D2.1 - State-of-the-art in training and capacity building

Deliverable Report n. D2.1: final version, issue date on 31/01/2026

Grant Agreement number:	101195149
Project acronym:	3D-4CH
Project title:	Online competence centre in 3D for Cultural Heritage
Funding programme:	Digital Europe
Project coordinator:	Marco Medici, INCEPTION
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Title:	D1.3 - Technical Progress Report
Issue Date:	31/01/2026
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Type:	R – Document, report
Dissemination :	PU – Public

Colophon

3D-4CH is a Digital Europe project co-funded by the European Union under Grant Agreement n. 101195149.

Document History

- 21/08/2025: Document template created
- 27/11/25: Kate Fernie and Catherine Anne Cassidy (CARARE) added section
- 15/12/25: Emanuele Piaia (University of Ferrara) added section
- 17/12/25: Michal Lorek (PSNC) and Luisa Bentivogli and Mauro Cettolo (FBK) added sections
- 17/12/25: Yuliia Frolova, Iana Boitsova (Pixelated Reality) added section
- 18/12/2025: Reviewers identified and added to the document
- 7/1/2026: Emanuele Piaia (University of Ferrara) added the introduction, chapter 5 and conclusion.
- 8/1/2026: Emanuele Piaia (University of Ferrara) added section 4.3
- 18/1/2026: Emanuele Piaia (University of Ferrara), Marco Medici and Roberto Di Giulio (INCEPTION) updating specific sections of the document in response to suggestions received during the review.
- 29/1/2026: Emanuele Piaia (University of Ferrara) added winter school open-badge logo in chapter 4

Table of Abbreviations and Acronyms

Acronym	Meaning
3D	Three-Dimensional
3D-4CH	Digital 3D Competence Centre for Culture Heritage
AI	Artificial Intelligence
AR	Augmented Reality
BLEU	Bilingual Evaluation Understudy
BIM	Building Information Modelling
CC	Creative Commons

CC-BY	Creative Commons By Attribution
CC-BY-SA	Creative Commons By Attribution Share Alike
CC-BY-NC	Creative Commons By Attribution Non Commercial
CC-BY-NC-ND	Creative Commons By Attribution Non Commercial No Derivatives
CC-BY-ND	Creative Commons By Attribution No Derivatives
CEDCHE	Commission Expert Group on the common European Data Space for Cultural Heritage
CH	Cultural Heritage
CHI	Cultural Heritage Institution
chrF	Character n-gram F-score
COMET	Crosslingual Optimized Metric for Evaluation of Translation
CPD	Continuing Professional Development
CV	Curriculum Vitae
DigComp	Digital Competence Framework for Citizens
DIGCURV	Digital Curator Vocational Education (Europe) project / curriculum framework
DMP	Data Management Plan
EC	European Commission
ECTS	European Credit Transfer and Accumulation System
EDCI	Europass Digital Credentials Infrastructure
EDPB	European Data Protection Board
EQF	European Qualifications Framework
ESCO	European Skills, Competences, Qualifications and Occupations
ESG	Standards and Guidelines for Quality Assurance in the European Higher Education Area
EU	European Union
FAIR	Findable, Accessible, Interoperable, Reusable
GDPR	Geographic Information System
GIS	Geographic Information Systems
IoT	Internet of Things
IPR	Intellectual Property Right
KPI	Key Performance Indicator

LiDAR	Light Detection and Ranging
MR	Mixed Reality
MS	Member States
MSI	Multispectoral Imaging
NFDI4Objects	National Research Data Infrastructure consortium for 3D/material objects
OCC	Online Competence Centre
OER	Open Educational Resources
QA	Quality Assurance
QGIS	Quantum GIS
QR	Quick Response
RTI	Reflectance Transformation Imaging
SLS	Structured Light Scanning
SME	Small and Medium-sized Enterprise
Tx.y	Task x.y. according to the Description of Work
UNESCO	United Nations Educational, Scientific and Cultural Organization
VR	Virtual Reality
WCAG	Web Content Accessibility Guidelines
WP	Work package
XR	eXtended Reality

Table of Contents

Executive Summary

This deliverable (D2.1, *State-of-the-art in training and capacity building)* establishes the analytical and operational baseline for WP2 (Training and Capacity Building) within the 3D-4CH project, supporting the design, delivery, publication and recognition of high-quality training through the Online Competence Centre (OCC). It combines a landscape review of training supply and demand in 3D for Cultural Heritage (CH) with a project-specific framework for assessment, digital credentialing, and content readiness, explicitly aligned with the project's quality and data governance.

Chapter 2 reports the results of an international survey carried out under WP2 Task 2.1, complemented by a Ukraine-focused survey and an additional scan of relevant training resources. These provide a picture of the current strengths and opportunities for training and capacity building in 3D for the CH sector in Europe, supported by the need and demand for training amongst CH professionals in Ukraine.

Respondents to the international survey came from 33 countries (mainly European with 4 non-EU responses) indicating the broad geographic sphere of interest in training in 3D, with some variation in availability from country to country. A majority of the respondents (69%) reported themselves as being actively involved in delivering training and capacity building, most of whom were based in educational institutions. 31% of respondents shared information about other training providers, including SMEs in addition to educational institutions. One respondent remarked that there was no training provider in their country yet, hinting at gaps in the landscape of training providers across Europe.

A significant proportion of respondents to the international survey reported having expertise in 3D techniques such as 3D data capture, data processing, visualisation, extended reality applications and data management. Topics which were less well represented included access and licences, uses of AI, 3D data preservation and archiving. The vast majority of respondents reported delivering training on both movable and immovable heritage. Intangible heritage was reported as being covered in training by around 30% of respondents. Notably, the responses to the survey suggest that a majority of the training that was reported is geared towards university students (both undergraduates and postgraduates) and CH professionals. Less training was reported for policy makers, managers and volunteers working in CH institutions.

The training courses reported in the international survey consisted of a mixture of comprehensive, structured learning pathways (e.g. a set of modules within a masters degree programme) and short, targeted modules (e.g. the use of a specific technology such as LIDAR). It is worth noting that training reported by cultural heritage institutions from other providers signifies a demand for short courses and bespoke training to meet specific needs or for career development.

The international survey indicates that current training provisions cover a broad range of topics and themes. However, the results also reveal a bias towards data creation (data capture, processing, and visualisation), with comparatively less availability in areas such as data storage, XR, AI, and the access and re-use of 3D content. The results from the Ukraine survey suggested a clear demand for training that delivers real practical skills coupled with a need to raise awareness of the project policy, planning and data management stages.

Building on this state-of-the-art evidence, **Chapter 3** presents the certification framework adopted within 3D-4CH to ensure that training and capacity-building activities are recognised in a transparent, verifiable, and quality-assured manner. Building on European lifelong learning policies and recent developments in digital credentialing, the chapter first clarifies the scope and methodological positioning of certification in the project and describes how assessment, evidence of learning, and credential issuance are coherently aligned. It then introduces the two main instruments used to certify learning outcomes - Open Badges and micro-credentials - highlighting their specific features and their complementary roles within a coherent certification ecosystem. Subsequent sections explain why Open Badges have been selected as the primary certification mechanism in the current phase, outline a forward-looking pathway for the future integration of micro-credentials, and detail the quality assurance, governance and scientific oversight structures that underpin all certification processes.

Chapter 4 translates the analytical findings and certification logic into implementation readiness. It shows how certification requirements are operationalised through the 3D-4CH curriculum with a standardised syllabus template designed to make each training unit "credential-ready" (by documenting learning outcomes, workload, assessment methods and rubrics, evidence requirements, accessibility, and licensing conditions). The chapter exemplifies the Brussels Winter School (21–23 January 2026) as the first pilot environment to test the end-to-end certification workflow assessment, evidence collection, badge metadata, issuance and verification, generating practical feedback for refinement before scaling training activities across the OCC catalogue. The chapter also introduces the translation workflow to be trialed which will enable the project to make its learning resources more accessible to different language communities in Europe.

Finally, **Chapter 5** consolidates the conditions that enable training contents to be reliably published and reused on the OCC: quality assurance gates (peer review, technical accuracy, accessibility checks, IPR/licensing clearance, and version control) and data ethics safeguards aligned with GDPR and the project's DMP.

Overall, D2.1 provides WP2 and the wider consortium with an evidence-informed basis for prioritising training topics, audiences and formats, while establishing the procedural backbone required to deliver, certify and safely disseminate 3D-4CH training outputs in the next project phases.

1. Introduction

This deliverable (D2.1, State-of-the-art in 3D training and capacity building) provides the WP2 analytical baseline for designing, delivering, and recognising high-quality training within the 3D-4CH Online Competence Centre (OCC), a central, user-friendly online platform that brings together training (including certified learning pathways), guidelines, standards, and best practices to help Cultural Heritage Institutions plan and carry out high-quality 3D digitisation and the uptake of advanced technologies (e.g. 3D, AI, XR).

It responds to WP2's mandate to:

- identify and validate existing training materials and practices;
- develop and deliver training in multiple formats (online modules and in-person schools/workshops); and
- establish a credible certification pathway supported by academic partners and the Europeana Foundation.

The report therefore combines a landscape review of training supply and demand with a project-specific framework for assessment, credentialing, and content readiness for publication on the OCC.

Methodologically, D2.1 adopts a mixed evidence strategy that integrates:

1) structured data collection through an international survey targeting consortium partners, Advisory Board members, and the Stakeholder Panel;
2) a qualitative desk review of additional training resources and initiatives; and
3) an interpretive analysis of learner and role profiles to support subsequent curriculum and training design decisions.

The international survey, implemented via Google Forms and combining closed questions with open-text fields, was designed to capture both "what exists" (courses, materials, curricula/methodologies) and "how it works" (delivery modes, prerequisites, assessment practices, licensing conditions, and existing forms of recognition).

This evidence base is complemented by a targeted focus on Ukraine and by an additional scan of other resources, ensuring that the deliverable reflects both the European landscape and WP2's strategic priority to widen access and build capacity across diverse institutional contexts.

The structure of the deliverable mirrors this methodological logic and supports WP2 implementation across the project timeline.

Chapter 2 presents the empirical core: survey results and their interpretation, including the international landscape of existing training and materials, the Ukraine-focused evidence, the analysis of further training resources, and an initial analysis of learning profiles.

This chapter is intentionally positioned as the main diagnostic instrument for WP2 Task 2.1 (analysis, validation, and collection of existing training and materials).

It does not only map the breadth of available training, but also reveals patterns and gaps, by topic, audience, and format, that directly inform how WP2 will prioritise content curation, module development, and translation workflows in the next phases.

Chapter 3 translates the state-of-the-art evidence into a coherent certification perspective. Building on European lifelong learning positioning and digital credential practices, it clarifies how certification is treated in 3D-4CH as an integrated component of learning design and assessment (not as a purely administrative afterthought), and introduces the project's logic for linking learning outcomes, evidence of achievement, and credential issuance.

While WP2 includes the development of online courses (T2.2) and the delivery of seasonal schools and workshops (T2.3), it also requires a certification process established by the 3D-4CH Consortium (T2.4).

Accordingly, Chapter 3 frames certification as the mechanism that enables transparency, trust, portability, and eventual recognition of competences acquired through non-formal and semi-formal training pathways delivered through the OCC.

Chapter 4 ("Next Steps") is the bridge between evidence and implementation. It operationalises the findings of Chapter 2 and the certification logic of Chapter 3 into a concrete WP2 roadmap, focusing on the consolidation of the 3D-4CH curriculum as a shared reference point; the adoption of a standardised syllabus template to ensure "certification readiness" of every module; the pilot implementation via the Brussels Winter School (21–23 January 2026) to test end-to-end workflows for assessment, evidence collection, and credential issuance; and the multilingualism strategy that supports scaling and accessibility across the consortium languages (including Ukrainian).

In doing so, Chapter 4 functions as the planning and integration layer that prepares WP2 delivery for the subsequent reporting milestones: D2.2 (Interim training report, M24) and D2.3 (High quality training, M36).

Chapter 5 ("Quality and Ethics Considerations for Training Content") provides the reliability and compliance envelope that makes training content auditable, reusable, and safe for publication on the OCC.

It formalises end-to-end quality gates across the content lifecycle (design, development, delivery, and revision), including peer review, technical accuracy checks, accessibility verification, IPR/licensing clearance, and version control; and codifies ethical and legal safeguards aligned with the WP1 Quality Management Plan and the Data Management Plan, including GDPR compliance, informed consent procedures (e.g., for image/voice capture in workshops), data minimisation, retention/erasure schedules, and anonymisation of learner analytics.

This chapter is not an isolated add-on: it reinforces the credibility of Chapter 3's certification model by ensuring that any issued credential is underpinned by transparent processes, documented evidence, and accountable governance—conditions that are increasingly expected for trustworthy digital credentials in European capacity-building initiatives.

Across all chapters, D2.1 is explicitly designed to connect WP2 to the wider 3D-4CH work programme.

The Online Competence Centre platform development in WP4 is a key dependency and integration point (see deliverable D4.1 and D4.2), because validated training materials, modules, and credentials must be ingested, discoverable, and maintainable through the platform infrastructure (including metadata-driven publication workflows). WP3 contributes tools and methodological advances that feed into hands-on training content (e.g., 3D digitisation, processing, visualisation, XR/AI-enabled workflows), while WP5 provides target-group segmentation and impact measurement logic that informs audience-specific training pathways and the evaluation of uptake and outcomes.

These inter-WP feedback loops are essential to ensure that WP2 does not merely "produce training", but iteratively improves it based on platform analytics, stakeholder needs, and evolving toolchains across the project.

Finally, D2.1 should be read in continuity with the deliverables already produced in the first project period (M1–M12) and those planned for the next phases.

In particular, the WP1 Quality Management Plan (D1.1) and Data Management Plan (D1.2) provide the governance backbone that D2.1 operationalises for training content and certification readiness; WP3's state-of-the-art on tools and methodologies (D3.1) informs the technical substance of training activities; and WP4's design and first implementation of the OCC platform (D4.1–D4.2) enables publication, discoverability, and reuse of training assets and credentials.

Looking forward, D2.1 establishes the baseline against which WP2 progress will be reported and evaluated in D2.2 (M24) and D2.3 (M36), moving from analysis to scaled delivery, continuous improvement, and consolidated "high quality training" that can persist beyond the project lifetime through the OCC.

2. Survey

A main objective for Work Package 2 - Task 2.1 during the first year of the project was to analyse the state of the art with regard to the availability of training and training materials in 3D for Cultural Heritage.

This deliverable presents the analysis of the results of this survey and related resources.

2.1. International survey of existing training and materials

A survey of existing training and materials was launched to all partners, members of the project advisory board and members of the project's stakeholder panel on the 3rd April 2025. The survey was then announced to the wider network in the week of the 7th April. The deadline for responses was the 21st May (the initial deadline of 23rd April having been extended). The survey was distributed using Google Forms and was predicted to take 10 to 15 minutes to complete.

Questions consisted of single-choice, multiple-choice, and open-text fields (see Annex 1). Most questions were not obligatory to complete; however, select questions, which would allow the project to contact and garner basic information about training, were required. Participants were directed to the general and preliminary training information section following consent, which led to a directive question asking the participant to share further details on either a training course, training materials, curriculum or training methodology, training from another organisation, or to submit the form. At the end of a section, the same options were available to choose from, which allowed participants to volunteer information about multiple types of training. If multiple types of the same training were submitted (e.g., multiple training courses), the entire survey would need to be done again with the new information.

The design consisted of five separate sections, including:

- **General and Preliminary Training Information**
  Data on the participant, including name of organisation, organisational type, areas of expertise, link to website, topics covered by training, cultural heritage types (e.g., moveable, immovable), target audiences, training level, and language.

- **Training Course**
  Focused on a specific training course as an example, including the title of the course, a link to the website relevant to the course, topics covered, technologies covered, expected knowledge and skills of students prior to the course, duration, delivery, standalone or part of a longer course, demonstration of knowledge for completion, formal evaluation, certification, and potential feedback.

- **Training Materials**
  Looked into training materials, including the title of the training material, a link to the website to the training materials, the topics and technologies covered, the licenses of the materials, their delivery, the types of media included and the language of the materials.

- **Curriculum or Training Methodology**
  This area investigated curriculum and training methodologies with questions including the title of the curriculum, description, link to a website where the curriculum or methodology could be found, topics covered, intended audience and licenses. In this section, a curriculum was described as a plan setting out the subjects, methods and activities, which inform the development of courses and materials. The European Qualifications Framework (EQF), the DIGCURV and the 4CH Curriculum Frameworks were cited as examples.

- **Training from another Organisation**
  This section enabled respondents to share details about other organisations delivering training in 3D for cultural heritage in their area. Data gathered included the name of the training providers, contact details, links to relevant websites, descriptions, topics covered, and intended audiences.

2.1.1. Response to the survey

2.1.1.1. Response by country

The survey received responses from 33 countries, mainly from Europe, with a small number of international responses.

Greece (11), Italy (7), Spain (6), Ukraine (6), and the United Kingdom (5) had the highest number of respondents. Belgium (4), France (3), Austria (3), Germany (3), Ireland (3), Luxembourg (3) and The Netherlands (3) also had a good response. The international responses included the USA (2), Canada (1), Colombia (1) and Ethiopia (1).

Table 2.1: Responses by country

Country	Number of responses
Greece	11
Italy	7
Spain; Ukraine	6
United Kingdom	5
Belgium; France	4
Austria; Germany; Ireland; Luxembourg; The Netherlands	3
Estonia; Israel; Malta; Portugal; Switzerland; USA	2

Albania; Bosnia and Herzegovina; Canada; Colombia; Czech Republic; Denmark; Ethiopia; Finland; Iceland; Lithuania; North Macedonia; Norway; Slovenia; Sweden; Turkey	1

Figure 2.1: Locations of institutions delivering training or training materials

2.1.1.2. Response by type of institution

In total, there were 84 responses to the survey from 80 different institutions. The largest percentage of respondents classified themselves as being from educational institutions, including universities, colleges or schools (38 or 45.2%). The next largest group of respondents were from governmental organisations (12 or 14.3%). Initially, 20 respondents labelled themselves as "other type of institution"; however, following a review of the survey responses, we were able to reassign all to other categories based on their institution name and website. 10 of these respondents were labelled as research institutions, 8 as cultural heritage organisations and 2 as enterprises.

Table 2.2: Responses by type of organisation

Type	**Number of responses**	Percentage of all responses
Educational institution (university, college, school)	38	45.2%
Governmental institution (ministry, local administration)	12	14.3%

Research	10	11.9%
Enterprise	8	9.5%
Cultural heritage organisation	8	9.5%
Professional association or network	7	8.3%
Vocational education and training provider	1	1.2%

To broaden the reach of the survey, we invited respondents to report on both the delivery of training in 3D by their own organisations and also to notify us of other training providers in their network. When asked "**do you deliver training relating to 3D in Cultural Heritage?**", 55 respondents said yes (68.8%), 25 respondents answered that they were sharing information about other training providers (31.3%), and 5 respondents left the question blank.

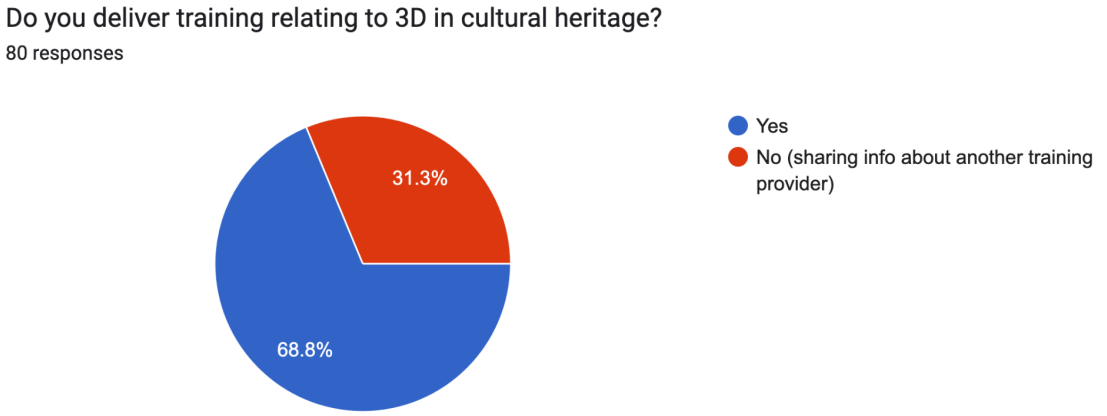

Figure 2.2: Type of response: own training or sharing info about other training providers

2.1.1.3. Areas of expertise

The areas of expertise reported by institutions which deliver training relating to 3D in Cultural Heritage covered a broad range of topics and subject disciplines. The most frequently mentioned areas of expertise were Image-based 3D modelling techniques (10), 3D survey techniques (12), XR, VR, AR and MR applications (13) and Data management (covering metadata, data management and digital preservation) (10). Perhaps not surprisingly, the largest number of respondents reported expertise in humanities disciplines (18), Digital Humanities and related disciplines (9), with a range of engineering disciplines (5) also reported. Applications and reuse of 3D ranging from interpretation for tourism, scholarly editions and storytelling (8) and Cultural Heritage projects (3) are also well represented. The areas of expertise that were less commonly reported include:

- Imaging techniques
- Acoustic modelling

- Open Access
- Software and hardware development

The full breakdown of the areas of expertise reported by respondents is provided in Table 2.3 below.

Table 2.3: Areas of expertise

No.	Area of expertise (summary for the report)
17	Humanities disciplines – interdisciplinary studies, archaeology, anthropology, geography, global studies, cultural heritage, world heritage architecture, digital archaeology, history, prehistory
13	XR – XR applications, Virtual Reality (VR), Augmented reality (AR), Mixed reality (MR), Metaverse, Immersive exhibits
12	3D survey for monuments and buildings – 3D data capturing and processing, Lidar, SLS (Structured Light Scanning), Laser scanning,
10	Image based 3D modelling – includes photogrammetry (terrestrial and aerial), gaussian splatting, image capture
10	Data management, preservation and metadata – GLAM data and metadata, interoperability, data management, 3D data management, digital preservation for the heritage sector, data analytics for humanities
9	Digital Humanities, Humanities and social science data, Digital Culture, Culture in Digital formats, Smart Cities, Internet of Things (IoT)
8	Applications and reuse – 3D applications, adaptive reuse, digital interpretation in heritage tourism, 3D scholarly editions, digital storytelling, workflows for VR/AR/XR applications
7	Software – web tools and apps, cultural technology, 3D technologies, digital imaging technologies, digital tools; XR software and applications; XP web-platform for knowledge transfer; Geographic information systems (GIS)
7	Preservation, conservation and promotion of cultural heritage – valorization, conservation and restoration of movable and immovable CH
6	Data analysis and AI – AI, Spatial AI, shape analysis methods and technologies, depth estimation from images, augmented textual studies
6	Other disciplines – Engineering, Civil and environmental engineering, electrical and computer engineering, Geomatics, Informatics and communication, Archives
6	Other areas – graphic design; media access; courses for the public on how to contribute to data collection of heritage remains; education in archaeology; accessibility strategies for museums, archives and libraries; university education
5	Digitization – 2D and 3D digitisation; 3D digitization of artworks
4	3D publishing and printing – Visualisation, 2D animation, visualisation, 3D printing
3	3D data processing and modelling – 3D editing, data optimisation, virtual reconstruction
3	CH projects, case studies and best practices
2	Imaging – Colour and spectral imaging, Surface Analysis, Reflectance Transformation Imaging

	(RTI), Multispectral Imaging (MSI)
2	Open access
2	Hardware – developing VR systems, 3D laser scanner
1	Acoustics simulation

2.1.1.4. Responses by training topic

Respondents were asked to categorise the training provided either by their organisation or by the external provider using 12 broad topics:

- 3D data capture
- 3D data processing
- Metadata and paradata
- 3D data management (storage and content hosting)
- 3D data preservation and archiving
- Visualisation (use of viewers etc)
- Creation of derivatives for specific audiences (education, tourism, other)
- XR and virtual worlds
- Use of Artificial Intelligence (AI) on cultural heritage data
- Access, rights and licences
- Planning 3D projects
- Uses of 3D in cultural heritage

The topics most commonly covered in training were 3D data capture (59 responses or 88.1%), Uses of 3D in cultural heritage (52 responses or 77.6%), 3D data processing (51 responses or 76.1%) and Visualisation (50 responses or 74.6%). The topics that were less frequently reported were Access and licences (21 responses or 31.3%), Uses of AI on cultural heritage data (27 responses or 40.3%) and 3D data preservation and archiving (31 responses or 46.3%). The other 5 topics were reported by 32-34% of respondents.

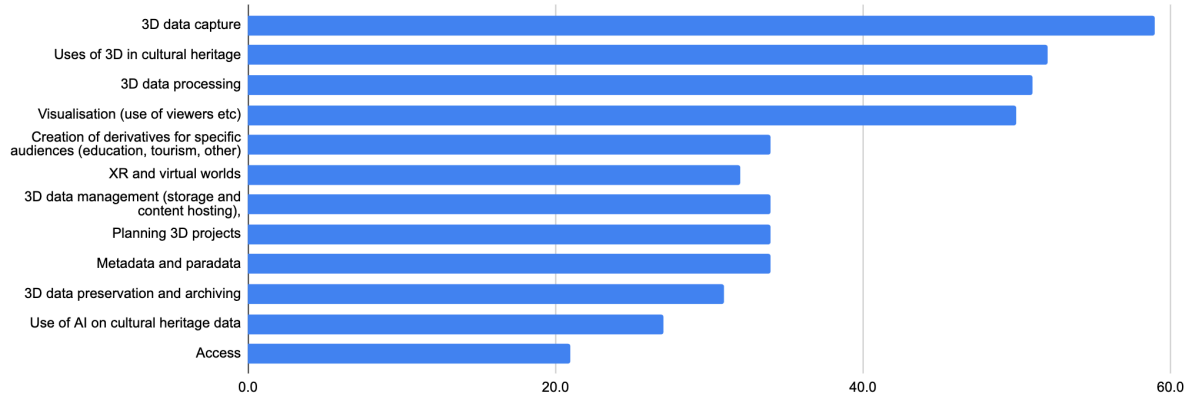

Figure 2.3: Responses by training topic

2.1.1.5. Responses by type of heritage

58 respondents reported on the type of heritage covered in their training. The results show a fairly even balance between training on the immovable heritage (94.8%) and the moveable heritage (87.9%), with intangible heritage covered by 31% of respondents.

One respondent noted that the type of heritage was 'other'; the exact type was not clear from the form; however, the course relates to basic 3D applications for Masters students.

Table 2.4 Type of heritage.

Type of heritage	No. of responses	%
Moveable heritage (artefacts, works of art, documents)	51	87.9
Immovable heritage (monuments, buildings, sites, gardens, landscapes)	55	94.8
Intangible heritage	18	31.0
Other	1	1.7

Of the 58 respondents, 84.5% reported covering both the immovable and the movable heritage in their training. Only 7% reported specialising in either immovable or movable heritage.

2.1.1.6. Responses by target Audiences

Respondents were asked to identify the types of audiences their training is designed for or aimed to teach. Multiple audiences could be selected by respondents, and their responses are shown in Figure 2.4. The responses suggest that training is predominantly geared towards university students (undergraduate and postgraduate) and cultural heritage professionals, which aligns with the large number of universities that answered the survey. Responses were at their lowest for roles such as policy makers at 21% and managers at 22%. Responses suggest that training is also available for vocational/technical students at 21%, Volunteers at 35% and 3D practitioners at 41%.

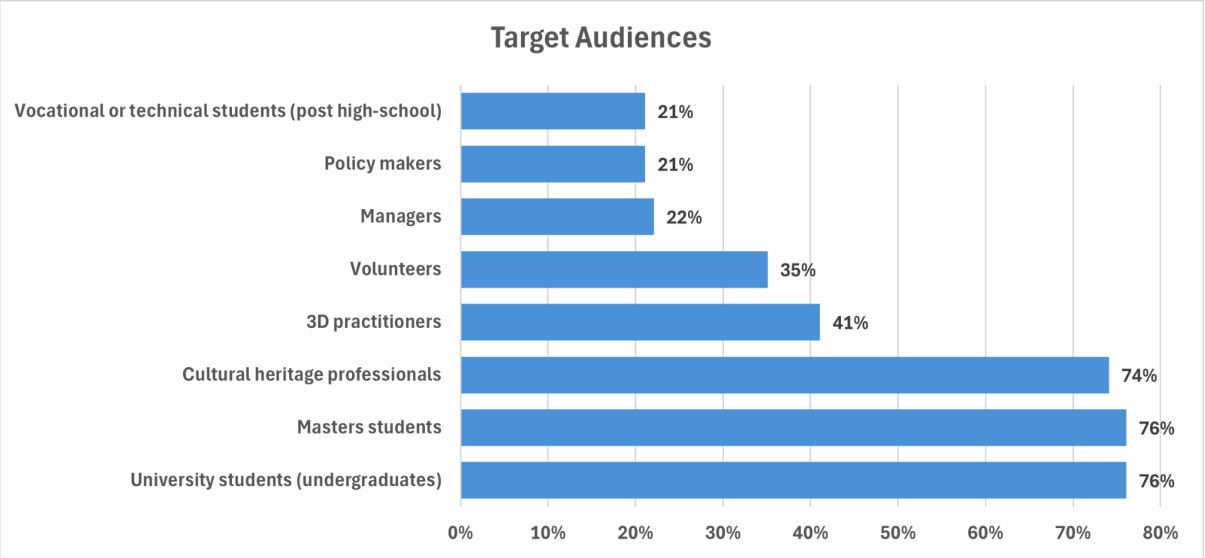

Figure 2.4: Percentage of different target audience types identified by respondents

2.1.1.7. Responses by training Levels

Respondents were asked to indicate the level(s) of their training, with the ability to choose more than one answer. Levels were described as an Introduction, Intermediate, Advanced or an Overview. Introduction and Intermediate were indicated as most prevalent, both at 81%, with 40% of responses indicating Advanced training, and 21% indicating an Overview.

The distribution of training levels indicated more organisations focused on lower to moderate training, with slightly less going into more in-depth topics. This aligns with whom the training was intended for: the target audiences were mainly university students, masters students and cultural heritage professionals. Higher levels of skills are required of teachers to provide Advanced training.

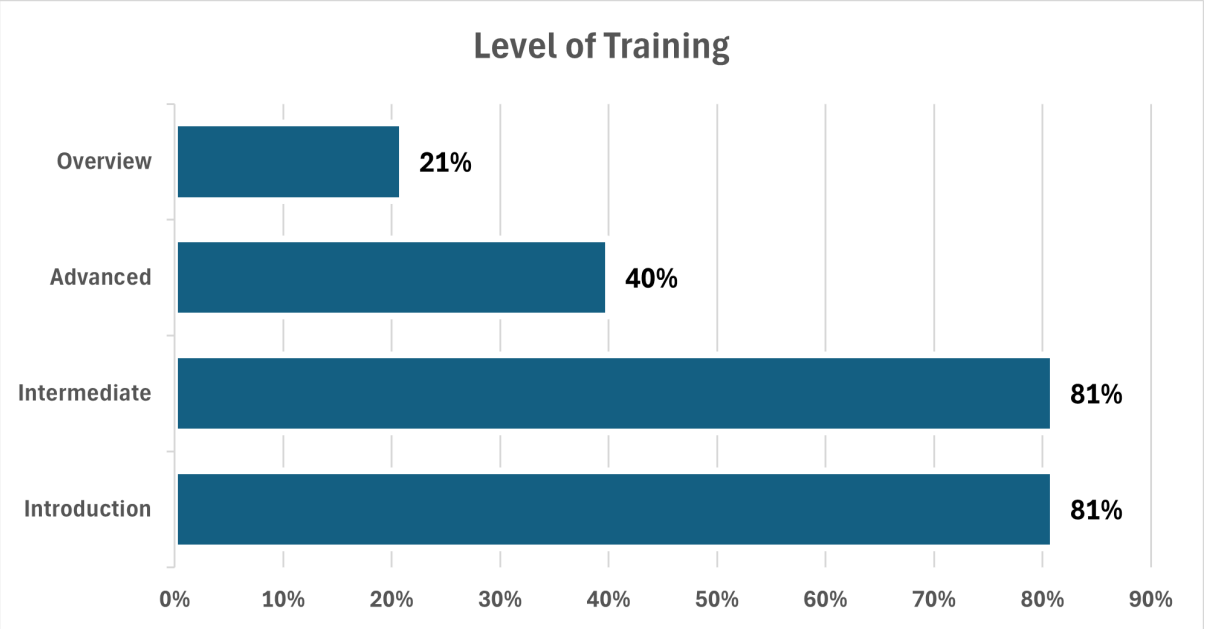

Figure 2.5: Percentage of training levels by each respondent

2.1.1.8. Responses by language

The languages of respondents' training were recorded, with the number of responses in Table 5. Out of 51 responses, 35 stated training was delivered in English, the most common language for training recorded in the survey. Greek and Spanish were the next most common, which aligns with the number of responses from those respective countries.

22 of the responses indicated that training was available in multiple languages, which demonstrates greater accessibility for participants.

Table 2.5: Languages of training by respondents

Language	Number of responses
English	35
Greek	7
Spanish	7
German, Catalan, French, Italian	3
Hebrew, Ukrainian, Portuguese	2
Dutch, Albanian, Lithuanian, Norwegian, Finnish, Icelandic, Swiss-German, Estonian, Slovenian	1

2.1.2. Training Courses

69% of respondents to the survey reported that they delivered training relating to 3D in cultural heritage; the remaining 31% of respondents shared information about other training providers. Details of training delivered by 67 different organisations were reported.

Respondents were invited to describe the training delivered by their organisation in general - the 55 respondents identified over 130 topics covered by their courses. In addition, 15 respondents provided detailed information about individual courses.

2.1.2.1. Topics Covered by Courses

Respondents were asked to describe the topics covered by their reported courses. Some topics were provided in detail to indicate individual processes or contents, such as " photogrammetry processes", "Dissemination of content for the internet", or "3D geometry processing". Other topics were described generally, such as "3D digitization", "surveying" or "visualisation". To understand the composition of topics covered by the courses, each entry was categorised into the 12 broad training topic classifications (see 1.1.2.4 Responses by Training Topic above). Each entry was classified under all topics within which it fell, for example, a broad description such as 'laser scanning' was assumed to include 'Data Capture', 'Data Processing', and 'Metadata and Paradata'. Topics which included the creation of 3D data, including '3D Data Capture', '3D Data Processing' and 'Metadata & Paradata' had the highest amount of coverage. Topics related to the use of 3D models had moderate responses, such as 'Uses of 3D in Cultural Heritage' at 36%, 'Creation of derivatives for specific audiences' at 29%, and both 'Access' and 'XR and Virtual Worlds' at 22%. Management and Preservation of 3D data were not well represented, and there were no responses for 'Planning of 3D Projects' and 'Use of AI on cultural heritage data'.

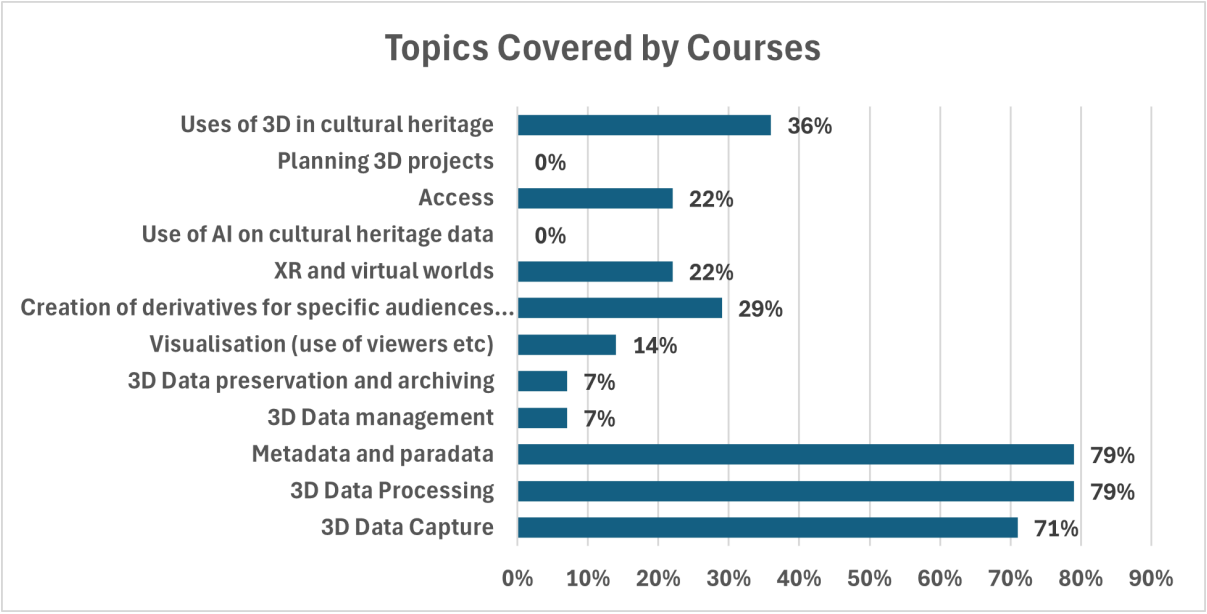

Figure 2.6:Topics Covered by Courses

2.1.2.2. Technologies Covered by Courses

Respondents were asked to include technologies which were covered by the courses they offered as part of the survey. These technologies were summarized into types detailed in Table 2.6, with the number of times the technology types were mentioned.

Table 2.6: Technologies Covered by Courses

No.	Technologies (summary for report)
4	Programming and software: OpenGL; GLSL; 3D FLOW ZEPHYR; QGIS; Autodesk Recap; Autodesk Revit; Unity; Blender; Meshlab; Unreal
5	Photogrammetry and image based capture: Photogrammetry; photogrammetry (aerial and terrestrial); aerial photography
7	Scanning: Structured Light scanning; Laser scanning; Fixed and mobile laser scanner (FARO Premium/Core and Orbis + Scene); Mobile and static laser scanner; SfM techniques; 3D scanning
7	Data processing and modelling: 3D models; Point cloud processing; Metashape for processing; 3D modeling in Blender; Meshlab; 3D modelling with primitives and NURBS (Rhinocers); BIM modelling
2	Applications and reuse: Game dev in Unity; Unreal
4	XR, VR and AR applications: AR technologies for digital publication; VR; Rendering and immersive environments
3	Sound and soundscapes: Auralization; room acoustic simulation; urban soundscapes
2	Online 3D viewers: SketchFab
1	Europeana

2.1.2.3. Knowledge and Skills expected of students before taking courses

The knowledge and skills that respondents reported that they expected students to have ranged from very basic/no prior knowledge required through to intermediate level.

Table 2.7: Prior knowledge and skills expected of students

Prior knowledge and skills expected of students
Academic: High school diploma
Understanding of cultural heritage (archaeology, architecture fundamentals)
No prior knowledge is necessary
Basic understanding of licenses and copyright
Basic computer skills: Windows PC; Access to the Internet
Basic knowledge of 3D creation software; Graphic design software; Video editing software
Understanding of acoustics
Knowledge of image processing and computer graphics

Ability to plan and carry out 3D surveys of archaeological sites
Proficient in programming and linear algebra

2.1.2.4. Format of the courses

Respondents were invited to describe the format of their courses – their duration, whether they are delivered as a stand-alone course or form a module in a longer course, the means of delivery (in-person, online or a mixture of both elements) and whether the course includes hands-on/practical activities. A majority (64%) of the courses reported were delivered over the course of a term (or longer) rather than being shorter courses of a week or less. Of the courses reported, 50% were delivered in-person, 36% were mixed delivery (in-person with online elements) and 14% were delivered online. With the exception of 1 online course, all the courses reported include hands-on or practical elements.

Table 2.8: Format of the courses

No.	Duration of course	Delivery	Part or whole?	Hands-on activities
1	Longer	In-person course	Stand alone course, Module in a longer course	Yes
2	Term	In-person course	Module in a longer course	Yes
1	Term	Mixed delivery (course with both online and in-person elements)	Module in a longer course	Yes
2	Term	In-person course	Stand alone course	Yes
2	Term	Mixed delivery (course with both online and in-person elements)	Stand alone course	Yes
1	Term	Online course	Stand alone course	No
2	Few weeks	In-person course, Mixed delivery (course with both online and in-person elements)	Stand alone course	Yes
1	Week	Online course	Stand alone course	Yes
1	Week	Mixed delivery (course with both online and in-person elements)	Module in a longer course	Yes
1	Half-day	Mixed delivery (course with both online and in-person elements)	Stand alone course	Yes

2.1.2.5. Evaluation and certification

Respondents were invited to report on the type of evaluation and certification that were offered in the courses identified in the survey. Around 43% of the courses consist of modules in longer programmes, and students are evaluated and certified as part of their degree. 57% comprised stand-alone courses, of which 75% had some form of formal evaluation that (with one exception) led to some form of certificate or ECTS credits. 25% of the stand-alone courses had no formal evaluation, although participants in one of these courses receive a certificate by completing the training hours.

A significant majority (95%) of the courses invite students to give their feedback on completion of the course.

Table 2.9. Evaluation and certification of the courses

Type of course	Specific tasks or knowledge that students need to demonstrate to complete the course	Formal evaluation	Certificate on completion	Students invited to give their feedback
Module in a longer course	FInal exams on data capturing and modelling with a commission appointed by the Ministry of Education with internal and external members	Yes	Yes, issued by the school upon appointment by the Ministry.	Yes
Module in a longer course	Exams in theory along with the completion of a series of projects	Yes	Completion of course goes towards degree	Yes
Module in a longer course	Be able to independently create a scan of one object using laser scanner and photogrammetry technologies.	Yes	Completion of course goes towards a degree. Students receive grades.	Yes
Stand alone course	Yes, there are small tasks they need to complete if they want to obtain the offered ECTS units.	Yes	Certificate of participation + ECTS offered to those who completed the required tasks.	Yes
Module in a longer course	a proposal for a multi-sensor survey of a site or building, together with a small photogrammetric or laser scanning project	Yes	Completion of course goes towards degree	Yes

Stand alone course	Design of acoustics according to comfort and standards. Strong project idea .	Yes	Yes	Yes
Module in a longer course	Yes, activities for assessment to receive full marks for completion	Yes	Completion of course goes towards degree	Yes
Stand alone course	Yes	Yes	Yes	Yes
Module in a longer course	yes	Yes	Completion of course goes towards degree	Yes
Stand alone course	Yes	Yes	Completion of course goes towards degree	Yes
Stand alone course	None	Yes	Yes	Yes
Stand alone course	The production of an augmented digital publication is highly advised but not compulsory.	No	Yes, by completing the training hours.	Yes
Stand alone course	No.	No	Completion of course goes towards degree	Yes
Stand alone course	-	Yes	No	No

2.1.3. Training Materials

A relatively small number of respondents (10%) to the survey provided additional information about training materials. An overview of the materials reported in the survey is provided in the table below.

Table 2.10: Overview of training materials reported

Topics	Technologies covered	Licence	Delivery	Language
Capturing heritage remains with smartphones	Smartphones, geo-location.	Open access (Public domain, CC0, CC-BY, CC-BY-SA)	not available online	Icelandic
3D capture, developing and	Photogrammetry and laser scanner	Licence not yet chosen (potential	not available online	Catalan

possible uses of 3D models		CC-BY)		
Digitization technologies and practices	Photography, elementary image processing, active 3D scanning, photogrammetry	Open access (Public domain, CC0, CC-BY, CC_BY-SA)	The slides and supplementary material are not publicly accessible	English
Image-based 3D modeling (data acquisition and processing), data management, metadata and paradata	Photogrammetry (SfM)	Open access (Public domain, CC0, CC-BY, CC_BY-SA)	Not found online	Ukrainian
Digital interpretation, digital storytelling, 3d capture, 3d uses	General overview of technologies	Access restrictions (CC-BY-NC, CC-BY-ND, CC-BY-NC-ND)	Downloadable online	English
3D Modelling. 3D Information Acquisition. Virtual Reality. Mixed Reality. Augmented Reality	Virtual Reality. Augmented Reality.	Other: Licence Property of the creators	Requires login to access	Spanish
A tutorial using an example from the PURE3D Project and also Generalised Tips on how to use the Voyager Story interface		Open access (Public domain, CC0, CC-BY, CC-BY-SA)	Online	English

Of the 7 training materials reported, 4 are made available under some form of open access licence while 3 are subject to restrictions.

2.1.3.1. Material Format

A majority of the materials reported in the survey are made available online (5 out of 7 resources) and contain media in the form of text and images. 3 out of the 7 resources reported include 3D models or 3D datasets.

Table 2.11: Format of training materials

Format of materials	Media included
Print materials	Text / Documents
Offline materials	Videos, Slides, 3D Models
Online materials	Text / Documents, Photos, 3D Datasets
Online materials	Text / Documents, Photos
Downloadable document	Text, Images
Online materials, Offline materials, Print materials	Text / Documents, Videos, Slides, Photos, 3D Models
Online materials, Print materials	Text / Documents, Videos, Photos, 3D Models

2.1.3.2. Materials from other providers

Respondents to the survey were invited to report on the availability of training and/or training materials from other providers (i.e. providers who are external to their organisation). Of these external training providers it was possible to identify 3 which offer training materials on their websites:

- Introductory guides to Airborne Laser Scanning and Digital Spectral Data Lidar and QGIS guides
- Knowledge Base
- Recommendations for long-term archiving for the NFD14 Objects community

2.1.4. Curriculum

With the specific questions to respondents asking to detail topics of 3D digitisation in cultural heritage, it was important to include any curriculum in which 3D digitisation was either a part of or the entire subject. Curriculum includes a prescribed course of studies in which objectives, lessons, learning experiences and evaluation are created for learning.

2.1.4.1. Curriculum reported in the survey

As with training materials, a relatively small number of participants responded with information about training curricula. All were based in Educational Institutions (Universities) delivering training in 3D for cultural heritage and chose to share information about a curriculum/training methodology rather than a training course. An overview of the curricula and their educational objectives is provided in the table below.

The survey form invited respondents to provide the title, description and a link to a web page about the curriculum (or the provider's website).

Table 2.12: Overview of curriculum reported in the survey

Title	Level	Note	Country
Architecture and Urban design - Architectural survey and restoration of cultural heritage	Course within Master of Science degree programme Advanced	ECTS credits, part of full-time course over 5 years	Albania
Introduction to 3D Technologies, Advanced 3D	MSC in digital humanities - 3D technologies is one of 4 specializations Intermediate, advanced	Student guide with subject, purpose and learning objectives, ECTS credits	Cyprus
2D Animation as a Visualization and Communication Model	Introduction, intermediate, advanced		Greece
Digital Heritage and Preservation	Postgraduate level module		UK
Acquisition, modeling processing, storage and dissemination of 3D data: best practices for the humanities and social sciences	One-day training course		France

3D Computer graphics, XR technologies	University course, undergraduate and postgraduate		Greece

In some cases, respondents to the survey provided links to downloadable resources with details of the educational objectives behind the curriculum. For example, these include:

Curriculum A:

- **Master Digital Tools**: Gain proficiency in leading digital tools used in Museums, Libraries, Archives, and in the world of Multimedia.
- **GIS Expertise**: Learn to leverage Geographical Information Systems (GIS) for innovative research.
- **Programming Foundations**: Build essential programming skills.
- **Language Mastery**: Dive into the essentials of Natural Language, Text, Handwritten Resources and Markup Languages, becoming an adept specialist.
- **Data Science skills**: Embrace the methodology behind Data Sciences, unlocking new perspectives in research.
- **Database Design and Digital Curation**: Design and customize Databases and Data Repositories appropriate to the demands of your work and research, curating and managing digital data, repositories, and ensuring longevity and accessibility.
- **3D Technologie**s: Explore 3D technologies to bring Historical Objects, Monuments, and Landscapes to virtual life.
- **Digital Modelling**: Craft digital models, breathing digital life into Cultural and Historical Artefacts.

Curriculum B:

- **Introduction to 3D technologies:**
    - understand 3D representation technologies and their application advantages in the humanities
    - be familiar with 3D modeling, digitization and printing
    - know software for the creation of 3D models and applications used in the humanities
- **Advanced 3D**
    - be familiar with machine vision components, 3D digitization technologies and Photogrammetry software
    - utilize these technologies in various fields of the humanities
    - Special topics in 3D
    - understand elements of 3D data analysis and processing and deepen their application in 3D digital reconstruction / restoration.

- become familiar with the digital representation of reality and its application in the creation of 3D digital landscapes.
- deepen into the application of 3D printing in the humanities with an emphasis on model printing and prosthetic reconstruction.

- **VR/AR Technologies**
  - After the course, the student will be able to develop virtual exhibitions of cultural content using virtual and augmented reality tools.

Topics covered

Of the 6 curricula reported in the survey, 100% covered the uses of 3D in cultural heritage and 83% covered 3D data capture, 3D data processing, 3D data management and 3D data preservation and archiving. XR and virtual worlds were covered in 83% of the curriculum, while Metadata and Paradata; Creation of Derivatives; Access, Rights and licences, and planning 3D projects are covered in 50% of curriculum. The use of AI on cultural heritage data was covered by only 3% of the reported curricula.

Table 2.13: Topics of the reported curriculum

Number	Topic
5	3D data capture
5	3D data processing
3	Metadata and paradata
5	3D data management (storage and content hosting)
6	3D data preservation and archiving
6	Visualisation (use of viewers etc)
3	Creation of derivatives for specific audiences (education, tourism, other)
5	XR and virtual worlds
4	Access, rights and licences
3	Planning 3D projects
6	Uses of 3D in cultural heritage
2	Use of AI on cultural heritage data

Target audiences

Of the curriculum reported in the survey, 33% were designed for a single target audience (1 being for masters students and 1 for undergraduate students). 67% addressed multiple target audiences. A majority of the curriculum reported were designed for masters students (83%) or university students (undergraduates) (83%). 3D practitioners were one of the target audiences for 50% of the curriculum, while cultural heritage professionals, volunteers and vocational or technical students were the target audience for 33% of the curriculum. Policy makers and Managers were one of the target audiences for one of the curriculum reported - alongside

practitioners, cultural heritage professionals, vocational students, university students, masters students and volunteers.

Table 2.14: Target audiences of the reported curriculum

Number	Audience
3	3D practitioners
5	University students (undergraduates)
5	Masters students
2	Cultural heritage professionals
2	Vocational or technical students (post high-school)
2	Volunteers
1	Policy makers
1	Managers

Licences

Respondents were asked to denote the license for the training resource and detail any additional information. Two licenses were considered Open Access, which included either Creative Common licenses CC-BY-SA, CC-BY, CC0 or within the Public Domain. One license was listed as Access Restriction, which included either Creative Commons licenses CC-BY-NC-ND, CC-BY-ND, or CC-BY-NC, with one noting that, as a university-taught module, access would only be from enrollment. Two of the licenses of the training resources were not specified, while the final training resource was described as Other, with the license retained internally to the university. Types of licenses for the resources are shown in Table 2.15 and distribution of responses are shown in Figure 2.7.

Table 2.15: Licenses for the curriculum reported in the survey

Licence for the resource	Note
Open access (Public domain, CC0, CC-BY, CC-BY-SA)	2 respondents
Access restrictions (CC-BY-NC, CC-BY-ND, CC-BY-NC-ND)	2 respondents - University taught module, must be enrolled to access
Other	These are internal to the university
Licence not specified	2 respondents did not specify

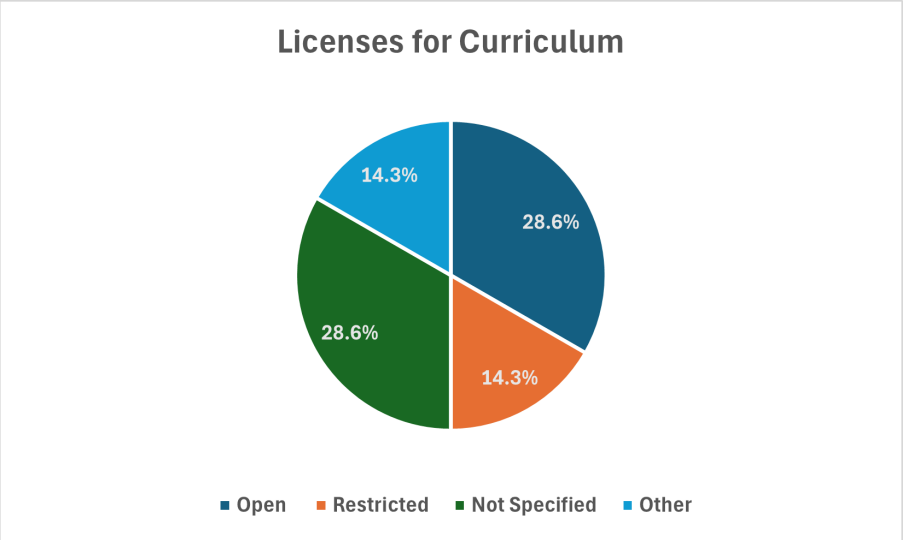

Figure 2.7 Licenses for curriculum reported in survey

2.1.5. 'Other' Training Providers

As part of the survey, respondents were invited to share information about 'other' training providers known to them. This section of the survey enabled respondents from cultural heritage institutions to share information about organisations which provide training in their region. In total 17 training courses/activities were described as being offered by 'other' training providers.

The information provided hints at the demand for more niche subjects, geared towards cultural heritage professionals requiring bespoke training to carry out or further develop their roles. A majority of other providers were described as Enterprises, which was opposite to those who actually responded to the survey (respondents of the survey identified as 45.2% higher education, 9.5% enterprises). Only 18% of 'other providers' were universities, with enterprises or other cultural heritage organisers being the main providers of training courses identified. The topics covered in the training leaned more to Data Creation (Data Capture, Processing and Visualisation) rather than storage, access or reuse, which would also be relevant for those in the cultural heritage sector. This nearly reflects the findings from survey respondents on the training which they provide, which shows Data Creation has a strong presence in cultural heritage training in 3D.

Looking at the countries identified as areas providing this kind of training, there were strong responses from Ukraine, Malta, Greece and Ireland. A respondent from Luxembourg commented that no provider was providing this kind of training in their country. The results may show gaps in providers in countries participating in this survey.

2.1.5.1. 'Other' training providers by country

Respondents of the survey were asked to identify the country in which 'other' training providers were known to them. A significant majority of respondents reported training providers which operate in their own country or neighbouring country. A majority of the 'other' training providers were in mainland Europe. An additional respondent from Luxembourg remarked that they don't have a training provider in their country as of yet.

Table 2.16: Countries from which 'other' training providers are located

Number	Country
1	Denmark
1	Ethiopia
1	France
2	Greece
3	Ireland
1	Italy
2	Malta
1	United Kingdom
5	Ukraine

2.1.5.2. Types of 'other' training providers

Respondents were asked to describe the type of 'other' training providers from a list supplied. By comparison to the training providers who responded directly to the survey, the training providers reported by survey participants included a far higher proportion of enterprises (41%) in comparison to educational institutions (18%).

Table 2.17: Types of 'other' training providers.

Number	Type
7	Enterprise
4	Educational institution (university, college, school)
1	Research
3	Cultural heritage organisation
1	Governmental institution (ministry, local administration)
1	Project

2.1.5.3. Topics Covered by Other Training Providers

Respondents were asked to describe the training offered by 'other' training providers and the topics covered. In general, the courses of training reported as being delivered by 'other' training providers were short and quite specialised. For example, they include training on specific

equipment, software and techniques, and training delivered on site for cultural heritage institutions. The description of the training is shown in Table 2.18, with any additional notes offered by respondents.

Table 2.18: Description of training from 'other' training providers

Description of the training	Note
3D scanning (other informal training may be offered)	
Scanning workshops in cultural heritage institutions	
Digital documentation and 3d modeling of urban heritage	
MSc in Digital Humanities, 3D Technologies	Msc
Introductory webinar on 3D digitisation of CH	
Bespoke training in the use and application of Lidar data	
Training for the Automatic Detection of Archaeological Features Machine Learning Model	
Training in the creation and management of collections on the Digital Repository	
Training on the virtual modelling of heritage buildings - the application of BIM and H-BIM	Award participants an open badge.
Training to obtain drone operation licence	
2-day training on specialised software for use with Leica Geosystems RTC360 3D Scanner	
Architectural Heritage Preservation in Times of War: a free 3D documentation course	
Training in the basics of the architectural cultural heritage digitisation	

Respondents to the survey categorised the training offered by 'other' providers using the general topics included in the survey forms. A majority of the training reported focused on 3D data capture (59%) and 3D data processing (47%), with Visualisation (47%), Metadata and Paradata (35%) and the uses of 3D in cultural heritage (29%) also being well covered. The topics that were least well represented in the survey responses were XR and virtual worlds (12%), creation of derivatives (12%), Access, rights and licences (18%) and the use of AI on cultural heritage data (18%). 3D data preservation and archiving, 3D data management and planning 3D projects were represented in 24% of the survey responses. A breakdown of these topics is summarised in Table 2.19.

Table 2.19: Topics from 'Other' Training Providers

Number	Topic
10	3D data capture
8	3D data processing
8	Visualisation (use of viewers etc)
6	Metadata and paradata
5	Uses of 3D in cultural heritage
4	Planning 3D projects
4	3D data management (storage and content hosting)
4	3D data preservation and archiving
3	Use of AI on cultural heritage data
3	Access, rights and licences
2	Creation of derivatives for specific audiences (education, tourism, other)
2	XR and virtual worlds

2.1.5.4. Audience

The audience for the training offered by 'other' training providers reflects its focus on more bespoke, specialised training for cultural heritage institutions. Cultural heritage professionals (along with others) formed part of the target audience for 82% of the training being described with managers (29%), policy makers (29%), volunteers (18%) and 3D practitioners (41%) also being well represented. In addition to the cultural heritage audiences, university undergraduate students (47%), Masters students (47%) and Vocational or Technical students (18%) also formed part of the audience for the training.

Table 2.20: Targeted audiences for training by 'other' training providers

Number	Audience
7	3D practitioners
14	Cultural heritage professionals
8	University students (undergraduates)
8	Masters students
5	Managers
5	Policy makers
3	Vocational or technical students (post high-school)
3	Volunteers

2.2. Ukraine Survey

In addition to the international survey of existing training and resources (see 2.1 above), a survey was launched in Ukraine in September-October 2025. The aim was to assess levels of knowledge and gaps in knowledge on the topic of 3D digitization to propose a training programme to be delivered in Ukraine. A summary of the findings is presented here, the full report is available in Annex 2.

There were 57 respondents to the survey of whom:

- 11 Policymakers,
- 7 Managers,
- 12 Practitioners and
- 27 students/teachers.

Of the Policymakers, the lowest level of awareness were in issues related to copyright and licensing, preparation of business cases for cultural projects, digital strategy and policy, prioritization of the collection, possibilities of intersectoral funding and cooperation with the community. Respondents had a higher level of awareness about international funding programs, modern technologies and the concept of omnichannel interaction. The highest levels of awareness indicated by respondents in the survey were examples of using 3D digitization and the benefits of 3D digitization.

Respondent X: *"Digitization of the funds of the First All-Ukrainian Museum of the History of Uniforms. As well as digitization of cultural heritage objects of Kremenchuk. For example, more than 2,000 exhibits were digitized in the museum. To change - the quality of equipment, deepen knowledge about photography, 3D digitization, work with UAVs and scanners."*

The projects described by respondents were practical and involved the direct implementation of digitalization tasks. Although the respondents classified themselves as 'Policymakers' the answers suggest their roles are inclusive of Management and Practitioner activities.

Of the Managers, the lowest level of awareness was of issues related to data quality monitoring, data management plan, FAIR principles, data processing basics and equipment evaluation. Respondents were slightly more knowledgeable about basic scanning methods, applying methods, the organization's policy and strategy, publication and promotion and also involving external contractors. Respondents indicated experience in forming a team, creating a project plan, agreements and reports. The highest level of awareness was coordination and control over the implementation of tasks.

- Respondent Y: "*Digitization of the Potocki Palace complex in Ivano-Frankivsk. 2. 2024-2025. 3. Digitize the complex of buildings of the Palace using a combination of laser scanning and photogrammetry, ensure the creation of a color point cloud of facades, exteriors, gates and fences of the palace. 4. Try different methodologies for choosing tactics for bypassing and flying over objects to create photogrammetric models, laser scanning and a combination. 5. Improve the material base (selection of the optimal camera lens and filters for it, sources of artificial lighting).*"

Respondents who identified as managers suggested the following areas of study (in order of priority by number of mentions):

- Data Management and Long-Term Storage
- Popularization and Use of Results
- Development of Policies and Strategies
- Project Planning
- Practical Digitization of Objects
- Search for Funding Justification
- 3D Data Processing

Of the practitioners, the lowest level of awareness was of content management systems, how to document the capture process, troubleshoot technical issues, have practical experience in creating 3D models, conduct quality control, have experience working with equipment and export to the required formats. Respondents were slightly more aware of publishing and distributing 3D materials, documenting the processing stages, selecting an object for scanning, understanding the requirements for long-term preservation of digital archives and copyright. Respondents indicated that they were familiar with data storage and backup procedures. The highest level of awareness was in terms of the benefits of 3D digitization for the organization.

- Respondent Z: *"As a curator, I have a fairly large cultural fund at my disposal, numbering almost 4,000 exhibits. The works are constantly being digitized, photos are used for scientific work, etc. I would really like to learn how to make 3D models, "revive" paintings, graphic works, old prints, photographs, etc. ."*

Respondents noted the needs and challenges of working with complex objects when scanning.

2.2.1. Conclusions of the Ukraine survey

The survey found low levels of awareness, notably among **policy makers**, of the Policy stages of digitisation projects (as identified In the 3D-4CH curriculum.

Respondents to the survey who classified themselves as **managers** indicated existing knowledge and skills from practical experience in projects. This could suggest that their roles include the activities associated with practitioners in the 3D-4CH curriculum.

Respondents to the survey who classified themselves as **practitioners** requested training to deliver real and practical skills.

Analysis of the survey responses suggests these areas to consider when developing a training programme for Ukraine:

Policy makers	**Managers**	**Practitioners**
Research Outputs	Project initiating (idea, feasibility, business case)	Capture
Funding opportunities	Project planning (project team, plan, agreements)	Processing
Digital engagement	Project management	Data management
Data Management	Digital engagement	Publishing
Promotion	Data Management	Promotion
	Data Capture and Processing	
	Publishing	
	Promotion	

2.3. Analysis of other training resources

Other training resources related to the 3D-4CH project have been included in this analysis as they are instrumental to the future development of training modules and the knowledge centre as part of the 3D-4CH Online Competence Centre.

2.3.1. 4CH Curriculum framework

The 4CH project developed a comprehensive curriculum framework that covers the 3D process from planning and execution of 3D digitisation to visualisation, preservation and sharing.

The curriculum framework covers training for policy-makers, managers and practitioners and varied training formats such as in-person workshops, live remote demonstrations, and self-driven learning using supportive materials.

The 4CH curriculum framework identifies:

- Three broad training profiles: policy maker, manager and practitioner with differing training needs,
- Three levels of learning (knowledge, understanding, and competence) reflect the needs of different user profiles in their roles, and this tiered approach is aligned with widely adopted international educational frameworks, including Bloom's taxonomy,
- Five project stages (policy, initiating, planning, executing and data management) and their relationship to the user profiles and learning levels,
- Subjects to be covered in each stage,
- Session plans which demonstrate the use of the 4CH curriculum and its capacity for adaptation to different training needs,
- Training formats and delivery methods - in person, remote, online learning, combination of online and in-person methods etc, and
- Example lesson plans covering format, skills, learning objectives, activities, resources and assessment methods.

The table below provides an overview of the subjects at each project stage and the level of learning expected for each training profile.

Table 2.21: Overview of subjects at each project stage with the level of learning for each training profile as part of 4CH Curriculum Framework

POLICY (PO)	**Practitioner**	**Manager**	**Policy Maker**
PO1 Research Outputs	Understanding	Understanding	Competence
PO2 Funding opportunities	Knowledge	Understanding	Competence
PO3 Digital engagement	Understanding	Understanding	Competence
INITIATING (I)			
I1 Project Idea	Understanding	Competence	Knowledge
I2 Feasibility	Understanding	Competence	Understanding
I3 Business Case	Knowledge	Competence	Understanding

PLANNING (PL)			
PL1 Establish Project Team	Understanding	Competence	Knowledge
PL2 Project Plan	Understanding	Competence	Knowledge
PL3 Agreements	Understanding	Competence	Knowledge
EXECUTING (E)			
E1 Project Management	Competence	Competence	Knowledge
E2 Capture	Competence	Understanding	Knowledge
E3 Processing	Competence	Understanding	Knowledge
DATA MANAGEMENT (DM)			
DM1 Data Management	Competence	Understanding	Knowledge
DM2 Publishing	Competence	Understanding	Knowledge
DM3 Promotion	Competence	Competence	Knowledge

The 4CH Curriculum Framework has been included in this document as it is a foundational infrastructure to the training curriculum and modules developed by the 3D-4CH project, delivered as part of the 3D-4CH Online Competence Centre.

2.3.2. TwinIt!

Twin iT! is a campaign promoted by Europeana and the European Commission with the aim of raising awareness about the digitisation of cultural heritage in Member States (MS).

The campaign encourages the MS to produce and send at least one high quality 3D model of a monument or object symbolising their national cultural heritage, especially one that is potentially at risk.

As part of Twin iT!, Europeana and the 4CH project reached an agreement to promote a series of five technical webinars to support the campaign, focusing on various aspects and phases of digitalisation. These webinars, aimed at member states, were coordinated by 4CH and its partners and took place in October and November 2025. Below is the list of the webinars and the topics covered:

Webinar 1: The overall 3D digitisation process
Main topics:

- Planning the 3D digitisation
- Choosing the right workflow and outputs of the 3D digitisation
- Storing, preserving and accessing 3D models

Webinar 2: 3D capturing techniques (on-field operations)
Main topics:

- Laser scanning – fixed station and mobile systems
- Aerial and ground photogrammetry
- Documenting on-field operations

Webinar 3: 3D modelling techniques
Main topics:

- From captured data to a 3D model
- Processing and optimising the 3D model for the right purpose
- 3D formats and standards

Webinar 4: A practical example: the 3D model of Villa Aldrovandi Mazzacorati in Bologna
Description of phases and final results presented at the hybrid CEDCHE meeting in Luxembourg

Webinar 5: Storing, managing and visualising the 3D models
Main topics:

- Documenting the 3D model with metadata, choosing the right data schemas
- Store and preserve the 3D models for the future
- Online visualisation of 3D models – platform and viewers

This final webinar was held at the hybrid 4CH event in Brussels. The webinars were recorded and are available online on Europeana Pro.

2.4. Analysis of learning profiles

3D-4CH has identified five target groups (D5.1 - Definition of the Target Groups) for the online competence centre, shown in Figure 2.8. The classification model considered six integrated criteria:

- Stakeholder role in the Cultural Heritage Ecosystem
- Level of engagement with 3D technologies
- Sectorial affiliation
- Geographic and strategic reach
- Capacity to influence or multiply impact
- Training and knowledge needs

This approach is intended to ensure a meaningful engagement by the competence centre across a wide array of stakeholders and to inform the design of services, tools and curricula.

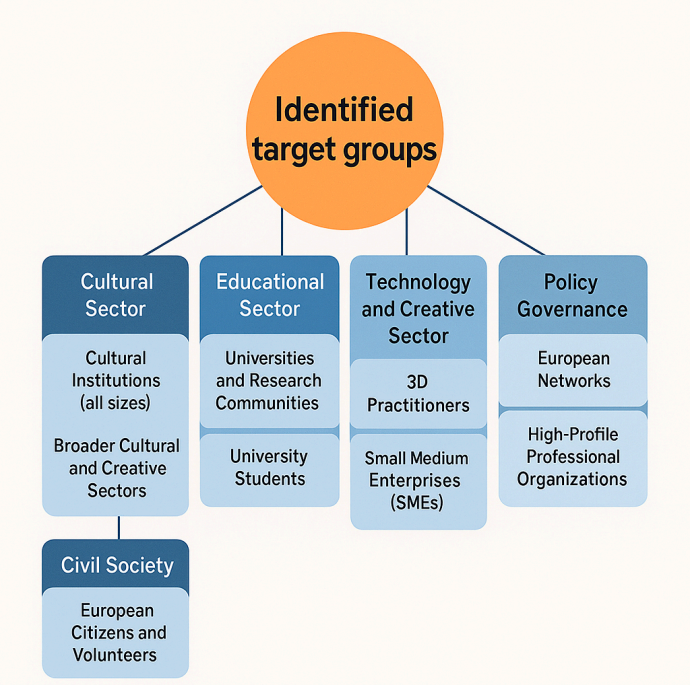

Fig. 2.8: Target groups identified by 3D-4CH

The target groups identified come from several business sectors and potentially can be engaged differently with the competence centre, whether through access to training, tools, standards, visibility, or opportunities for collaboration and growth.

The focus of this deliverable (D2.1) is on stakeholders who can benefit from learning and knowledge resources made available through the 3D-4CH competence centre. The survey

carried out under 3D-4CH work package five found a strong and widespread interest among professionals in acquiring skills across the entire 3D workflow in the cultural heritage sector, shown in Figure 2.9.

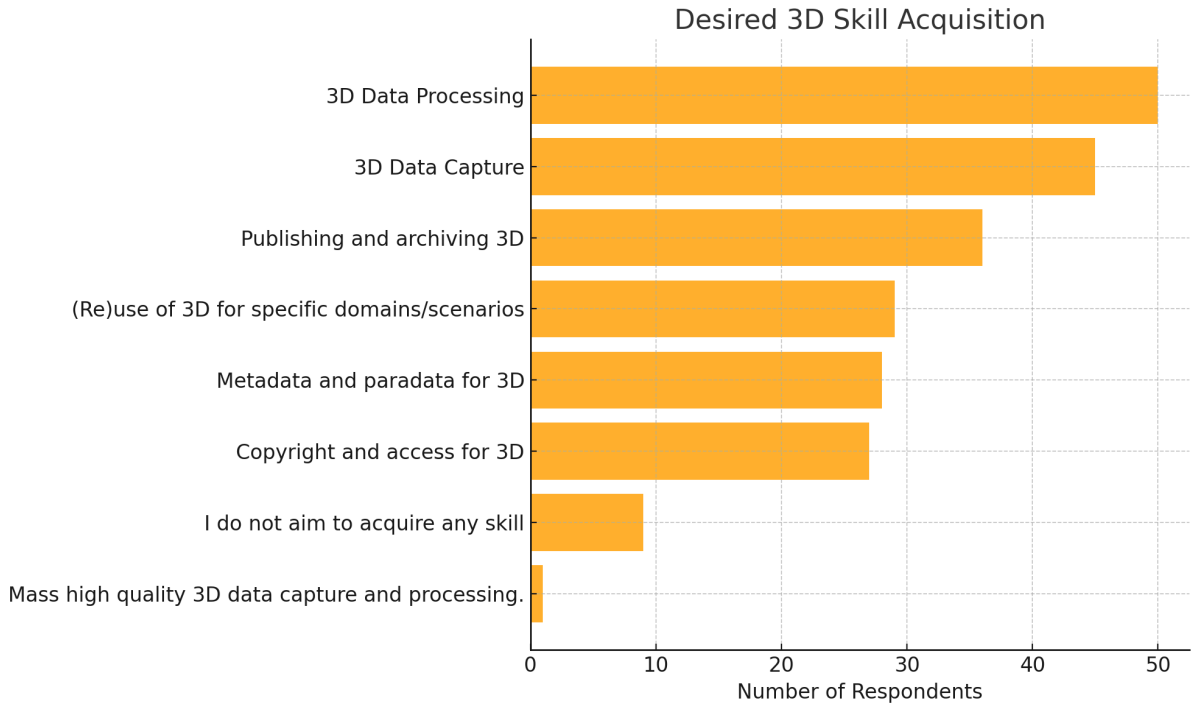

Fig. 2.9 Desired 3D skill acquisition amongst respondents to WP5 survey

The WP5 survey indicated a strong interest from respondents in participating in online training for Skill development and career advancement. However, the respondents also showed a clear preference for flexibility and variety in learning formats:

- 35% of WP5 survey indicate an interest in both structured, comprehensive learning pathways and targeted, skill-specific modules/practical answers to specific questions.
- 33% favored targeted training modules, focusing on short, focused courses that address specific skills or needs.
- 20% favoured full learning pathways - comprehensive courses covering end-to-end processes.

In terms of the preferred training formats, WP5 survey participants valued:

- Online self-paced learning
- Live webinars and online workshops with real-time interaction with trainers and speakers
- Blended learning, combining online and in-person elements

- Projects or assignments and group discussions
- Practical, hands-on learning methods

In contrast, reading materials and interactive quizzes were generally seen by WP5 survey participants as supplementary rather than central to their preferred learning experiences.

Fig. 2.10 Preference expressed in different training formats by WP5 survey participants

The survey carried out by WP5 identified target groups for the 3D-4CH competence centre both in terms of their sector and their training needs. Within each sector, there is a range of actors - from large institutions to small and medium enterprises (SMEs), independent practitioners, students, citizens and volunteers.

The 4CH curriculum framework identified three broad training profiles: policy maker, manager and practitioner.

As 3D-4CH develops its curriculum and training resources (see 4.1 below), it will evaluate whether these three generic profiles fit the needs of stakeholders identified by the project.

It may also be noted that the results of the survey carried out under WP 5 found that certification is seen as highly important by cultural heritage sector respondents. Its results underlined the need for training programmes to be formally recognised within the sector as well as being accessible in terms of their formats and means of delivery.

3. Certification

A main objective for Work Package 2 - Task 2.4 during the first year of the project was to analyse the state-of-the-art with regard to certification of training courses for professional development.

The task evaluated options for offering qualifications and micro-credentials which could enable the formal recognition of the skills gained by participants in training courses (online, in-person and blended). The aim of this work has been to establish a framework through which 3D-4CH training activities can be certified.

3.1. Scope and methodological positioning of certification within 3D-4CH

Within the 3D-4CH project, certification of training activities is conceived as a strategic instrument for capacity building, transparency, and recognition of competences developed in non-formal and semi-formal learning contexts.

In line with European lifelong learning policies, certification is not treated as a purely administrative outcome but as an integral component of the learning design, assessment, and quality assurance processes. 3D-4CH considers a certificate to be an official document that formally recognises the acquisition of specific skills, knowledge, or competencies by an individual. It is awarded by an authorised institution (e.g. University of Ferrara, etc.) or accredited body following the successful completion of a training course, assessment, or qualification process (e.g. test, exams, practical exercise, etc.). Unlike a simple attendance statement, a certificate confirms that measurable learning outcomes have been achieved and validated.

The certification strategy adopted by 3D-4CH explicitly addresses the challenges identified in recent European policy and research documents, notably the fragmentation of recognition practices in non-formal education and the limited portability of learning outcomes across institutional and national boundaries.

To respond to these challenges, the project prioritises digital, verifiable and metadata-rich credentials, capable of documenting not only participation but also demonstrable learning outcomes and associated evidence.

From a methodological perspective, the certification framework is grounded in:

- outcomes-based education and assessment, ensuring coherence between learning objectives, assessment methods, and certification artefacts;
- authentic assessment, focusing on learners' ability to apply knowledge and skills in realistic and professionally relevant contexts;
- open recognition principles, promoting transparency, interoperability and learner ownership of credentials.

3.2. Assessment, evidence of learning and certification logic

Assessment within 3D-4CH training activities follows an evidence-based and criterion-referenced approach, explicitly linked to the learning outcomes defined for each activity.

Assessment is conceived as a structured process that starts during the learning design phase and culminates in the issuance of a digital credential.

A key methodological principle is the clear distinction between participation and achievement. While participation in training activities is recognised as a relevant learning experience, certification of competences requires the demonstration of learning outcomes through assessed activities. This distinction is operationalised through different types of credentials and issuance criteria.

Assessment methods are selected based on the nature and level of the learning outcomes and may include:

- quizzes and structured tests for conceptual understanding;
- practical exercises and hands-on tasks;
- individual or group project work;
- oral examinations, presentations, or structured discussions;
- peer-review activities supported by explicit rubrics.

To ensure validity, reliability, and feasibility, assessment design follows a proportionality principle: assessment complexity, time investment, and evidence requirements must be commensurate with the training workload (e.g. hours/ECTS), the level of the learning outcomes, and the badge type. This helps prevent over-assessment (which may discourage participation) and under-assessment (which may undermine the credibility and comparability of the credential).

Indicative scaling examples (to be adapted to context):

- Micro-modules (2–4 hours): short quiz (10–15 minutes) and/or a brief structured reflection question.
- Short courses (8–16 hours): multiple-choice/short-answer test plus submission of a practical exercise (e.g., a file, checklist, or short technical output).
- Intensive schools (20–40 hours): project work (individual/group) combined with an oral presentation and peer review against explicit rubrics.

Similarly, evidence packages scale with badge type and training intensity:

- Participation badges: attendance record (and, where relevant, participation log).
- Achievement badges (short formats): 1–2 evidence items (e.g., quiz result + practical output).
- Achievement badges (intensive formats): a complete evidence package, such as a short report, dataset/output files, technical documentation, and a reflective note on process and learning.

This proportional approach supports fair workload allocation, transparent expectations, and robust quality assurance across different learning formats.

For each assessment method, evaluation rubrics define criteria, performance indicators, and minimum achievement thresholds. Such transparency is essential to ensure the credibility of Open Badges (see 3.3) and to support potential future micro-credentials, in line with European quality assurance principles for non-formal learning.

Central to the 3D-4CH certification model is the concept of the evidence package. Evidence is not treated as an optional attachment but as a core component of the credential itself. Each certified training activity requires the definition of a minimum evidence set, proportionate to the scope and workload of the activity.

Evidence packages may include:

- technical outputs (e.g. datasets, 3D models, repositories);
- written reports or documentation;
- reflective learning logs;
- attendance and participation records, where relevant.

Evidence is securely stored in compliance with the Data Management Plan and linked to the credential metadata, ensuring verifiability, auditability and long-term traceability.

To strengthen the credibility of credentials and reduce the risk of unauthorized claims, the development of the Online Competence Centre (OCC) will explicitly consider a fit-for-purpose infrastructure covering: (1) user registration requirements and access control; (2) identity verification mechanisms appropriate to online activities; (3) procedures for automated and/or manual validation of evidence, depending on the assessment type and risk level; (4) a personal learner dashboard to support progress visibility.

3.3. Open badges and Micro-credentials

This section introduces the two main digital credentialing instruments adopted and analysed within the 3D-4CH project to support the certification of training and capacity-building activities: Open Badges and micro-credentials.

Both tools respond to the growing need for transparent, portable, and verifiable recognition of learning outcomes acquired in non-formal and lifelong learning contexts, yet they differ in terms of level of formalisation, governance requirements, and intended use.

The following subsections describe the characteristics, advantages, and application contexts of Open Badges and micro-credentials, before outlining how they can be positioned as complementary elements within a coherent and future-oriented certification ecosystem.

3.3.1. Open Badges

Open Badges are digital credentials in which standardised metadata are embedded directly within the image file or made accessible through persistent web links.

These metadata store all the information necessary to unambiguously identify both the certified competence and the individual to whom it has been awarded. Each badge combines a recognisable visual icon with structured metadata that describes the learning experience, the acquired skills, and the badge holder. Through this embedded information, third parties are able to verify the authenticity of the badge and access key details such as the issuing organisation, the date of issuance, the assessment criteria, and the associated learning outcomes.

Open Badges are particularly well suited to a wide range of training activities, especially in contexts where it is important to certify acquired skills, completed learning activities, or defined levels of participation. Their flexibility makes them especially effective in non-formal education, modular training programmes, and short-duration courses, typically ranging from a few hours to one week. In such contexts, traditional academic qualifications or formal credits are often impractical or disproportionate, whereas Open Badges provide a lightweight yet robust mechanism for recognition.

One of the distinctive features of Open Badges is their portability and flexibility. Badges can be shared online, displayed on professional social media platforms, or embedded directly into digital résumés and personal websites. They can also be collected, organised, and curated within a digital portfolio, allowing individuals to construct a coherent and evidence-based representation of their learning pathway across multiple training experiences. For more traditional or hybrid contexts, Open Badges can be included in the appendix of a curriculum vitae as both an image and a QR code, enabling immediate access to verified information even in printed formats.

From a recognition perspective, Open Badges are particularly valuable because they can certify micro-level competences or specific skills that are often not captured by traditional academic degrees. In this sense, they may function as micro-credentials or skill-specific attestations, even when they are not formally issued as micro-credentials under national or European qualification frameworks. This makes them especially suitable for recognising transversal skills, professional development activities, and continuing education, which are increasingly central to lifelong learning pathways.

Open Badges are based on an open and decentralised model of issuance. Any organisation, company, association, or -under specific conditions- even individuals may issue Open Badges. However, issuing a badge is not a purely technical act; it is fundamentally a trust-based declaration. By issuing an Open Badge, the issuer formally attests that a learner has completed a defined learning experience, demonstrated specific competences, or shown a sustained level of engagement or interest in a given domain. The credibility of the badge, therefore, depends on the transparency of its criteria, the robustness of the assessment process, and the reputation and governance of the issuing body.

Claiming an Open Badge offers significant benefits for learners and professionals. It increases the usability and visibility of acquired competences, making skills easier to communicate and interpret across different professional, institutional, and cultural contexts. Open Badges enable individuals to present their expertise directly to organisations seeking specific profiles, particularly through professional networking platforms.

They provide an effective means to validate and showcase lifelong learning achievements within a personal e-Portfolio, thereby supporting employability, career development, and professional mobility. When integrated into an electronic CV, Open Badges complement traditional qualifications with verified, skills-oriented credentials that are immediately accessible and trustworthy.

Beyond individual benefits, Open Badges facilitate the structured collection, display, and sharing of achievements over time, allowing learners to narrate their professional growth in a coherent and cumulative manner. Their digital nature supports rapid and reliable international communication of skills, which is especially valuable in recruitment, selection, and mobility contexts. Badges can be easily shared via social media channels either through direct links or downloadable assets, further amplifying their visibility and impact. In doing so, Open Badges also contribute to enhancing the digital reputation of issuing organisations, signalling their commitment to transparent, innovative, and skills-oriented recognition practices.

More broadly, Open Badges offer additional systemic advantages. Their adoption supports international recognition of competences by enabling a common and globally understandable language for skills. They enhance visibility by clearly communicating certified learning outcomes to employers, institutions, and other stakeholders. Finally, as an open-source standard, Open Badges ensure interoperability, transparency, and long-term verifiability, making them a robust and future-proof solution within evolving digital credential ecosystems, particularly at the intersection of non-formal education, professional training, and lifelong learning.

From a technical perspective, the most widely used Open Badges standard is Version 2.0.
Version 2.0 (OB 2.0) is broadly adopted and enables the inclusion of key metadata such as issuer, criteria, evidence, and recipient. It is interoperable across major issuing platforms and already supports a wide range of learning contexts.

At the same time, a new standard is emerging: Version 3.0. Open Badge 3.0 (OB 3.0), based on the JSON-LD format, represents a significant evolution toward semantic interoperability and alignment with the Linked Open Data ecosystem. It allows for the expression of relationships between badges (e.g., part-of, equivalent-to), enhanced verification, and easier integration with EU digital credentials frameworks (e.g., Europass, EQF).

During the initial development phase and pilot actions of the 3D-4CH project, Open Badges will be issued in the 2.0 format to ensure rapid deployment and compatibility with existing platforms. However, the adoption of the 3.0 standard is not excluded and may be considered in future phases, should institutional, technical, or European framework requirements call for it.

3.3.2. Micro-credentials

Micro-credentials are emerging as a key instrument within the European lifelong learning ecosystem to formally recognise clearly defined, assessed, and quality-assured learning experiences. According to the Council Recommendation on a European approach to micro-credentials for lifelong learning and employability, a micro-credential certifies the achievement of specific learning outcomes following a short learning experience, assessed against transparent standards and issued by a trusted and identifiable organisation.

Unlike traditional academic qualifications, micro-credentials are designed to be flexible, modular, and targeted, allowing learners to acquire and demonstrate competences aligned with rapidly evolving labour market needs. At the same time, they introduce a higher degree of formalisation and institutional responsibility compared to other digital credentials, as they explicitly document workload, assessment methods, quality assurance mechanisms, and -where applicable- alignment with national or European qualification frameworks such as the EQF.

Micro-credentials are particularly well suited to short- to medium-duration learning activities, typically ranging from approximately 5 to 100 learning hours, including contact time and guided self-study. They are widely applied in contexts of continuing professional development (CPD), adult education, reskilling and upskilling initiatives, and training activities delivered within publicly funded programmes, including European research and innovation projects. In these contexts, micro-credentials respond to the need for recognisable and trustworthy certification that does not require the full structure of degree programmes.

A defining characteristic of micro-credentials is their emphasis on learning outcomes and assessment transparency. Each micro-credential explicitly states what the learner is expected to know, understand, and be able to do upon completion of the learning experience. These learning outcomes are formulated using action-oriented verbs and are directly linked to assessment

methods and achievement thresholds. This tight coupling between outcomes, assessment, and certification is essential to ensure credibility and comparability across institutions and countries.

From a recognition perspective, micro-credentials are particularly valuable because they can certify competences and skills that are not typically captured by traditional academic degrees, including highly specialised technical skills, transversal competences, or emerging professional profiles. When appropriately designed, micro-credentials may be aligned with European reference frameworks such as ESCO and DigComp and, in some cases, referenced to an EQF level. This alignment enhances their interpretability for employers, institutions, and public authorities, and supports their potential accumulation or combination within broader learning pathways.

The issuance of a micro-credential is inherently an institutionally accountable act. The issuing organisation formally attests that the learning experience has been designed, delivered, assessed, and quality-assured in accordance with defined standards. For this reason, micro-credentials typically require robust governance structures, including academic or scientific oversight, documented quality assurance procedures, and clear policies on data protection, retention, and verification. These requirements distinguish micro-credentials from more lightweight recognition instruments and contribute to their higher level of formal credibility.

Micro-credentials are increasingly supported by digital credential infrastructures, such as the Europass Digital Credentials Infrastructure (EDCI), which enable secure, interoperable, and verifiable issuance in compliance with the European Learning Model. Through these infrastructures, micro-credentials can be easily shared, verified, and integrated into digital CVs and professional profiles, while maintaining strong guarantees of authenticity and data integrity.

From the learner's perspective, micro-credentials offer several advantages. They provide formal and trusted recognition of learning achievements in a compact format, enhancing employability and professional mobility. They support lifelong learning by enabling individuals to progressively build and document competences over time, without committing to long-term degree programmes. When designed as stackable units, micro-credentials can contribute to more comprehensive qualification pathways, fostering flexibility and personalisation in education and training.

At the systemic level, micro-credentials contribute to strengthening the link between education, training, and labour market needs. By making skills acquisition more visible, comparable, and verifiable, they support transparency and trust within the European learning space. However, their effective implementation requires careful consideration of governance, quality assurance, and institutional capacity, particularly in contexts -such as EU-funded research projects- where training activities are embedded within broader innovation and capacity-building actions.

3.3.3. Complementary roles in a coherent Certification Ecosystem

Open Badges and micro-credentials are often discussed as alternative approaches to the recognition of learning; however, within a coherent certification strategy, they should be understood as complementary instruments serving different purposes, levels of formalisation, and recognition needs. Both tools respond to the growing demand for transparent, portable, and verifiable certification of skills acquired in non-formal and lifelong learning contexts, yet they differ significantly in scope, governance, and institutional implications.

Open Badges are characterised by a high degree of flexibility and agility. They are particularly effective in contexts where learning experiences are short, modular, experimental, or embedded within professional practice, such as workshops, winter schools, pilot training activities, or project-based capacity-building initiatives. Their strength lies in their ability to certify specific competences, learning achievements, or levels of participation without imposing the structural and administrative requirements associated with formal qualifications. For this reason, Open Badges are especially well suited to non-formal education, continuing professional development, and innovation-driven training environments, including those developed within EU-funded research projects.

Micro-credentials, by contrast, introduce a higher level of formalisation and institutional responsibility. They are designed to certify structured learning experiences with clearly defined learning outcomes, workload, assessment criteria, and quality assurance mechanisms, often aligned with European or national qualification frameworks. Micro-credentials are particularly appropriate when training activities reach a certain level of maturity, duration, and stability, and when there is a clear demand for formal recognition by higher education institutions, employers, or public authorities. Their value lies in their potential to be accumulated, combined, or even integrated into formal education pathways, provided that institutional and regulatory conditions are met.

The choice between Open Badges and micro-credentials should therefore be guided by contextual and strategic considerations, rather than by an assumption of mutual exclusivity. Open Badges are preferable when the primary objectives are rapid deployment, flexibility, visibility of skills, and learner engagement, especially in early-stage, pilot, or highly modular training initiatives. Micro-credentials are more suitable when the objective is to provide formally recognised certification for well-established training units, supported by robust governance structures and institutional endorsement.

Importantly, Open Badges and micro-credentials can be used together to certify the same course or learning activity, provided that their roles are clearly defined. In such a combined approach, the micro-credential represents the formal certification of the learning experience, documenting workload, assessment, and quality assurance in line with institutional and European standards.

The Open Badge, in turn, acts as the digital, portable and user-facing representation of that micro-credential, embedding its key metadata and linking to evidence and verification mechanisms. This dual issuance model enhances both formal recognition and practical usability, allowing learners to benefit from the strengths of both systems.

From a strategic perspective, adopting Open Badges as an initial certification layer and progressively integrating micro-credentials as training offers mature represents a sustainable and evidence-based pathway. This approach enables organisations and projects to pilot assessment and quality assurance processes, build institutional capacity, and respond to learner needs, while remaining aligned with European policy developments in micro-credentialing. Rather than competing, Open Badges and micro-credentials together form a graduated recognition ecosystem, capable of supporting diverse learning trajectories and recognition needs across the continuum of lifelong learning.

3.3.4. Open Badges as primary certification instrument

In the current phase of 3D-4CH project development, the first certification activities include the adoption of Open Badges. The choice to prioritise Open Badges is both strategic and methodological.

Open Badges are particularly well suited to the characteristics of the project's training activities, which are often:

- short or intensive;
- modular and stackable;
- delivered in non-formal or blended contexts;
- aimed at heterogeneous professional audiences.

According to the Open Recognition Alliance and recent academic literature, Open Badges enable a form of recognition that is granular, transparent and learner-centred, while remaining interoperable with institutional and professional platforms.

Each Open Badge issued within 3D-4CH embeds structured metadata, including:

- learning outcomes;
- assessment criteria and methods;
- required evidence;
- issuing organisation;
- date of issue and, where applicable, expiry;
- alignment with European frameworks (ESCO, DigComp, EQF).

In order to reflect different levels of learner engagement and achievement, 3D-4CH distinguishes between:

- Participation Badges, certifying attendance and active participation;
- Achievement Badges, certifying the successful completion of assessed learning outcomes.

Only Achievement Badges are considered suitable building blocks for potential future aggregation into micro-credentials. This distinction is essential to maintain the credibility of the certification system and to align with European transparency requirements.

3.3.5. Integration with Academic Teaching

To increase academic uptake, reusability, and long-term sustainability, the 3D-4CH badge-to-micro-credential pathway should be complemented by an explicit strategy for integration into university teaching and curricula.
Within the project, the 3D-4CH curriculum is already positioned as a strategic instrument to support training development in non-formal and semi-formal contexts, with skills recognised through Open Badges and, in the longer term, potentially through micro-credentials.
In practical terms, this integration is enabled by the project's standard syllabus template, conceived to make every training unit "credential-ready" by documenting learning outcomes linked to assessment, assessment methods and rubrics, required evidence, credential type, and quality assurance and data protection measures.
This design operationalises constructive alignment by ensuring that certification is an integral component of learning design rather than an ex-post add-on.

1) Course integration model

A scalable adoption model can be articulated through three complementary patterns that university instructors can select depending on course size, learning level, and available teaching time.

- "Embedded modules in existing courses": 3D-4CH units can be integrated as supplementary readings, guided activities, or short applied tasks within existing heritage, digital humanities, conservation, or BIM/GIS-related courses.
- "Standalone elective course": a full elective module can be constructed by sequencing 3D-4CH learning pathway components into a coherent course structure mapped to the curriculum, supported by explicit learning outcomes, assessment rubrics, and a structured evidence package.
- "Laboratory and project-based teaching": 3D-4CH technical materials can underpin hands-on labs and project work. This format aligns particularly well with the evidence package approach, where technical outputs, documentation, and reflective logs are securely stored and linked to credential metadata for verifiability and auditability.

To reduce barriers for faculty adoption, the OCC should publish "teaching packages" for each unit, combining learning materials, instructor notes, prerequisites, suggested classroom activities, and assessment rubrics.

2) Academic credit recognition (CFU/ECTS)

Formal credit recognition ultimately depends on individual university regulations, but 3D-4CH can enable a systematic process by providing an "ECTS-ready" description for eligible training units.

The Council Recommendation on a European approach to micro-credentials defines standard elements that emphasise learning outcomes, assessment, workload, and quality assurance, and it explicitly frames micro-credentials as complementary tools that can support recognition across institutions and borders.

In parallel, the ECTS Users' Guide clarifies that ECTS credits express the volume of learning based on defined learning outcomes and associated workload, with 60 ECTS corresponding to a full-time academic year or its equivalent.

On this basis, 3D-4CH can provide, for each training unit that is intended to support academic recognition:

- a transparent workload statement (hours and notional learner effort);
- an indicative ECTS mapping aligned with the learning outcomes and assessment design;
- explicit grading rubrics and minimum achievement thresholds;
- a specification of the minimum evidence set required for achievement.

This approach also aligns with the project's staged pathway for future micro-credential integration, including an eligibility phase (identifying units meeting workload, assessment and QA requirements), followed by institutional endorsement and alignment with the Europass Digital Credentials Infrastructure, and finally dual issuance where an Open Badge can serve as a portable digital representation of a formal micro-credential.

3) Faculty adoption strategy and university partnerships

An explicit faculty adoption strategy can be structured around three actions.

1. "Instructor guidelines": provide practical guidance for integrating 3D-4CH materials into existing syllabi, including learning outcome mapping, recommended evidence sets, assessment rubrics, technical prerequisites, licensing notes, and data protection considerations.
2. "Train-the-trainer programme": offer periodic training for university staff (including teaching assistants and lab tutors) to support consistent delivery, assessment, and evidence validation workflows, leveraging the Scientific Committee's oversight model for credibility, consistency, and trustworthiness.
3. "Repository of documented use cases": curate and publish examples of course adoption (syllabi, assignments, assessment rubrics, student outputs, lessons learned), consistent

with the project's commitment to collect and share best practices through standardised templates in the Competence Centre knowledge base.

For institutional partnerships, 3D-4CH should provide a "Memorandum of Understanding template" to streamline recognition agreements with universities. The template can define roles for issuing and endorsing bodies, quality assurance responsibilities, rules for credit recognition, evidence retention and verification, and alignment with European quality assurance principles (ESG) for higher education.

3.3.6. Future integration of micro-credentials: a forward-looking pathway

While Open Badges are prioritised in the current project phase, 3D-4CH explicitly recognises micro-credentials as a key component of the evolving European learning and recognition ecosystem. Micro-credentials offer a higher degree of formalisation, particularly in terms of workload definition, EQF alignment and institutional endorsement.

The decision not to issue micro-credentials at this stage reflects a deliberate and evidence-based strategy. It allows the project to:

- pilot assessment and QA processes;
- consolidate governance structures;
- collect empirical evidence on feasibility and impact.

A future integration of micro-credentials is envisaged through a phased approach:

1. Consolidation phase. Stabilisation of assessment, evidence and Open Badge practices across multiple training activities.
2. Eligibility phase. Identification of training units meeting micro-credential requirements (workload, assessment, QA).
3. Institutional endorsement phase. Engagement with higher education institutions and alignment with Europass Digital Credentials Infrastructure.
4. Dual issuance phase. Parallel issuance of:
    a. a formal micro-credential;
    b. an Open Badge acting as its digital, portable representation.

This integration is expected to:

- enhance formal recognition opportunities for learners;
- strengthen the position of 3D-4CH within European capacity-building initiatives;
- maintain openness and flexibility through continued use of Open Badges.

3.4. Quality assurance, governance and scientific oversight

Certification processes are fully aligned with the 3D-4CH Quality Management Plan (WP1) and the Data Management Plan. Quality assurance is implemented as a process-oriented system, integrating quality checkpoints throughout the lifecycle of training activities. Quality checks address:

- pedagogical coherence between learning outcomes, assessment and certification;
- accessibility and inclusiveness of learning materials;
- intellectual property rights and licensing;
- data protection, consent and retention policies.

This integrated approach reflects recommendations from European quality assurance bodies for non-formal and continuing education.

As part of the adoption of a robust quality framework, 3D-4CH has formally established a Scientific Committee responsible for overseeing all training and certification activities. The establishment of this committee responds to best practices identified in EU-funded projects and to recommendations for enhancing the credibility of non-formal learning certification. The Scientific Committee is tasked with:

- evaluating and validating the contents of all training activities;
- reviewing the syllabi and assessment methodologies;
- assessing the curricula vitae of trainers involved in the courses;
- overseeing eligibility criteria and, where relevant, participant profiles;
- supervising the certification process and authorising the issuance of credentials.

For each training activity, the Committee may appoint specific delegates responsible for monitoring delivery, assessment and certification workflows. These delegates act under the mandate of the Committee and ensure consistency with the approved quality standards.

The involvement of the Scientific Committee in the certification process reinforces:

- institutional accountability;
- transparency of decision-making;
- trustworthiness of issued credentials.

4. Frameworks

4.1. 3D-4CH curriculum

Within the project, the 3D-4CH curriculum is conceived as a strategic instrument on which training can be developed in non-formal and semi-formal learning contexts, and the skills and knowledge acquired formally recognised through open badges and/or micro-credentials.

A main objective of the work package during the first year of the project has been to build on and extend the 4CH curriculum framework (see 2.3.1 above) both through analysis of the results of the surveys and by work on learning pathways.

The 3D-4CH Curriculum is available in draft at the time of writing this document. Work in progress is evolving the framework to provide a comprehensive overview of the topics, the diversity of disciplines, technologies, and roles involved in 3D workflows.

4.1.1. Learning pathways

A Learning Pathway is a structured approach to learning and development which can serve as a roadmap for learners to identify the topics, skills and knowledge needed to achieve their goals. Within WP2, this approach is being used to identify themes and topics related to the use of 3D technologies in the context of cultural heritage and key activity areas. The work is both adding topics to the 3D-4CH curriculum and also creating Learning Pathways which will serve as conceptual maps or guides for learners for example in how to develop their capabilities in using 3D for digital story-telling.

4.2. Syllabus and certification readiness

Within 3D-4CH the curriculum will be a key tool for both syllabus design and certification readiness. A standard syllabus template has been developed for use across all training activities to ensure that all elements required for certification are defined ex ante.

From a certification perspective, it is important to explicitly document (in a course syllabus): learning outcomes linked to assessment; assessment methods and rubrics; required evidence; type of credential to be issued (Open Badge; micro-credential-ready); quality assurance and data protection measures.

The 3D-4CH syllabus template calls for the following information:

- Course title
- Duration (hours or days)
- Location and Class Days
    - EQF Level
    - Conduct mode

- Aims of the Course
- Target audience
- Requirements / Prerequisites
- Learning Methods
- Learning Outcomes
- Skills (ESCO, DigComp 2.2, etc.)
- Course structure: outline of sessions and the topics to be covered (mapped to the 3D-4CH curriculum)
- Learning Resources
- Assessment methods and Grading rubric
- Language of delivery

- Max number of students.

This approach operationalises the principle of constructive alignment and ensures that certification is not an ex-post addition, but an integral part of the learning design.

To improve consistency and credit-readiness, 3D-4CH training units could adopt standard duration bands and an explicit total workload estimate (contact hours plus guided/individual study). The following proportionality scheme could supports the selection of credential type and, where applicable, an indicative ECTS mapping aligned with workload. Certification eligibility requires a minimum total workload and achievement badges should normally be linked to assessed learning outcome starting with the pilot implementation describe in the following section.

Training type	Duration	Total workload (indicative)	Badge type	Indicative ECTS
Micro-module	2–4 h	~5 h	Participation	0
Short course	8–16 h	~20 h	Achievement	0.5–1
Intensive course	20–40 h	~50 h	Achievement	2–3

4.3. Pilot implementation: Brussels Winter School

The Brussels Winter School (21–23 January) represents a pilot implementation of the 3D-4CH curriculum and of the certification workflow developed within WP2.

The Winter School will provide a controlled environment to:

- test assessment and evidence collection procedures;
- validate badge metadata structures;
- verify institutional workflows for issuance and verification;
- collect feedback from learners and trainers.

The outcomes of this pilot will help inform the project of any refinements and adjustments to the certification framework in subsequent training activities.

In Detail, the 3D-4CH 1st Winter School (21–23 January 2026) is hosted at the Royal Museums of Art and History, Cinquantenaire Park 10, 1000 Brussels.

Conceived as the first major in-person pilot within WP2, the Winter School is designed not only as a training event but also as a controlled test environment for the full "training-to-credential" pipeline.

The programme follows a two-tier participation model. Day 1 (21 January) is open to all interested participants and delivered in blended mode, enabling broad access to the wider community; attendance is expected to reach approximately 100 participants.

The first day provides the strategic and operational framing that supports the 3D-4CH curriculum and learning pathways already described in the previous chapter. It includes a structured sequence of thematic sessions addressing:

- the European context for 3D cultural heritage and the role of competence centres and data-space initiatives;
- connections with complementary European project experiences relevant to 3D workflows;
- institutional perspectives on planning and implementing 3D projects (including inclusion and access perspectives);
- enabling infrastructures for storage, publication and web-based access to 3D assets.

This open day therefore functions as a shared "orientation layer" that aligns participants around common concepts, challenges and opportunities, and prepares the ground for the hands-on training pathway.

Days 2 and 3 (22–23 January) adopt a restricted, practice-orientated format with 25 participants selected by the project's Scientific Committee based on CV, sector relevance, and motivation. These two days are explicitly designed to generate learning evidence through applied work, consistent with the assessment and evidence logic described in this deliverable.

The hands-on pathway begins with an overview of an end-to-end workflow and project stages and then moves into group-based workshops on digitisation techniques, structured as supervised practical rotations across different approaches. The programme then expands from technical production to communication and reuse via an interactive workshop on storytelling and XR, supporting participants in translating digitisation outputs into context-specific scenarios and narratives that reflect real institutional needs and intended impact.

The third day consolidates this applied learning through a focused visit that encourages critical reflection on the role of replication and access, drawing parallels between historical practices of

reproduction and contemporary digital 3D dissemination, and culminates in the presentation of results by participants.

A core expected result of the restricted pathway is the production of a minimum evidence package for each participant (or participant group), proportionate to the short and intensive nature of the Winter School. A concise presentation of results, confirming not only participation but also the ability to interpret and communicate workflow decisions and reuse implications.

In this pilot edition, the project's certification approach is intentionally focused on Open Badges. The badge issued at the end of the Winter School is conceived as an evidence-informed participation badge, awarded to the selected cohort only if they both attend the training and demonstrate, through practical work and final reporting, that they have understood and can apply the topics addressed across the programme.

This framing is important: the Open Badge is not treated as a generic attendance statement, but as a digital credential grounded in documented participation and a minimal threshold of demonstrated competence within a short-format learning experience, consistent with the project's early-stage, pilot-orientated certification strategy.

Fig. 4.1 3D-4CH Winter School 2026 Open-Badge

To ensure trustworthiness and OCC readiness, the Winter School pilot is also used to validate the project's quality and ethics safeguards as they apply to training content and evidence. In line with the quality and ethics approach presented in chapter 5, training assets and learner-generated outputs intended for reuse will be subject to clear QA gates (technical checks, accessibility considerations where relevant, and IPR/licensing clarity for materials and third-party assets), while participant-related data and media (including any image/voice capture in workshops, if performed) will follow informed-consent procedures and GDPR-aligned handling principles, consistent with the Data Management Plan and the project's quality governance.

Finally, the Winter School is designed to create a direct implementation bridge to the post-M12 project phase. Feedback from participants and tutors, combined with the operational evidence

gathered during the pilot (e.g., feasibility of evidence packages, clarity of badge metadata, robustness of issuance workflows), will feed into iterative improvement of WP2 training design and into the refinement of certification procedures, supporting the scaling-up of additional seasonal schools, workshops, and OCC-published learning assets planned for subsequent project months.

4.4. Translation workflows

To widen access to the training materials and resources developed within the 3D-4CH project, comprehensive translation workflows are being implemented by FBK. This activity aims to make a significant portion of the project's teaching materials available across the linguistic diversity of the consortium partners, thereby maximising the reach and impact of the training offer among target audiences throughout Europe.

In line with the project requirements, both audio-visual and textual teaching materials produced in English will be translated into at least six languages, including Ukrainian. In the following, we describe the planned translation activities and outline their main characteristics.

4.4.1. Core Teaching Materials and Language Coverage

A first set of teaching materials has been identified for trialling the translation process, including a sample of the following in the first phase:

- The 3D-4CH curriculum (text document);
- Teaching materials from the 3D-4CH Winter School, including textual resources and recordings of lectures (audio-visual content).
- One or more components from online training modules to be developed in WP2 (textual materials and audio visual content);
- One or more "Good Practices" (textual materials).

With regard to the translation services to be trialled, both speech-to-text translation (automatic subtitling) and text-to-text translation systems will support translation into the following languages. This set covers all consortium partners' languages, with the addition of Spanish, one of the most widely spoken languages in Europe, included to further enhance accessibility:

- Bulgarian
- Dutch
- French
- German
- Greek
- Italian
- Polish
- Slovenian

- Spanish
- Ukrainian
- (English captions for audio-visual materials)

The specific content to be translated automatically and the target languages selected will be determined by the consortium on a case-by-case basis, taking into account the volume and nature of the available materials, as well as the availability of volunteers for the manual validation of automatic translations.

The next sections describe the translation services to be trialled for audio-visual and textual content, as well as the methodology for their automatic evaluation.

4.4.2. Audio-Visual Content: Automatic Subtitling

For video recordings and audio-visual materials, the translation system can provide high-quality subtitles in both the source language (English) and all ten target languages. The subtitling workflow is powered by a fully open-source system originally developed for the EU-funded AI4Culture project. This system is customized for the 3D-4CH project in the following ways:

Language Coverage. The system is capable of covering all languages required by the consortium, ensuring consistent quality across the full linguistic range.

Transcription and Translation Quality. The transcription and translation models can be made more effective on the contents of interest to the project (3D technologies) if the consortium can provide in-domain data on which an adaptation step can be carried out.

Subtitling Guidelines Compliance. The system will adhere to established subtitling guidelines, including appropriate line length and reading speed.

User-Friendly Subtitle Visualization. FBK is evaluating the possibility of integrating an innovative post-processing module, which could automatically select the optimal screen region for subtitle display through video content analysis. By identifying areas with minimal visual information and avoiding overlap with on-screen text, this technology can significantly enhance subtitle readability which is an important consideration for instructional videos.

The fully automated nature of this workflow, combined with the quality assessment process (see below), enables rapid turnaround times while maintaining high standards of accuracy and readability.

To facilitate the foreseen manual validation of the automatically generated subtitles, FBK will provide a web-based subtitling editor, which will be released as open source software.

4.4.3. Textual Content: Document Translation

For textual documents, FBK employs state-of-the-art neural machine translation models capable of handling all languages required by the consortium with high accuracy. These models are trained on extensive multilingual corpora and have demonstrated strong performance on technical and professional content domains.

However, the translation of project documents presents a specific technical challenge: materials are typically provided not as plain text, but in formatted document types such as Microsoft Word, PDF, Google Docs, and Google Slides. These formats embed complex layout information, formatting specifications, graphics, and structural elements that must be preserved in the translated output to maintain usability and professional presentation. Training content developers can be requested to follow guidelines that minimise technical issues during translation.

The ideal solution would provide translation while fully preserving the original document layout, formatting, and embedded visual elements. We will investigate existing tools that can parse structured document formats, extract translatable content while maintaining positional and formatting metadata, translate the text, and reconstruct the document in the target language with preserved layout. While achieving perfect layout preservation across all document types and complexity levels remains a technical challenge in the field, we are committed to developing practical solutions that maximise automation, resorting to semi-automated post-processing to handle complex layouts or documents with extensive embedded graphics and formatting.

4.4.4. Quality Evaluation

The quality of translation outputs will be assessed primarily through automatic evaluation metrics computed on relevant public benchmarks, due to the unavailability of dedicated data within the consortium. FBK will select evaluation datasets that are as close as possible to the characteristics of the project's materials, including technical content, educational resources, and domain-specific terminology related to 3D technologies and cultural heritage. These benchmarks will provide objective, quantitative measures of translation quality across all language pairs, enabling systematic monitoring of the translation systems throughout the project lifecycle.

Automatic evaluation metrics such as BLEU, chrF, COMET, and other state-of-the-art neural-based metrics will be employed to assess translation accuracy, fluency, and adequacy. These metrics have been shown to correlate well with human judgments when applied to appropriate test sets, and they offer the advantage of rapid, consistent, and cost-effective quality assessment at scale. Additionally, conformity metrics will be used for measuring the adherence to standard subtitling guidelines of automatically generated subtitles.

5. Quality and Ethics Considerations for Training Content

Within 3D-4CH, training contents are conceived not only as pedagogical resources supporting capacity building, but also as publishable and reusable assets intended for dissemination through the project's Online Competence Centre (OCC).

This dual role, supporting learning and enabling responsible publication, requires a robust framework that ensures reliability, accessibility, traceability, and compliance throughout the entire lifecycle of each module.

In this perspective, quality and ethics are not "add-on" obligations addressed at the end of a course; rather, they are methodological conditions that must be embedded from the outset in instructional design, assessment planning, content production, delivery, revision, and release.

The chapter adopts a process-oriented understanding of quality, aligned with European Quality Assurance expectations for higher and continuing education.

The Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG) emphasise that quality is achieved through coherent internal processes, transparent responsibilities, and systematic monitoring and enhancement, rather than through isolated checks performed ex post. In the context of non-formal and semi-formal training activities, where learners' profiles are heterogeneous and delivery formats may be intensive, modular, or blended, Quality Assurance must also provide evidence that learning outcomes are meaningful, assessment is fair and defensible, and the training offer is accessible and inclusive.

Methodologically, the chapter connects quality to the learning design logic already established in the deliverable's previous chapters, where certification is framed as a "trust statement" supported by explicit learning outcomes, assessed evidence, and verifiable digital credentials. This implies that training quality must be auditable: a third party should be able to reconstruct how the learning outcomes were addressed, how evidence was produced and evaluated, and under which criteria a credential (e.g., Open Badge or, potentially, micro-credential) was issued.

In turn, the credibility of digital credentials relies on the credibility of the learning process that produced them, and therefore on transparent QA gates, documented assessment rubrics, and clearly defined evidence packages.

Ethics, in this chapter, is treated as a second and equally binding axis. First, 3D-4CH must comply with the General Data Protection Regulation (GDPR) whenever training delivery or certification involves processing personal data (e.g., enrolment lists, attendance, assignments, learning analytics, and media capture). The GDPR establishes fundamental principles such as lawfulness, fairness, transparency, purpose limitation, data minimisation, storage limitation, integrity, and confidentiality. Second, the project must follow responsible practices for the use of learning data

and training-related analytics, avoiding disproportionate monitoring, opaque profiling, or secondary uses that undermine trust. Ethical guidance for EU-funded projects further supports this approach by stressing the need to anticipate ethics issues, implement safeguards, and document compliance in an auditable manner, explicitly including programmes such as Digital Europe.

Finally, the chapter links ethics to intellectual property rights (IPR) and licensing. Because OCC publication implies reuse, adaptation, and redistribution of training artefacts, the project must implement clear licensing decisions (preferably through recognised open licences) and careful checks for third-party assets.

UNESCO's Recommendation on Open Educational Resources frames open licensing as a lever for equitable access, quality learning, and sustainable reuse—provided that rights management, attribution, and accessibility are effectively addressed.

Against this background, this chapter operationalises a coherent approach:

- section 5.1 defines end-to-end quality assessment processes and "quality gates" for training contents;
- section 5.2 codifies data ethics safeguards, including GDPR compliance, informed consent (with specific attention to image/voice capture in workshops), secure storage and retention, anonymisation of analytics, and licensing/attribution procedures for publishable assets.

Together, these two sections ensure that every module released on the OCC is reliable, inclusive, reusable, and safe both for learners and for the institutions issuing credentials.

5.1. Quality Assessment processes

This section sets a structured Quality Assurance (QA) model for 3D-4CH training contents, covering four interdependent phases as design, development, delivery, and revision/publication—and translating quality principles into measurable checks, documented evidence, and corrective-action workflows.

The underlying assumption is that quality in training is not a single "verification event" but a chain of aligned decisions, each of which can introduce risks if left unmanaged. Therefore, the QA model is organised as a set of "quality gates" that must be passed before a module can (i) be delivered, (ii) be certified, and (iii) be published on the OCC.

Gate 1: Learning design coherence and constructive alignment

A first quality gate validates coherence between intended learning outcomes, learning activities, and assessment. This gate is grounded in constructive alignment, which requires that what learners are expected to achieve is explicitly aligned with what they do during the course and how they are assessed.

In practice, reviewers verify that learning outcomes are formulated in actionable terms (observable performances), that teaching and practice tasks plausibly support those performances, and that assessment tasks generate evidence that directly corresponds to the intended outcomes. Complementarily, the gate uses a backward design logic, starting from the evidence required to demonstrate learning and then designing instruction accordingly, to prevent "activity-driven" courses where assessment becomes incidental.

This gate is also where certification readiness is checked: if a course is expected to issue an Open Badge (and, in the future, potentially a micro-credential), the design must specify what the credential claims, what evidence supports the claim, and what minimum achievement threshold is required. The output of Gate 1 is a short "design validation record" confirming alignment decisions, including the mapping between outcomes, assessment methods, rubrics, and evidence packages.

Gate 2: Technical accuracy, disciplinary integrity, and reproducibility

Given the specialised scope of 3D-4CH training (e.g. digital heritage, 3D workflows, data practices, etc.), a second gate performs technical accuracy checks.

This gate verifies that statements are correct, procedures are up to date, referenced standards or tools are appropriately cited, and practical demonstrations are reproducible in a reasonable environment (or, where not reproducible, clearly labelled as demonstrative). Technical QA includes consistency of terminology, correctness of workflow steps, and clarity of prerequisites. Because OCC publication implies reuse by external audiences, reviewers also check for "hidden dependencies" (e.g., proprietary data, inaccessible links, missing software versions, etc.), ensuring that learning materials remain actionable beyond the original delivery context.

Gate 3: Assessment validity, reliability, and fairness

Assessment is a central quality determinant because it underpins the legitimacy of certification.

Gate 3 adopts a defensible approach to assessment validity, drawing on the unified view of validity: the interpretation of assessment results must be supported by evidence, and the consequences of assessment decisions should be considered as part of validity itself.

In operational terms, reviewers check (i) whether rubrics describe criteria and performance levels unambiguously; (ii) whether assessors could apply the rubric consistently (basic reliability);

and (iii) whether assessment conditions are fair and inclusive. Where feasible, the gate recommends moderation strategies (e.g., double-marking of a sample, calibration meetings among trainers) and transparency measures (rubrics shared in advance, examples of expected outputs).

In addition, Gate 3 checks that assessment does not conflate participation with achievement. The project's certification logic, especially when issuing Open Badges, requires an explicit distinction between mere attendance and demonstrated competence. This distinction must be reflected in both assessment design and credential criteria to protect the credibility of the system and avoid "credential inflation".

Gate 4: Accessibility and inclusive delivery readiness

Accessibility is treated as a release condition for OCC publication. Gate 4 requires that training materials and digital interfaces meet recognised accessibility principles, referencing WCAG 2.2 as the baseline standard for web content accessibility.

Checks include: captions or transcripts for recorded materials; alternative text for images; readable slide structure; sufficient contrast; keyboard navigability for interactive resources; and clear language for instructions and rubrics. Where training is multilingual or intended for international audiences, the gate also includes quality checks for translations and terminology consistency, ensuring that accessibility is not undermined by linguistic ambiguity.

Gate 5: IPR and licensing clearance

Because training contents are intended to be reusable and publishable, Gate 5 performs an IPR and licensing audit.

This gate verifies ownership and rights for original materials (slides, recordings, datasets, code), checks the licensing compatibility of third-party assets, and ensures that proper attribution is provided. In line with the UNESCO Recommendation on OER, open licensing is encouraged to support reuse and equitable access, while recognising that openness must be compatible with legal constraints and ethical safeguards.

Where an open licence is adopted, Creative Commons licences provide a standard mechanism; at minimum, the gate ensures that licence obligations (credit, indication of changes, no additional restrictions) are satisfied.

Gate 6: Version control, release checklist, and corrective actions

A final gate formalises release readiness through version control and documented checklists.

Each module receives a version identifier and release note, enabling traceability of updates over time. The QA model includes issue tracking (errors, broken links, accessibility defects), learner-feedback loops, and corrective actions.

Consistent with the ESG emphasis on continuous improvement, QA is not closed at delivery: learner feedback and performance indicators are treated as evidence for revision cycles.

KPIs and quality monitoring

To ensure quality is measurable and comparable across training activities, the project could adopt a minimal KPI framework.

At minimum, modules could be monitored through: completion rates; credential award rates (separating participation from achievement); learner satisfaction and perceived relevance; and learning gain indicators (e.g., pre/post quizzes, rubric-based performance improvement). Where appropriate, the evaluation logic can draw on established models such as the four-level approach to training evaluation (reaction, learning, behaviour, results), not as a rigid template but as a structured way to connect immediate learning evidence to broader capacity-building outcomes.

5.2. Data & ethics

This section codifies "ethical and legal safeguards" for training delivery, certification, and publication, ensuring that 3D-4CH training processes remain compliant, trustworthy, and safe for participants. The ethical scope includes:

- personal data protection and privacy;
- informed consent, especially in contexts involving image/voice capture and recordings;
- responsible learning analytics;
- licensing and controlled reuse of training artefacts in ways that respect both rights and participant expectations.

GDPR compliance as a baseline (lawfulness, transparency, minimisation)

Training activities typically require processing personal data such as names, contact details, affiliation, attendance records, assessment outcomes, and credential identifiers.

Under the GDPR, such processing must have a lawful basis and must respect transparency and purpose limitation.

Accordingly, each training activity should provide a concise privacy notice specifying: what data are collected; for what purposes (e.g., course management, assessment, certification, aggregated quality monitoring); who will access them; how long they are retained; and how participants can exercise their rights (access, rectification, erasure, restriction, objection).

Data minimisation is implemented as a practical rule: if an item of personal data is not needed for participation management, assessment/certification, or justified quality improvement, it should not be collected.
This rule also supports ethical proportionality in non-formal learning contexts, where extensive data collection may be perceived as surveillance rather than support.

Secure storage, access control, and integrity

GDPR requires appropriate technical and organisational measures to ensure confidentiality, integrity, and availability of personal data.
In training contexts, this translates into role-based access (trainers and assessors' access only the datasets needed for their tasks), secure institutional storage (authenticated platforms, controlled sharing), and avoidance of informal data transfers (e.g., uncontrolled spreadsheets, personal cloud drives).
For certification, secure storage supports auditability: the project must be able to demonstrate that credential claims were based on legitimate evidence and assessed under approved criteria.
When evidence packages include learner-created outputs (e.g., datasets, 3D models, repositories, reflective logs), the ethical requirement is twofold: protect personal data that may be embedded within outputs, and ensure that participants understand how their outputs may be stored, assessed, and, where relevant, published.

Retention, erasure schedules, anonymisation, and pseudonymisation

Storage limitation requires that personal data not be retained longer than necessary.
Therefore, 3D-4CH differentiates between: administrative data (retained minimally for operational and reporting needs), certification records (retained long enough to support verification and auditability), and analytics traces (retained briefly and preferably in anonymised or aggregated form). Where ongoing verification of credentials is required, the project can retain minimal verification data without retaining full learner datasets.
For analytics and reporting, the preferred approach is aggregation and anonymisation, recognising that anonymisation must be treated carefully to avoid re-identification risks. Guidance from European data protection authorities highlights common misconceptions about anonymisation and stresses that true anonymisation requires robust risk assessment.
Where anonymisation is not feasible, pseudonymisation can reduce risk, provided that re-identification keys are protected and access is restricted. Recent EDPB guidance clarifies expectations and good practices for pseudonymisation as a risk-reduction measure under GDPR.

Informed consent procedures, including image/voice capture

Training activities such as workshops and summer/winter schools frequently involve photography, video recording, and audio capture for documentation, dissemination, accessibility (e.g., captioning), or training reuse.

In these cases, the ethical and practical requirement is explicit informed consent with a genuine opt-out option that does not disadvantage participation. EU ethics guidance for funded projects stresses the importance of anticipating ethics issues and documenting safeguards, including consent procedures and templates.
Practical models also exist in EU template materials that explicitly address ad hoc consent for video recording and image capture.
In 3D-4CH, consent procedures should separate: (i) consent for participation-related data processing (where institutions may rely on other lawful bases depending on context), and (ii) consent for media capture and dissemination.
Participants should be informed about: purposes of recording; where recordings may appear (OCC, project channels); retention periods; withdrawal mechanisms; and whether recordings will be edited or anonymised (e.g., blurring faces, removing identifiers).
Safeguards for vulnerable groups require heightened caution. Even when training audiences are primarily professionals, the project should implement a conservative approach: minimise exposure, ensure opt-out pathways, avoid unnecessary publication of identifiable media, and apply additional approvals where sensitive contexts arise.

Ethical learning analytics and learner agency
Beyond legal compliance, learning analytics raises ethical issues related to autonomy, fairness, and trust. Ethical frameworks in learning analytics highlight risks such as function creep, disproportionate monitoring, opaque profiling, and harm to vulnerable learners if interventions are poorly governed. 3D-4CH therefore positions analytics as a support tool for quality improvement, not as a surveillance mechanism.
Good practice includes: transparency about what is measured; preference for cohort-level analytics; avoidance of high-stakes automated decision-making; and clear boundaries preventing secondary uses unrelated to training improvement or certification integrity.

Licensing, attribution, reuse, and takedown procedures
Ethical publication/presentation on the OCC requires legally sound licensing and clear reuse rules. UNESCO frames open licensing as a strategic enabler of quality learning and equitable access, while acknowledging the need for sustainable governance and rights respect.
In practice, 3D-4CH adopts a licensing workflow: original materials are, where feasible, released under a clear open licence (e.g., CC BY), while third-party assets are used only when compatible or replaced. The CC BY 4.0 licence, for instance, requires appropriate credit, a reference to the licence, and indication of changes.
In addition, the project establishes a takedown and correction procedure: if rights holders contest an asset, or if a participant withdraws consent for identifiable media, the OCC version must be updated promptly (e.g., removal, replacement, blurring) while maintaining version traceability.

Responsible openness and data stewardship
Finally, the chapter links ethics to responsible openness.
While the OCC encourages reuse and dissemination, openness is not unconditional: it must coexist with privacy, consent, and rights. Data stewardship principles such as FAIR support structured management for reuse and interoperability, but they do not override GDPR constraints; rather, they provide a quality lens for how training-related datasets and metadata can be managed responsibly.

6. Conclusion

D2.1 consolidates a set of actionable results that move 3D-4CH from an exploratory phase to an operational phase, providing WP2 and the wider consortium with a shared, evidence-informed basis to scale training, publication, and recognition activities from Month 13 (February 2026) onwards.

The deliverable's main added value is not merely descriptive: it translates the project's early analytical work into a coherent set of instruments, methodological, procedural, and governance-related, that can be immediately activated across work packages to ensure that training outputs are trustworthy, reusable, and fit for publication on the OCC.

A first key result is the establishment of an evidence-driven decision foundation for WP2 implementation.

The survey and complementary review activities provide a structured understanding of the current training landscape and, crucially, the gaps and priorities that matter for 3D-4CH. From Month 13, this evidence can be used as a practical prioritisation tool to:

- select and validate external materials suitable for reuse,
- target new module development where scarcity or fragmentation is most significant, and
- justify strategic choices to stakeholders and reviewers (e.g., multilingual adaptation, focus areas for seasonal schools, and sequencing of topics).

This reduces the risk of duplicating existing initiatives and supports a more efficient allocation of effort across partners.

A second major result is the operational consolidation of a trustworthy certification model anchored in assessed evidence.

The deliverable clarifies the project's recognition stance through a defensible logic that links learning outcomes to assessment methods, rubrics, and evidence packages, enabling credentials to function as credible "claims" rather than symbolic participation tokens.

From Month 13, this model becomes a consortium-wide reference for designing training activities that are auditable and consistent across institutions.

Importantly, it also provides a shared vocabulary and a common threshold logic that will facilitate cross-partner delivery, moderation, and mutual recognition of training outputs, an enabling condition for scaling the training catalogue within the OCC.

A third result is the strategic and technically sound positioning of Open Badges as the immediate credentialing mechanism, while keeping a structured pathway open for later micro-credential integration.

The deliverable operationalises Open Badges as a pragmatic solution for the project's early training formats (short, modular, blended), including pilots, while avoiding over-formalisation in the absence of consolidated institutional endorsement routes.

From Month 13, this enables WP2 to issue credentials at scale and to build user trust early, while simultaneously collecting the empirical and organisational evidence needed to assess whether micro-credentials can be introduced as an additional layer. The resulting benefit for the project is twofold: rapid deployment in the short term, and long-term compatibility with emerging European credential ecosystems.

A fourth result, and a critical enabler for cross-WP implementation, is the definition of an end-to-end quality and ethics envelope that makes training outputs safe to publish and reuse.

The deliverable establishes quality gates (peer review, technical accuracy checks, accessibility verification, IPR/licensing clearance, version control) and codifies GDPR-aligned safeguards and consent procedures, including media capture in workshops.

From Month 13, this framework can be applied beyond WP2 as a shared operational standard: it ensures that any training-related asset produced by other WPs (e.g., tool demonstrations, workflows, datasets, tutorials) can be converted into OCC-ready learning objects without increasing legal, ethical, or reputational risk.

This is particularly relevant as the project begins to disseminate more openly and to expand its community engagement and uptake.

The formalisation of a Scientific Committee, with the possibility to appoint activity-specific delegates, represents an additional governance result with immediate operational value. During the next month the Committee can function as a cross-cutting mechanism that (i) validates training content quality, (ii) ensures consistency of assessment and certification decisions, and (iii) strengthens institutional accountability for what is published and certified. This governance

layer is especially relevant when training delivery becomes distributed across partners and when the project begins to scale up outputs and public visibility.

Looking ahead, the deliverable's results enable concrete implementation actions across the WPs from next steps:

- WP2 can immediately translate the evidence base into a prioritised production and delivery plan, using the certification logic, QA gates, and consent/licensing workflows as mandatory design constraints for every training activity and OCC publication.
- WP4 (OCC) can leverage the deliverable's structured requirements (metadata expectations, versioning discipline, licensing clarity, accessibility readiness) to strengthen ingestion, indexing, and maintenance workflows, ensuring that the OCC becomes not only a repository but a governed competence platform.
- WP3 (tools/methods) can transform technical outputs into reusable training assets with clearer pathways to certification, by packaging demonstrators and workflows together with evidence requirements and safe reuse conditions.
- WP1 (quality and management) can use the QA and ethics framework as a practical extension of the Quality Management Plan and DMP into training operations, strengthening auditability and reducing implementation variability across partners.
- WP5 (impact and uptake) can build on the KPI logic and evidence packages introduced in D2.1 to support consistent monitoring of training effectiveness, adoption indicators, and stakeholder feedback, enabling data-informed iteration of both training offers and dissemination strategies.

In conclusion, D2.1 equips the consortium with a shared operational backbone for the next phase of implementation.

Its results should be used to accelerate delivery while safeguarding credibility: enabling rapid scaling of training and certification through Open Badges, ensuring that published content remains accessible and legally reusable, and creating the governance and evidence conditions required to evolve, when appropriate, towards more formal micro-credential integration.

Annex 1: Survey forms

The data collection forms used in the survey are included for information in this linked file.

Annex 2: Ukraine survey report

The report of the Ukraine survey is included for information in this linked file.