"), in line with indications from the literature.

The dimension of perceived learning was investigated through items designed to capture the extent to which participants believed they had acquired knowledge and skills during the course. The concept refers to the subjective perception of an intervention's educational effectiveness, assuming that awareness of learning is a valid indicator of engagement and practical utility. The statements addressed both theoretical acquisition and the strengthening of operational competencies. Here, too, a 7-point Likert scale was adopted. The methodological reference is the work of Caspi et al. (2006), which explores the relationship between individual characteristics and perceived learning in digital educational contexts.

The usability of the ArtSteps platform was assessed by adapting several items from the System Usability Scale (SUS), which enables a quick yet reliable evaluation of a system's ease of use, functional integration, and learnability. The questions used explored perceptions of complexity, consistency, confidence in use, and desirability of future use, employing a 1–5 scale. The adaptation retained the original scale's balanced structure, alternating positive and negative statements.

Together, these three metrics provided a triangulated picture of the training experience, integrating self-perceived competence, the value attributed to learning, and the ease of use of the proposed tools. Their combined use enabled a more robust analysis of the workshop's effectiveness, in line with European recommendations on digital training in the cultural sector.

5. Results

The analysis of the data from the evaluation questionnaire highlights a substantial baseline skills gap. Regarding participants' familiarity with the use of VR and the metaverse in the cultural heritage domain, the results indicate a rather limited initial competence: on a 7-point Likert scale (1 = no familiarity), 11 participants assigned a score of 1, 2 participants a score of 2, another 2 a score of 3, 5 a score of 4, and only 1 participant a score of 6. This distribution confirms the need for targeted upskilling and reskilling initiatives to bridge the digital divide in the cultural heritage sector. While the baseline data highlight a limited initial familiarity with immersive technologies, the pre- and post-course comparison provides quantitative evidence of the impact of the training activities on participants' digital competencies.

Participants' self-assessed knowledge of platforms and tools for digital and virtual exhibitions (5-point Likert scale; N = 21) shows a clear increase from pre- to post-course evaluation. Before the course, the majority of participants reported low familiarity, with 13 out of 21 respondents (61.9%) selecting levels 1–2. After completing the course, responses shifted towards higher levels, with 16 participants (76.2%) reporting high familiarity (levels 4–5). Overall, 17 participants (81.0%) reported an improvement in their self-assessed competence, while 4 participants reported no change.

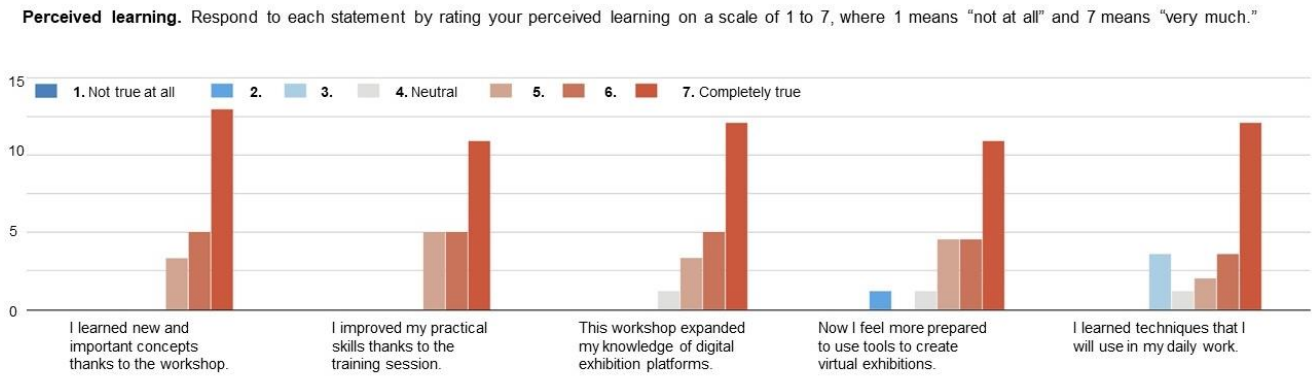

Fig. 2. Perceived learning scale results based on the 5 statements

5.1 Perceived learning

Participants were asked to rate their learning on five statements using a 7-point Likert scale (1 = "not at all," 7 = "very much").

Central tendency was very high across all items: the median is 7 (IQR = 6–7) for four out of five statements, and 6 (IQR = 5–7) for the item on the future use of the techniques acquired (see *Figure 2*).

In terms of frequencies, over 80% of ratings fall in categories 6 and 7, indicating a marked effect of the workshop: Concepts learned and Knowledge of digital platforms are the highest-rated items (62–67% "7 = completely true"); Preparation for using tools for virtual exhibitions shows a slightly broader distribution, with 14% of responses ≤ 4; the only sign of uncertainty concerns everyday applicability: 19% fall in the 3–4 range.

The composite perceived learning index (mean of the five items) is M = 6.33 ± 0.58, with values between 4.8 and 7.0. The scale showed excellent internal consistency (Cronbach's α = 0.92), confirming the reliability of the measurements.

Overall, the results indicate that the workshop generated substantial and transferable learning, but they also suggest strengthening the applied components (i.e., guided exercises, use cases) to increase perceived utility in everyday work and further reduce variability on the "techniques to use every day" item.

5.2 Self-efficacy

The data on perceived self-efficacy offer further interpretive insights. The self-efficacy construct was measured with five statements rated on a seven-point Likert scale (1 = "not at all true," 7 = "completely true"). The composite index, calculated as the arithmetic mean of the five items, is M = 5.18 with SD = 1.48; the median is 5.8, while the interquartile range lies between 4.2 and 6.0, indicating a distribution that tends to be shifted toward the upper end of the scale. The items show excellent internal consistency (Cronbach's α = 0.97), confirming that the statements measure a single dimension of personal confidence in one's abilities.

An analytical examination of the individual items reveals specific differences within an overall positive picture (see *Figure 3*). The statement that, with sufficient effort, most problems related to digital platforms can be solved garners the highest level of agreement (M ≈ 5.7); two-thirds of participants choose scores of 6 or 7, indicating a high level of optimism about their problem-solving. Very similar mean values (around 5.1) are recorded for the ability to tackle complex tasks and to manage problematic situations during the development of digital exhibitions. The only notable deviation concerns the item on working without external support, which drops to M ≈ 4.9: in this case, almost a quarter of the sample falls at values ≤ 3, indicating a segment of users who do not yet feel fully autonomous in more advanced activities.

Overall, the workshop appears to have generated a medium-to-high level of self-efficacy, particularly pronounced in the areas of personal effort and problem management, but with room for improvement in perceived autonomy. Integrating guided exercises, self-help resources, and mentorship opportunities could help reduce the share of participants who continue to feel the need for external support, further shifting the

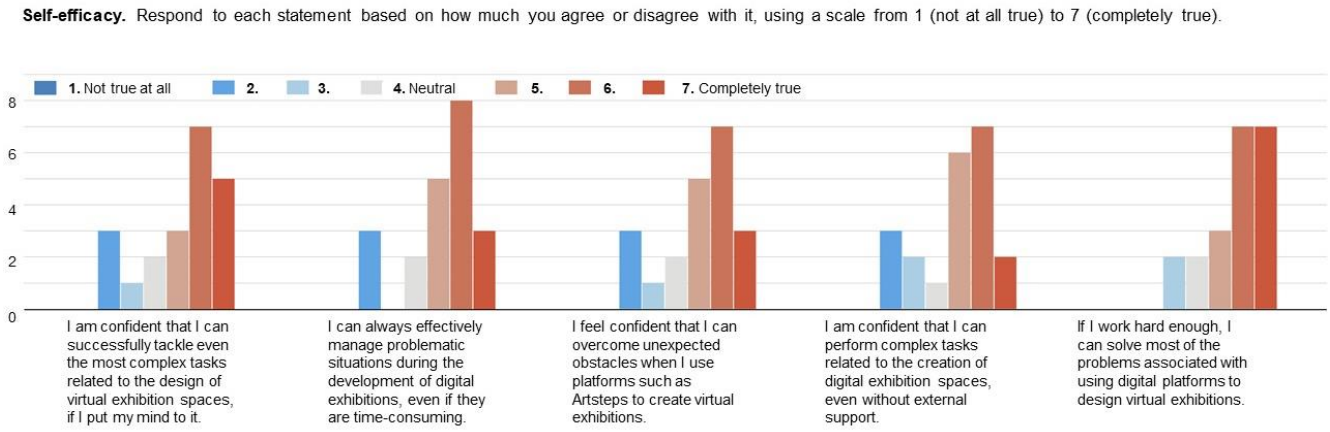

Fig. 3. Self-efficacy scale results based on the 5 statements

score distribution toward the upper end of the scale.

5.3 System Usability Scale

The SUS administered to 21 participants yielded a mean score of 70.8 ± 12.0 (M ± SD) and a median of 68 (IQR = 60–80) (see *Figure 4*, section a). According to Bangor et al. (2009), this corresponds to the "Good/Acceptable" range (grade B); our value falls at the 55th percentile of the normative database of >5,000 software products (see *Figure 4*, section b), thus slightly above the average (50th percentile).

The item-level analysis (see *Figure 4*, section c) shows strong agreement with the positive statements "ArtSteps is easy to use" (Q2, 48% "Agree/Strongly Agree") and "The functions are well integrated" (Q8, 57%). By contrast, items related to learnability and confidence show room for improvement: 33% report needing assistance to use the system (Q4) and 24% report not feeling confident while using it (Q9).

Overall, the results indicate good usability but suggest intervening on initial training, contextual help messages, and error handling in order to push the score toward the "Excellent" range (>80) and the 80th percentile. With a sample of 21 users, the standard error of the SUS (≈ 2.6 points) is already stable, so further sessions should focus on targeted redesign tests rather than increasing the sample size.

From a qualitative point of view, the evaluation of the training experience as a whole was broadly positive. Participants gave an average score of 4.67 out of 5 for the overall quality of the course. The instructors were rated as excellent both for their expertise and for their clarity of communication and ability to engage. The most appreciated components of the course, according to open-ended responses, include the hands-on, workshop dimension; the opportunity to learn about and experiment with new tools; and the instructors' availability. Suggestions for improvement include interest in in-person sessions and expanding the practical component. In sum, the questionnaire

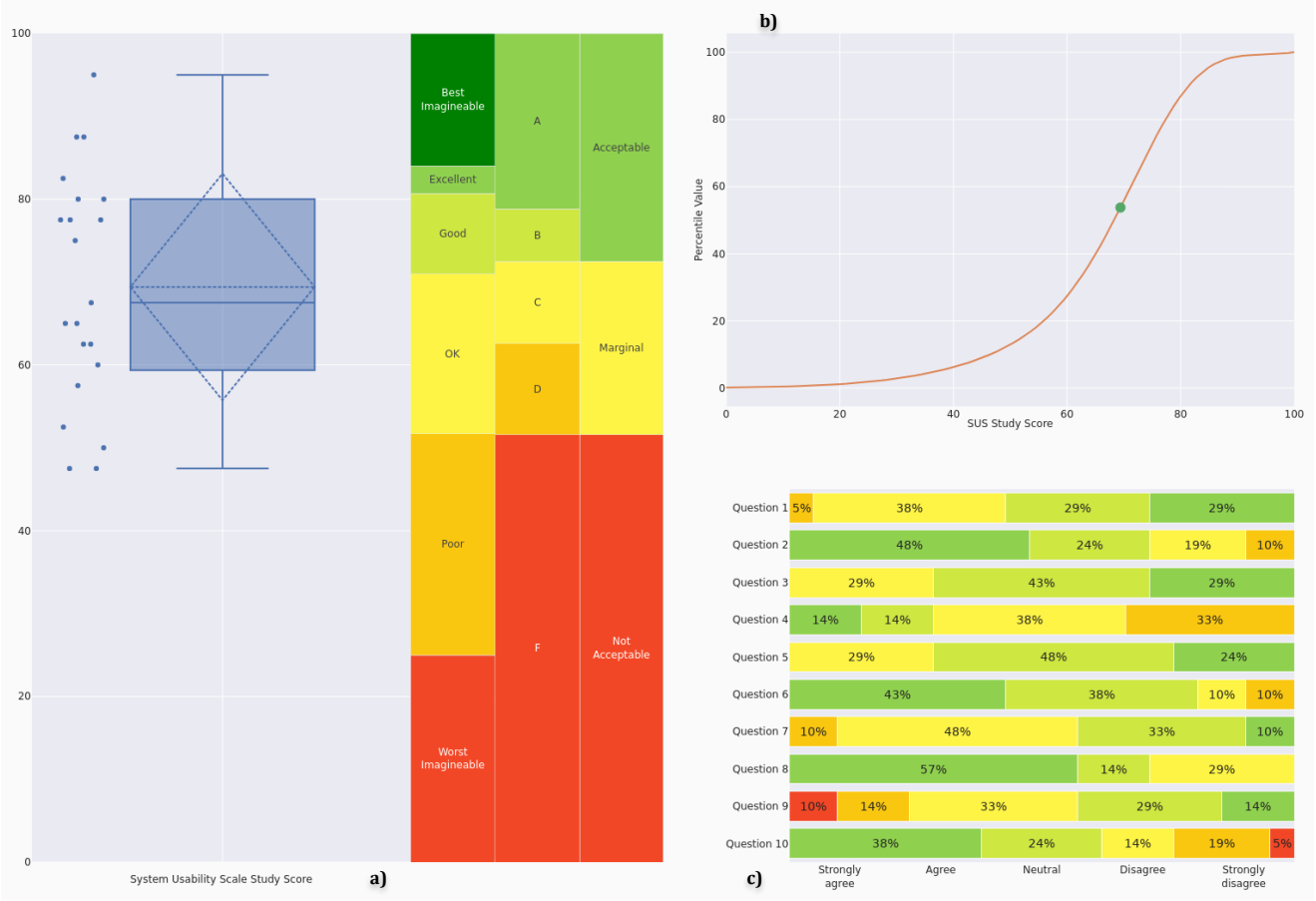

Fig. 4. Usability scale results based on the SUS questionnaire

results point to an effective training experience across multiple dimensions: increased knowledge, strengthened self-efficacy, appreciation of the teaching methodology, and a positive perception of the usability of the digital tools introduced.

6. Discussion

The workshop results show that brief, intensive pathways based on accessible platforms can contribute to bridging CHPs' digital skills gap, yielding very high perceived learning (M = 6.33 ± 0.58) and a good level of self-efficacy (M = 5.18 ± 1.48), supported by an overall positive usability assessment of the ArtSteps platform (SUS = 70.8 ± 12.0) (Bandura, 1977; Bangor et al., 2009).

These findings suggest that the combination of hands-on exercises, prototyping, and peer exchange is a crucial training lever to foster upskilling and reskilling processes in line with European recommendations on digitalization: the workshop-based dimension, the adoption of user-friendly technical solutions (ArtSteps for static exhibitions, Spatial for collaborative metaverse environments), and the building of professional networks emerge as substantive strengths of the format.

Nonetheless, some critical issues remain: the exclusively online nature of the course limited the face-to-face support requested by part of the cohort; the time intensity reduced opportunities for theoretical reflection; and effectiveness depended on stable connectivity—a factor not always guaranteed in small museums in rural areas. Moreover, the study presents two methodological limitations: data were collected only post-intervention, without a pre-test that would have enabled a more rigorous quantification of the change in self-efficacy, as recommended by the pre/post-design literature; and the small sample (n = 21) limits the generalizability of the results. Nevertheless, prior research shows that, with validated scales and homogeneous samples, post-only measurements can still yield reliable estimates of perceived change (Caspi et al., 2006). Accordingly, the findings should be interpreted as exploratory evidence of feasibility and perceived learning outcomes rather than as definitive or generalisable effects.

Moreover, the evaluation relied primarily on self-reported measures (perceived learning, self-efficacy, usability), without incorporating objective performance indicators such as the assessed quality of the prototypes produced, task completion rates, or error frequencies during platform use. In addition, the study did not include longitudinal follow-up measures; therefore, the retention and transfer of the acquired skills over time could not be examined. Finally, the limited sample size prevented comparative analyses across target subgroups (e.g., professional role, institutional type, age, or prior digital expertise), which would require larger cohorts and more robust statistical designs.

Finally, the experience with Spatial points to the metaverse's potential as an immersive learning environment capable of enhancing collaborative design and developing a digital mindset oriented toward adopting emerging technologies, while also highlighting the need for phased onboarding strategies and adequate hardware resources for small institutions. Overall, the initiative confirms that targeted training interventions—calibrated to the operational realities of cultural institutions and supported by robust evaluation metrics—are a fundamental step toward ensuring the long-term sustainability and innovation of heritage valorization processes.

7. Conclusions

The workshop "Platforms and Tools for Digital and Virtual Exhibitions" proved to be an effective training intervention for strengthening CHPs' digital skills, as evidenced by increased self-efficacy, high perceived-learning scores, and the good usability of ArtSteps. The integration of user-centered practical activities with emerging technologies fostered the creation of a dynamic regional ecosystem capable of combining cultural content and innovation in line with the European Union's digitization strategies.

The rigorous evaluation strategy—based on validated metrics such as Bandura's self-efficacy scale, the learning-perception model, and Brooke's SUS—provided a structured and validated framework of the training pathway, offering useful guidance for future upskilling and reskilling programs in the sector. In light of the results, there is a need to consolidate blended formats that combine online sessions with in-person meetings, to include pre- and post-intervention measurements for more precise estimates of competence change, and to ensure the infrastructural support essential for adopting

metaverse solutions in small institutions. In this perspective, scalability is not understood as technological replication alone, but as the capacity of CHPs to appropriate, adapt, and redeploy digital exhibition practices within their own institutions and professional networks.

Looking ahead, several limitations of the present study point to clear directions for future work. First, future iterations should involve larger and more diverse samples, enabling comparative analyses across different target groups (e.g., by professional role, age, institutional type, or prior digital expertise) and supporting more robust statistical testing. Second, evaluation protocols should integrate objective performance measures alongside self-reports, such as rubric-based assessments of the virtual exhibitions produced, task completion rates, and error frequencies during key design operations. Third, longitudinal follow-ups (e.g., after several weeks or months) should be introduced to investigate the long-term retention and transferability of skills to real institutional workflows. Addressing these aspects would strengthen the empirical grounding of this training model and provide more actionable evidence for scaling up digital upskilling and reskilling initiatives in the cultural heritage sector.

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