



E-RIHS

EUROPEAN RESEARCH INFRASTRUCTURE
FOR HERITAGE SCIENCE

E-RIHS IP

European Research Infrastructure for Heritage Science Implementation Phase

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D4.5 Revised E-RIHS Training Strategy

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ABSTRACT

E-RIHS' vision is to become a European research infrastructure that provides state-of-the-art tools and services. This will be managed by cross-disciplinary groups of researchers for cross-disciplinary users and scientific communities working to advance knowledge about heritage and to devise innovative strategies for its preservation and presentation. Such a unique vision demands also a detailed and result-oriented training strategy.

The purpose of the E-RIHS Education and Training Strategy is to set out skills development priorities, key areas of training and delivery channels as well as ensure optimum use of available resources for training and strengthen capacity of those who use and manage the European Research Infrastructure for Heritage Science, including access providers, researchers and postgraduate students. The approach has been separated into several objectives, which provide a formalised approach to training provisions. The report was synthesised by conducting several desk-based reviews. Its overall motivation is to ensure that future training is purposeful and directly relevant to application within the research infrastructure.

The objectives are to:

- *Establish a skills and competencies profile for access providers and managers;*
- *Assess the current provision of training resources for access providers and managers;*
- *Develop the training offer for access providers and managers that provides a targeted approach to training, addressing areas where there is the most need first and considering how to meet accessibility aims;*
- *Propose a direction for the provision of infrastructure for continuous skills development of Heritage Scientists working with RIs;*
- *Suggest approaches for high quality communications and engagement to build a strong Heritage Science training community and wider network;*
- *Describe how interactions with Higher Education might be managed to provide support for Heritage Science students and ensure long-term sustainability of E-RIHS.*

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ABBREVIATIONS

Abbreviations	Expansion
CHARTER	European Cultural Heritage Skills Alliance
CPD	Continuing Professional Development
E-RIHS	European Research Infrastructure for Heritage Science
ESFRI	European Strategy Forum on Research Infrastructures
EU	Council of the European Union
HS	Heritage Science
HS-DSS	Heritage Science Doctoral Summer School
HS-TC	Heritage Science Training Camp
HE	Higher Education
IPERION HS	Integrating Platforms for the European Research Infrastructure on Heritage Science
RI	Research Infrastructure
SSH	Social Sciences and Humanities

Introduction

The mission of E-RIHS ERIC is to deliver high quality services (excellent science) for the scientific communities that the research infrastructure serves. High quality services need to be supported by high quality staff. Hence, the sustainability of a RI is linked to the capability of attracting, training, re-training and retaining skilled human resources. It is crucial that research infrastructure staff, with all their knowledge and experience, are supported and nurtured for the future. It is also essential to look at ways to connect with Higher Education to start to develop the next generation of RI staff and leaders. In other words, to remain competitive and at the forefront of scientific research, it is essential to invest in the training and development of heritage scientists.

Heritage science is an inherently cross-disciplinary domain requiring knowledge of science and engineering as well as of arts and humanities and social sciences. Most researchers enter the field at a postgraduate level or at a post-doctoral level with a diverse range of academic backgrounds; therefore, training opportunities to develop a variety of complementary skills may be required. Staff working within E-RIHS ERIC will require technical skills and knowledge that allow them to uncover what others may not perceive. Additionally, heritage scientists that interact with and contribute to E-RIHS work across diverse environments: in academia, heritage institutions, as well as in business environments, and transferable skills are needed for research to have the desired impact. Since many heritage scientists have parallel careers with multiple skillsets, it is likely that they will be constantly learning throughout their working lives. E-RIHS ERIC needs to make sure that RI staff can easily broaden their skills by accessing specialised lifelong training for the specific RI challenges.

This training strategy builds on findings regarding the education and training landscape identified by previous reporting and surveys, namely Deliverables 7.1 and 7.2 of E-RIHS PP, Deliverable 8.3 of IPERION HS, and the HS Academy Questionnaire conducted in early 2023. These investigations mapped required skills for heritage scientists contributing within the context of research infrastructures, as well as other key issues regarding training like resource, organisation, infrastructure, provision, accessibility, communications, and engagement. This strategy has also been influenced by two meetings, one in Ljubljana (in October 2023) and one in Bologna (in January 2024), which have set out the main ways that Higher Education can be connected to E-RIHS. While the training strategy is mainly focused on the provision of training for infrastructure managers and access providers, it will also aim to provide rough guidance regarding how the RI can engage with HE and ensure that appropriate understanding is cultivated surrounding the specific arrangements of working with PhD students.

The primary aim of this strategy is to ensure that resources are invested into the creation of a training experience that enriches the quality and pushes the boundaries of collaborative heritage science research. It will achieve this by identifying the range of skills necessary to sustain and grow E-RIHS into the future, as well as proposing mechanisms to reach training providers and the wider heritage science community. E-RIHS aims to deliver a training offer through the HS Academy, representing: (i) training organised by E-RIHS where there are gaps in the current training offer, (ii) a network of institutions, projects and programmes delivering heritage science training, and (iii) a self-reinforcing community of E-RIHS alumni with unique and competitive heritage science skills. In order to fulfil its mission to stretch the boundaries and the impact of heritage science, E-RIHS will work with researchers, organisations, and industry.

EDUCATION AND TRAINING LANDSCAPE

This strategy has been calibrated by other E-RIHS internal strategies and external evidence. The education and training landscape of heritage scientists has been the subject of several reports, investigations, and

developments as part of both the focused initiatives of E-RIHS and IPERION HS partners, and within the context of research conducted on the cultural heritage sector as a whole. The aim of this section is to review the efforts that have taken place to try to understand, and make provision for, necessary training requirements for access to, and management of, E-RIHS services. This will set the scene for the strategy developed within this report for the continuation of the delivery of training in E-RIHS IP and beyond.

EU Publications and Initiatives

Heritage science faces many of the same challenges as other communities of practice in regards to the need to enhance EU cooperation in training and develop 21st century skills. In 2017 and 2018, the Council of the European Union invited a group of national experts to investigate skills, training, and knowledge transfer in the heritage professions in Europe. In 2019, the group completed and published a study named ‘Fostering cooperation on skills, training and knowledge transfer in cultural heritage professions’. The report concluded that core and transferable skills that are required within a profession should be defined within role profiles to demonstrate to learners and training providers the competencies required to practice in each role. This has been reinforced by the “European Skills Agenda for sustainable competitiveness, social fairness, and resilience”, which puts forward the idea that skilling for a specific job should be one of the guiding principles to be taken into consideration in the EU paradigm-shift on skills.

Building on the above work by the European Commission and sectoral partners to investigating sector skills mismatches, at the end of 2020, cultural heritage became one of twenty-eight ‘Blueprint for Sectoral Cooperation on Skills’ projects funded through the Erasmus+ programme. The project, named ‘Cultural Heritage Actions to Refine Training, Education and Roles’ (Charter), aims to address lifelong learning requirements in cultural heritage by 1) the clarification of occupational roles and activities; and 2) the identification of curricula and learning outcomes to equip education and training to respond to current and future needs for cultural heritage skills. Deliverable 3.4 of the Charter, ‘Identifying gaps and needs in the educational and training programmes’, has indicated some general trends within the skills gaps of the sector: management, project coordination, teamwork dynamics, and communication.

E-RIHS Internal Documents

The key guiding influence is the E-RIHS Scientific Vision and its priority areas and core values, in particular the emphasis on competencies, responsible and ethical research, and excellence. The training offer of the E-RIHS Academy will reflect these values, supporting interdisciplinarity, co-creation, ethics, communication, innovation, complementarity, interoperability and quality user experience. As set out in the E-RIHS User Strategy and Access Policy, the educational and training activities must reach the following three main audiences:

Table 1: The three main audiences identified within the E-RIHS User Strategy and Access Policy.

Users	Providers	Managers
Users of E-RIHS infrastructures encompass a wide ranging group, including diverse scientific communities, scholars, curators, conservators and other heritage professionals, as well as other stakeholders who require access to E-RIHS facilities	Providers of access work with users to utilise the diverse resources across the four key modes of access (MOLAB, DIGILAB, FIXLAB and ARCHLAB). They provide training and ad hoc learning opportunities to users at the point of access	Managers of the research infrastructure on national and international level include E-RIHS senior and middle management, and heads and administrators of national nodes as well as other members of E-RIHS community, with specific training needs

The E-RIHS report on Education and Training needs (Deliverable 7.1 of E-RIHS PP), which was submitted in May 2018, constitutes the results of a survey aimed at the heritage science community. This investigation was undertaken to understand the landscape of heritage science training provision from the viewpoint of both users and providers of access to infrastructure services. The report identified some of the required skills needed for heritage scientists working within the remit of E-RIHS and the associated gaps in training provision. This insight, along with reviews of future skill needs in the heritage context, raise important questions about how to develop a future-proof, cross-disciplinary, and supportive training ecosystem. Much of this strategy, and the delivery channels in particular, are a response to the E-RIHS needs assessment. This document also draws heavily upon the E-RIHS Training Strategy (Deliverable 7.2 of E-RIHS PP). The five objectives that are proposed in the existing strategy have been taken forward here-in. However, they have been reorganised and, in some cases, collated in order to reduce repetition and produce simplified objectives that are more easily operationalisable.

HS Academy

The HS Academy was launched by IPERION HS and E-RIHS partners in 2020, with the aim of addressing some of the gaps identified within the training provision for the E-RIHS community. The HS Academy offers several mediums and intensities of training to suit different types of professionals, users, and research communities with varying levels of involvement with E-RIHS.

The most accessible type of training activity takes the form of online training content, which is available through the E-RIHS YouTube channel. The HS Academy webinars and HS Current Topics lectures cover a range of important issues related to Heritage Science, i.e., understanding the importance Heritage Science, how to submit a proposal, FAIR data, interdisciplinary collaboration, monitoring of ESFRI Infrastructures, as well as an overview of different analytical techniques and approaches to elucidate the breadth of fields and services that make up E-RIHS. These topics are described in more detail within the Training Audit of current training resources for heritage scientists working in the context of E-RIHS (Section 5). The HS Academy also runs a series of service user meetings that provide a platform for users who have accessed services to talk about the outcomes of their research and connect with one another. The online content is targeted at emerging professionals, such as students and young researchers, as well as to advanced conservators, curators, restorers, and other cultural heritage stakeholders, covering university, public and private sectors.

The HS Academy has been responsible for organising several Doctoral Summer Schools to provide a multidisciplinary interactive learning experience within the field of Heritage Science. The HS-DSS are specifically aimed at early career researchers within HS and contain theoretical and technical lectures delivered by a wide range of international experts in the field of Heritage Science. All lectures are intended to provide an overview of the state-of-the-art as well as specific details of their topic. The first HS-DSS occurred in July 2021, with the theme, 'Excellence in heritage science for conservation and collection care research and access'. This summer school (organised by the University of Bologna – Microchemistry and Microscopy Art Diagnostic Laboratory) was taught completely online and took the structure of 3 days of lectures and 2 half days of virtual study tours. The second HS-DSS, named 'Environmental impact on built heritage and its digitalization', took place in July 2023. This summer school was held in-person at ZAG (Slovenian National Building and Civil Engineering Institute), Ljubljana, Slovenia. The HS-DSS comprised four full days of lectures, during which participants became acquainted with the multidisciplinary skills of the IPERION HS consortium and knowledge accumulated by the partners.

Heritage Science Training Camps, which are targeted at potential users of E-RIHS, have also been organised by the HS Academy. The training camps are intended to be more interactive and more appropriate for learners with a mixed educational and professional background. Through the use of innovative mobile and laboratory equipment, best practices and methodological approaches can be transferred directly to new potential users, to trainees, students, and small or medium-sized enterprises. To promote the involvement

of new heritage science communities, the subject of the first HS-TC, organized by CENIEH and held in-person at Place Burgos (Spain) and Atapuerca (UNESCO site), was ‘Cutting-edge tools for materials characterization and dating applied to Paleontological and Paleoanthropological heritage’. The HS-TC was held in July 2022 and took the form of 5 days of hands-on experience, laboratory analyses, group projects, general lectures, and fieldwork sessions. The second HS Academy Training Camp was focused upon ‘Built Heritage in a Changing Environment’. This was held in-person at the Centre Telč of ITAM CAS (Telč, Czech Republic) in June 2023 over the course of 5 days. It included general lectures and hands-on activities on specific case studies, including on-site sessions and laboratory experiments within the realm of built heritage.

IPERION HS Report on Existing RI Centralised Procedures

IPERION HS collected information on how training activities are organised in other European research infrastructures between November 2022 to February 2023. The purpose of the investigation was to assess the organisation of training on the RI website, as well as ascertaining the type of training activities and who they are aimed at. Of the 36 RI websites that were included in the analysis, over half have a section/webpage or an online platform dedicated to training resources. Only 28%, contained a registry of available resources external to the RI. However, many included a news section to inform about relevant training events across the sector.

A survey disseminated to thirteen case-study RIs surveys contained useful guidance for the implementation of training activities within E-RIHS. For example, over two thirds of RIs have a budget allocated specifically for training activities by the central hub and half of the RIs have dedicated staff working on developing training resources. Furthermore, a high proportion of RIs emphasised the need for a helpdesk or training specific email address. At the point of data collection, none of the RIs had a specific request procedure for PhD students, while only 1 of 6 were involved in providing funds for doctoral students. The recommendations given within the report are used here-in (see section on defining strategic objectives below) to ensure that the E-RIHS training strategy is informed by the practice of other RIs.

HS Academy Questionnaire

In 2023, the HS Academy disseminated a questionnaire that comprised an updated landscaping exercise to assess the demographics, interests, and engagement of the Heritage Science community with HS Academy, as well as to identify barriers to training provision and investigate the emergence of the heritage scientist identity. The questionnaire was distributed within E-RIHS and Iperion HS communities over the course of 6 months and had over 400 respondents. This has provided up-to-date information regarding training expectations in a post-covid world, where reliance on technology for dissemination and education has been magnified. The conclusions and recommendations generated from the HS Academy Questionnaire results can be found within Table 1 below.

Table 2: The conclusions and recommendations from the HS Academy Questionnaire regarding the demographics, interests, and engagement of the Heritage Science community with HS Academy.

Conclusion	Recommendation
Highly trained, research-intensive community	Requires professional, equitable, scientific communication
By a wide margin: mostly conservators, archaeologists, chemists	More intensive engagement with other fields
Even age distribution	Masters and doctoral-level training, life-long training

50% IPHS/E-RIHS users	Revise how services are communicated
40% not engage in IPHS/E-RIHS, 54% unaware of HS Academy	Requires more community-level dissemination
Online events preferred	Strive to make all events hybrid
Technical notes, hands-on training popular	Consider more practical training content
Most relevant to identity: funding, facilities, training, networking, professional organisation	Revise how E-RIHS works with professional organisations
84% identify as heritage scientists	Continue to establish heritage scientist as professional identity

RIs and Higher Education

Iperion HS and E-RIHS partners have organised two workshops, one in Ljubljana in October 2023 and one in Bologna in January 2024, which have started to investigate and debate the role of E-RIHS in formal education. The case for closer involvement of research infrastructures in education has been made repeatedly by ESFRI, who claim that the new ERA requires the development of an “interconnected environment of which RIs are an important element... not restricted only to research, it extends also to other areas like education, innovation, health and others.” While RIs contribute to education by providing specialised training and access to students, it is less clear how the desired “interconnectedness” could be enshrined more deeply in the conceptualisation as well as in the process of education at the level of higher education.

STRATEGIC OBJECTIVES

The primary aim of this strategy is to ensure that E-RIHS invests its resources into the creation of a training experience that enriches the quality and pushes the boundaries of collaborative heritage science. The suggested approaches and recommendations from the above internal strategies and external evidence can be simplified into six strategic objectives that will frame the overall training strategy for E-RIHS ERIC. The first two strategic objectives, *Develop a skills profile for access providers and managers* and *Address gaps within the training provision for access providers and managers*, have been developed to address the needs of E-RIHS access providers and managers specifically. The strategic objectives, as well as the recommendations that are encapsulated by them, can be found below.

Strategic objective: Develop a skills profile for access providers and managers.

OMC Report 2019: *Classify heritage occupations and assess current and future skills needs.*

Erasmus+ Blueprints/Sectoral skills alliance projects: *Clarify occupational roles and identify existing and emerging skills needs.*

D7.1 Recommendation 3: *E-RIHS should develop a catalogue of HS skills, starting with technical skills, but also emphasizing collaborative, communication and engagement, digital skills.*

D7.1 Recommendation 4: *E-RIHS should develop a clear catalogue of expected skills related to access to infrastructure to manage expectations and ensure a high quality of the experience of access to infrastructure.*

Strategic objective: Address gaps within the training provision for access providers and managers.

Erasmus+ Blueprints/Sectoral skills alliance projects: *Highlight the areas in which there is a greater need for improvement of the education and training provision.*

Charter Alliance D3.4: Skills gaps identified within management, project coordination, teamwork dynamics and communication.

D7.1 Recommendation 5: E-RIHS should develop training courses specifically focussing on the provision of SSH and digital skills, as well as transferable, collaborative working skills.

D7.1 Recommendation 9: The content of E-RIHS courses should address some specifically identified gaps, such as knowledge management.

D7.1 Recommendation 10: E-RIHS Academy provision should include training in international collaboration.

D7.1 Recommendation 11: The training offer could incorporate courses supporting potential users in preparing proposals to win a project granting access to research infrastructure

D7.1 Recommendation 12: There are opportunities for a training offer for providers that combine innovation and commercialisation within heritage science development.

D7.1 Recommendation 13: The training offer needs to empower providers in skills enabling them to design and deliver training aimed at heritage practitioners.

D7.1 Recommendation 14: E-RIHS training could address the lack of conservation-oriented training among the facility providers to enhance collaboration with heritage practitioners.

D7.1 Recommendation 15: The training provision and the catalogue of expected skills need to be clearly interrelated, ensuring that the experience of training is purposeful and directly relevant to the application within the research infrastructure.

D7.1 Recommendation 16: The provision of training covering data science, social science and transferable skills content needs to be improved to support the development of E-RIHS DIGILAB, and the enhancement of cross-disciplinary skills.

D7.1 Recommendation 18: The E-RIHS Academy should not be treated as primarily providing core technical and scientific education of heritage scientists.

D7.1 Recommendation 19: E-RIHS access should include training organised by individual access providers to ensure knowledge exchange and specialist skill building within the infrastructure.

D7.1 Recommendation 21: E-RIHS training should develop skills in designing interdisciplinary research, combining scientific and applied competence in the cultural heritage field.

D7.1 Recommendation 22: The E-RIHS training strategy needs to address gaps in interdisciplinary scientific communication skills to build purposeful relationships between different communities of heritage experts.

D7.1 Recommendation 23: E-RIHS training strategy should include training in ethics and management skills for actors engaging with the research infrastructure to empower all providers and users and ensure that the research process proceeds in an effective and efficient manner.

Strategic objective: Provide infrastructure to ensure continuous skills development.

D7.1 Recommendation 2: E-RIHS to develop or to enable the development of a CPD system for HS.

D7.1 Recommendation 18: The E-RIHS Academy should create partnerships with existing providers of heritage science education and specialist training to share best practice and seek opportunities for training partnerships.

Iperion HS Report on existing RI centralised procedures: A distinguishable and updated web space dedicated to training activities is essential (website, platform etc.)

Iperion HS Report on existing RI centralised procedures: Helpdesk or email contact of a training office on the website is an added value.

Iperion HS Report on existing RI centralised procedures: Availability of funding for organization of training activities at central level is fundamental.

Iperion HS Report on existing RI centralised procedures: Dedicated training staff, as well as generally competences of the personnel responsible for central activities, are essential.

HS Academy Questionnaire Recommendation: Provide life-long training.

Strategic objective: Make the delivery of training accessible and efficient.

D7.1 Recommendation 6: E-RIHS should focus on online delivery of training, although there is a place for face-to-face training that participants would be able to pay.

D7.1 Recommendation 7: The typical duration of E-RIHS courses should be up to a week.

E-RIHS should focus on online delivery of courses.

D7.1 Recommendation 8: E-RIHS should focus on online delivery of courses.

Iperion HS Report on existing RI centralised procedures: Dedicate particular effort to develop online training modules and data repositories.

HS Academy Questionnaire Recommendation: Strive to make all events hybrid.

HS Academy Questionnaire Recommendation: Consider more practical training content.

Strategic objective: Build a strong Heritage Science training community.

D7.1 Recommendation 1: E-RIHS training strategy needs to explore mechanisms to attract more users to join HS training courses and diverse formulations of communicating data that might be called otherwise than “training courses”.

D7.1 Recommendation 17: The E-RIHS Academy should develop a range of training channels, suited to the different training aims and research communities that the training activities might be focusing on.

Iperion HS Report on existing RI centralised procedures: Targeted training opportunities are crucial to reach the appropriate audience. It is crucial to tag information with type of training, date, time, organiser, and place and give a structured description of the event.

HS Academy Questionnaire Recommendation: Requires professional, equitable, scientific communication

HS Academy Questionnaire Recommendation: More intensive engagement with other fields

HS Academy Questionnaire Recommendation: Revise how services are communicated

HS Academy Questionnaire Recommendation: Requires more community-level dissemination

HS Academy Questionnaire Recommendation: Revise how E-RIHS works with professional organisations

HS Academy Questionnaire Recommendation: Continue to establish heritage scientist as a professional identity.

Strategic objective: Support Higher Education programmes engaging with Heritage Science.

Iperion HS Report on existing RI centralised procedures: Many RIs consider a priority their involvement in university education, the E-RIHS community should consider it critical. Although not generally implemented by RIs yet but recommended by the most recent European policies, involvement in PhD education can be a crucial direction for the E-RIHS agenda and strategy.

HS Academy Questionnaire Recommendation: Provide Masters and doctoral-level training.

ESFRI Recommendation: The interconnectedness of RIs should extend to education.

This report will address each of these strategic objectives in-turn, describing the work that has already been undertaken to achieve them and structuring the direction of future efforts. Most of the strategic objectives are considered in isolation; however, *Address gaps within the training provision for access providers and managers*, and *Make the delivery of training accessible and efficient*, have been combined due to the interdependence between these two aims.

DEVELOP A SKILLS PROFILE FOR ACCESS PROVIDERS AND MANAGERS

The development of a skills profile relevant to the management and provision of services within E-RIHS is an important step in understanding the required competencies of those working within the context of the RI. Beyond their roles as experts in technology and experimental applications, RI staff serve as facilitators, who combine broad expertise, gained from working with different labs, with a wide professional network, that together, help to catalyse interdisciplinary research. While those working within E-RIHS will mainly be scientists with well-developed research skills, RIs are primarily service organisations; they need to operate as

businesses with a client base. As such, research infrastructure managers and providers within pan-European RIs need be able to engage and influence others effectively, understand the governance and management of RIs, have cultural awareness and strong interpersonal skills, in addition to possessing excellent research and intellectual abilities. In the future, access providers may also need to have more/better teaching skills, not just because of hands-on training during access but also because RIs will engage in research student supervision. Moreover, since the field is so interdisciplinary in nature, continuous skills development is an important requirement to succeed in a career within heritage science.

Although many providers might also be users (e.g., participating in research proposals within E-RIHS) or managers and vice versa, E-RIHS sees these roles as distinct in the project settings, and demanding project-specific skills. Training will, therefore, cover core skills required by the scientific aims of project teams, but also transferable and management skills. This will enable project teams consisting of users and providers to obtain a greater insight into what they might do with and through the infrastructure, as well as to maximise the impact of their research.

Draft skills profile

A draft skills profile (Figure 1) for access providers and managers within E-RIHS has been created. The Vitae Researcher Development Framework established by the Careers Research and Advisory Centre was used to determine four main skill domains: Engagement, Influence, and Impact; Knowledge and Intellectual abilities; Research Governance and Organisation; and Personal Effectiveness. Required skills for access providers and managers are an amalgamation of those suggested within the Researcher Development Framework and skill requirements indicated in the D7.1 Report. The suggestions of required skills taken from the D7.1 Report are specific to E-RIHS and the nature of the Heritage Science field, for example, skills to communicate the public benefits and significance of Heritage Science, Data Management skills for DIGILAB, SSH research skills, conservation research skills, and interdisciplinary collaboration skills. To supplement the skills profile with additional ones that will likely be necessary for the smooth running of E-RIHS, the Competency Profile for RIs developed by RItrain was also consulted. The RItrain Competency Profile was developed through consultation with a wide range of managers/leaders and technical operators of research infrastructures. Several skills, particularly within the realm of RI governance and organisation, for example, knowledge of compliance, understanding of governance, financial management skills, were adopted for the E-RIHS skills profile for access providers and managers.

It should be noted here that while this skills profile has been developed with E-RIHS access providers and managers in mind, there will likely be merit in further tailoring this skills profile to represent specialised roles. This may require the development of additional skills profiles that reflect the needs of different positions within the RI, demonstrating alternative progression pathways. For example, separate skills profiles should be developed for the positions held by staff within the Central Hub and for the users of E-RIHS. Using a skill acquisition framework, we will continuously review the catalogue, learning objectives and outcomes to meet the emerging needs of the community.

Engagement, influence, and impact

- Communicating the public benefits and significance of Heritage Science
- Designing and delivering high quality training events
- Relationship building skills to grow and draw upon different communities of heritage experts
- Innovation skills
- Commercialisation skills
- Using the E-RIHS brand

Knowledge and intellectual abilities

- Developing proposals for access to E-RIHS
- Specialist and cross-disciplinary knowledge, skills and expertise required to use and provide access to the E-RIHS research infrastructure and facilities
- Research skills in conservation
- Humanities and social sciences research skills
- Digital research skills
- Object handling skills
- Knowledge of research ethics

Research governance and organisation

- Knowledge of compliance
- Understanding of purpose and strategic vision of E-RIHS
- Understanding of governance
- Financial management skills
- Service management skills
- Data management skills for DIGILAB
- Knowledge of quality assessment procedures
- Knowledge of resourcing and recruitment

Personal effectiveness

- Interdisciplinary collaboration skills
- Leadership skills
- Equality and diversity awareness
- Emotional intelligence
- Integrity

Figure 1: Required skills relevant to the management and provision of services within E-RIHS.

As part of the RItrain Competency Profile, next to each skill is an indication of how relevant the skill is within the context of the management of research infrastructures. A similar weighting was considered a useful method of determining which skills should be prioritised first in terms of structuring a future E-RIHS training plan. Hence, the working group for the task (seven respondents) were asked to select a value between 1 and 10, that indicated how strongly they agreed that skills were relevant for access providers and managers responsible for helping to manage E-RIHS. The results of this exercise are presented in Figures 2-5 below.

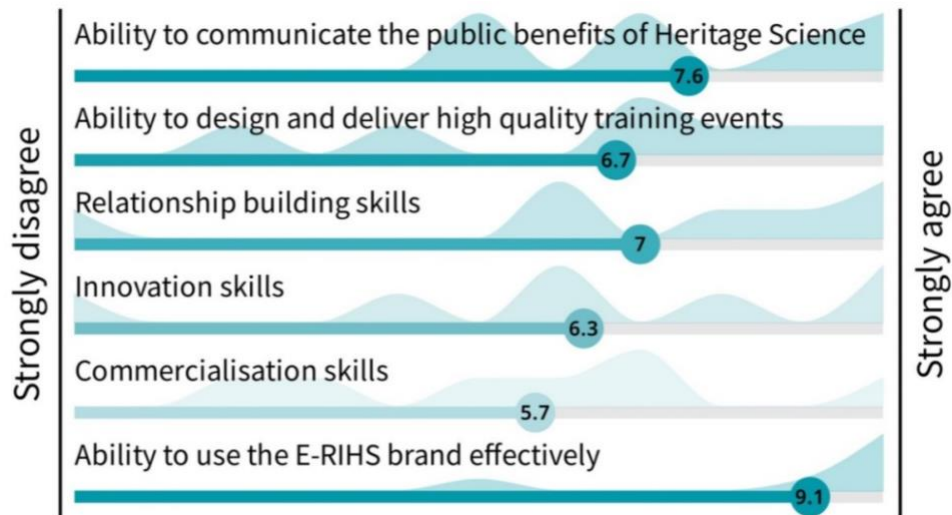


Figure 2: The results of the relevance ranking exercise for the skills within Engagement, Influence, and Impact. Participants were asked if E-RIHS access providers and managers need these skills and competencies.

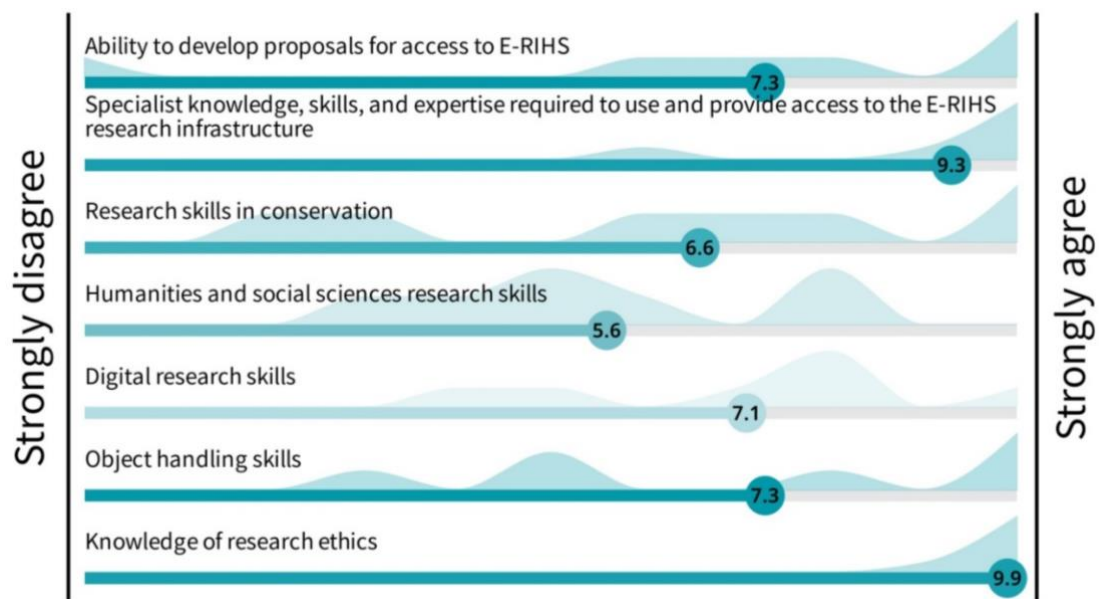


Figure 3: The results of the relevance ranking exercise for the skills within Knowledge and Intellectual abilities. Participants were asked if E-RIHS access providers and managers need these skills and knowledge.



Figure 4: The results of the relevance ranking exercise for the skills within Research Governance and Organisation. Participants were asked if E-RIHS access providers and managers need these skills and knowledge.

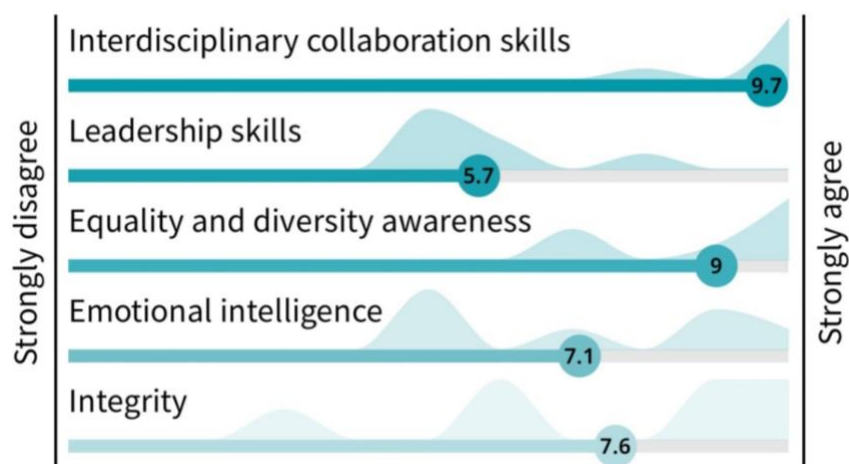


Figure 5: The results of the relevance ranking exercise for the skills within Personal Effectiveness. Participants were asked if E-RIHS access providers and managers need these skills and behaviours.

Skills were then sorted into three categories according to their scores: 5-6.9 – medium relevance; 7-8.9 – high relevance; 9-10 – very high relevance. Subsequently, an expanded skills profile for E-RIHS access providers and managers with descriptions of indicative knowledge, abilities, and behaviours and associated relevance attribution was developed and can be found below in Tables 3-6. This skills profile was largely based off the Rittrain Competency Profile but has been adapted and tailored to E-RIHS access providers and managers.

Table 3: Necessary skills for access providers and managers within the domain of Engagement, Influence, and Impact (adapted from Ritrain Competency profile)

Skill	Indicative knowledge, abilities, and behaviours	Relevance for E-RIHS
Communicating the public benefits and significance of Heritage Science	<ul style="list-style-type: none"> • Can distinguish between different target audiences and identify the most appropriate means of reaching them • Proactive in discovering different audiences and their interests • Understands the services that E-RIHS' provides and can communicate clearly and precisely about them • Invites two-way communication; actively listens/pays attention • Appreciates the value of social media and uses it to communicate with different audiences • Able to work effectively with creative professionals, e.g., designers, animators, journalists 	High
Designing and delivering high quality training events	<ul style="list-style-type: none"> • Understands current state of Heritage Science skills and where to prioritise training efforts • Ensures training aligns with the E-RIHS' broader objectives and values • Understands the importance of offering different training mediums, e.g., online, hybrid, in-person • Able to identify and mitigate barriers to training • Assesses the resources required to implement the training program effectively • Good networking and influencing skills that can encourage in-kind contributions to training program • Follows a timeline that outlines the sequence and duration of each training module • Able to adapt training content or delivery to meet changing needs of E-RIHS • Understands the importance of gaining feedback • Learns from feedback and adapts format of training accordingly 	Medium
Relationship building skills to grow and draw upon different communities of heritage experts	<ul style="list-style-type: none"> • Broad understanding of Heritage Science • Broad understanding of who E-RIHS' stakeholders are, their interests, and their sphere of influence • Actively builds on and invests in relationships • Negotiation and conflict management skills • Influencing skills • Communication and presentation skills, including ability to translate complex concepts into lay language and pitch the message appropriately for the audience • Ability to manage expectations 	High
Innovation skills	<ul style="list-style-type: none"> • Leverages innovations through service development • Fosters a culture of innovation by encouraging learning, collaboration, and growth mindset • Evaluates the current performance of the RI and find ways to help the organization reach its full potential 	Medium

Commercialisation skills	<ul style="list-style-type: none"> • Understanding of entrepreneurship • Understands the need to conduct market research, analyse data, and monitor competitors to identify gaps and opportunities • Effectively communicates the value of the proposition to potential funders • Able to adapt to changing market conditions and customer feedback and adjust strategy accordingly • Understanding of compliance to manage the financial, legal, and regulatory aspects of the product or service 	Medium
Using the E-RIHS brand	<ul style="list-style-type: none"> • Understands that positive brand reputation increases loyalty, builds trust, and will help position E-RIHS as a leader within the Heritage Science community • Engages with stakeholders and the public positively • Is transparent and authentic in all interactions when representing E-RIHS 	Very high

Table 4: Necessary skills for access providers and managers within the domain of Knowledge and Intellectual abilities (adapted from RItrain Competency Profile)

Skill	Indicative knowledge, abilities, and behaviours	Relevance for E-RIHS
Developing proposals for access to E-RIHS	<ul style="list-style-type: none"> • Understands how to design a research project in the context of Heritage Science, i.e., background of literature, defining problem, impact of research for wider cultural, societal, and environmental issues, technical specification • Understands the process of application to E-RIHS' services, including calls for projects, peer review, and potential outcomes • Can demonstrate project management skills to facilitate completion of project, e.g., time management, organisation, collaboration, problem-solving and adaptability • Demonstrates a commitment to fulfilling post access duties 	High
Specialist and cross-disciplinary knowledge, skills and expertise required to use and provide access to the E-RIHS research infrastructure and facilities	<ul style="list-style-type: none"> • Has developed a solid understanding of types of research questions, materials, methods, and data related to own research (user) or within service facilities (provider) • Has received training and is competent in use of scientific instruments or software related to research • Follows standards and internal guidelines for experimental procedures or data processing • Understands that additional expertise should be consulted when in doubt over methods or results • Is proactive in organising continuous professional development to deepen and widen competencies 	Very high
Research skills in conservation to enhance	<ul style="list-style-type: none"> • Understands the aim of conservation: to preserve cultural heritage for the benefit of present and future generations 	Medium

collaboration with heritage practitioners	<ul style="list-style-type: none"> ● Appreciates the impact that science can have on wider cultural, societal, and environmental issues related to heritage conservation ● Understands the relevance of the conservation history, materials, and chemical characteristics of cultural heritage to their care and repair ● Has an awareness of material change, the agents of deterioration, preventive conservation policies and procedures, intervention, and risk management ● Appreciates the difficulty of decisions relating to the sampling, cleaning, or repair of historic materials ● Understands the importance of using conservation values to direct research inquiries and interpret scientific results 	
Humanities and social sciences research skills to enhance collaboration with heritage practitioners	<ul style="list-style-type: none"> ● Understands that humanities and social sciences research is invested in discovering new ways of understanding human behaviour and culture ● Appreciates the impact that heritage science can have in creating new levels of sophistication in debate within wider cultural, societal, and environmental issues ● Understands the importance of the provenance, materials, and history of cultural heritage to their meaning and relevance for modernity ● Appreciates the ethics relating to the destructive sampling of historic materials ● Understands the importance of using humanities and social sciences frameworks to direct research inquiries and interpret scientific results 	Medium
Digital research skills	<ul style="list-style-type: none"> ● Is able to undertake data processing, coding, crowd-sourced data science, machine learning, digitalisation, and data visualisation ● Understand the complexities of acquisition, analysis, and exploitation of the variety of data that is generated and used in heritage contexts 	High
Object handling skills	<ul style="list-style-type: none"> ● Understands that good object handling practices should be applied to all historic objects to minimise the risk of damage during consultation, moving, and handling ● Has received training and is deemed competent to handle historic objects 	High
Research ethics	<ul style="list-style-type: none"> ● Broad understanding of ethical implications of research, and the responsibility of researchers and research infrastructures to work within ethical constraints, e.g., ethical sampling, responsible research and innovation, FAIR data ● Firm understanding of E-RIHS' internal ethical policies ● Confronts or reports potentially unethical behaviour or behaviour that is at odds with E-RIHS' values 	Very high

Table 5: Necessary skills for access providers and managers within the domain of Research Governance and Organisation (adapted from RItrain Competency Profile).

Skill	Indicative knowledge, abilities, and behaviours	Relevance for E-RIHS
Compliance	<ul style="list-style-type: none"> ● Firm understanding of E-RIHS' internal legal policies ● Broad understanding of E-RIHS' responsibilities in the context of local, national and international legal frameworks, e.g., GDPR and safeguarding ● Basic understanding of intellectual property law, contractual law and copyright law ● Respects confidentiality: knows when and how to use confidential information 	Very high
Purpose and strategic vision of E-RIHS	<ul style="list-style-type: none"> ● Has an overview of E-RIHS and the research that it supports ● Knows who E-RIHS' key stakeholders are ● Has the influencing skills to foster a common vision ● Takes action to translate the organisation's vision into a clear operational strategy, cascades this into individual objectives and enables operational delivery of the strategy ● Makes decisions that support and are aligned with the overall strategy ● Can demonstrate how tasks and projects fit in with the bigger picture and broader context 	Very high
Governance	<ul style="list-style-type: none"> ● Understands the structure and administration of E-RIHS, e.g., the ICC, GA, central hub, national nodes, partners, affiliated partners ● Fosters a unity of purpose between different organisational bodies within E-RIHS 	High
Financial management	<ul style="list-style-type: none"> ● Understands institutional and national financial systems for supporting research ● Understands funding complexities and variety of sources for funding ● Understands the importance of independent audits and the organisational processes necessary to comply with them ● Budget planning and control skills ● Can monitor use of funds to avoid significant under- or over-spending ● Understands accounting, timesheets, access project management (following Horizon guidelines) ● Understands how to include in-kind contributions 	High
Service management	<ul style="list-style-type: none"> ● Understands service design and delivery management ● Understanding of procurement procedures ● Understands operations management ● Focuses on the needs and desires of the service user ● Continuously optimises processes and services according to the needs of service users 	High

Data management skills	<ul style="list-style-type: none"> • Understands the importance of good data management and curation within RIs, e.g., the data lifecycle, FAIR data, metadata, paradata, vocabularies, controlled lists • Understands that the preservation and accessibility of knowledge, via Zenodo and Github, is very important for the long-term sustainability and impact of E-RIHS 	Medium
Quality Assessment	<ul style="list-style-type: none"> • Understands that there must be ongoing quality assessment of E-RIHS operations and services to comply with ESFRI Research Infrastructure Monitoring • Appreciates the main objectives of E-RIHS and the types of metrics that might be useful for assessing quality (research quality, impact, collaboration, service quality) • Is familiar with the steps service providers must take to begin or retain partnership with E-RIHS • Can exercise impartiality and rigour when reviewing E-RIHS' service quality 	Very high
Resourcing and recruitment	<ul style="list-style-type: none"> • Firm understanding of HR processes and policies, including rules governing international recruitment • Firm understanding of organisational competency requirements • Impartial, regardless of prior knowledge of the candidates 	Medium

Table 6: Necessary skills for access providers and managers within the domain of Personal Effectiveness (adapted from RItrain Competency Profile)

Skill	Indicative knowledge, abilities, and behaviours	Relevance for E-RIHS
Interdisciplinary collaboration skills	<ul style="list-style-type: none"> • Is responsive to collaborative opportunities across disciplines/research areas and with non-academic organisations • Cultural awareness • Active listening skills • Questioning skills • Is flexible and adaptable • Cooperates willingly with other teams • Expresses appreciation for the contributions of others • Understands own role in the team and other team members' roles • Accepts and supports team interests and decisions and is willing to compromise • Addresses difficult issues openly; gives honest feedback and accepts feedback 	Very high
Leadership skills	<ul style="list-style-type: none"> • Understands personality types and how to make the most of them in a team context • Active listening skills • Empathetic • Conflict management skills • Resilient • Expresses appreciation for the contributions of others • Shares strategic vision and inspires team members to work towards common goals 	Medium

	<ul style="list-style-type: none"> • Motivates team members and delegates to them accordingly • Can make difficult decisions and ensures that they are accepted by team members 	
Equality and diversity awareness	<ul style="list-style-type: none"> • Is alert to all forms of discrimination on grounds of race, ethnic origin, nationality, political or religious opinions, age, health, sex, or sexual orientation • Is aware of unconscious bias and its consequences • Cross-cultural and cross-disciplinary sensitivity • Responds to differences sensitively • Addresses and corrects the use of inappropriate language or actions detrimental to diversity • Makes diverse newcomers feel welcomed and integrated • Treats everyone equally, regardless of their background or status within E-RIHS • Recognises and makes optimal use of the skills of staff with diverse backgrounds/profiles to benefit the organisation 	Very high
Emotional intelligence	<ul style="list-style-type: none"> • Has the ability to recognize their emotions, understand them, and realise how they might affect those around them • Can effectively self-regulate during difficult or high-pressured situations, leading to better outcomes for E-RIHS • Understands how their personal values and goals fit with E-RIHS', producing a strong motivation and work ethic • Has empathy and patience for those working alongside them, being able to resonate with the struggles of others and build understanding, trusting professional relationships 	High
Integrity	<ul style="list-style-type: none"> • Communicates intentions, ideas, and feelings openly and directly • Declares situations involving impartiality and conflicts of interest • Holds self and others accountable for supporting E-RIHS' values 	High

ADDRESS GAPS WITHIN THE TRAINING PROVISION FOR ACCESS PROVIDERS AND MANAGERS/MAKE THE DELIVERY OF TRAINING ACCESSIBLE AND EFFICIENT

The provision of training resources for Heritage Scientists working within the context of E-RIHS is not equally distributed across the skills listed within the profile above. In some areas, where the skills can be generalised between fields, resources developed by other research infrastructures can be used for the training of E-RIHS access providers and managers. This will prevent the fragmentation of training initiatives and improve cooperation with other RIs. As already established within the section detailing the education and training landscape, efforts have already been made by HS Academy to advance specialised heritage science training resources for those engaging with E-RIHS. However, there are still many areas of skill development relevant to working within E-RIHS for which there is very little relevant training or where available resources require further development.

Training Review

The present section uses the skills profile as a reference to conduct an review of available RI-specific training resources for E-RIHS access providers and managers, assessing where there is a lack of provision. The review compiles available non-formal training from Research Infrastructures, as well as some resources external to RIs that may be useful for the purpose of training E-RIHS managers and service providers. Hence, this review has included materials produced by E-RIHS and Iperion HS, as well as available courses, webinars, and modules produced by RItrain, Parthenos, DARIAH, Una Europa, eutopia, and the Museum of London. It does not, however, consider formal training content within specific Masters or PhD programmes and cannot be considered to represent an exhaustive list of resources. The results of the training review can be found below in Tables 7-10.

Table 7: The results of the training review for the skills within the domain of Engagement, influence, and impact.

Competency to be developed	What resources already exist	Where are the gaps
Communicating the public benefits and significance of heritage science	<p>Relevant master's and doctoral programs.</p> <p>HS Academy webinar 1 – Heritage Science and IPERION HS. Develops awareness of what HS is and how it can be used.</p>	<p>Concepts and techniques surrounding heritage science have been explored within available online content.</p> <p>Lack of 'light touch' training developing the concept and value of heritage, as well as promoting the impact that heritage research can have on wider societal, economic, and environmental issues.</p>
Designing and delivering high quality training events	<p>DARIAH webinar – 'Research Infrastructures are Vital in Providing Hands-on training'. Reinforces the importance of learning situations that allow learners to 'get hands dirty'.</p> <p>DARIAH webinar – 'Research Infrastructures Should Inspire, Theoretically and Practically'. Explains the importance of facilitating learning about cutting-edge techniques and creating a feeling of optimism that inspires research.</p> <p>DARIAH webinar – 'We Are a 'People Infrastructure and Training is Crucial to That''. Explains the importance of RIs for the transference of knowledge and the need to be at flexible in training to reach all types of community.</p>	<p>Available training communicates the importance of training within RIs but does not include much practical guidance in how to develop training.</p>

	<p>DARIAH webinar – ‘We Should Think More About Learning Environments.’ Explains the importance of in-person environments and workshops.</p> <p>Rltrain Plus - Coaching development program. Seven-day free course with CPD recognition.</p>	
Relationship building skills to grow and draw upon different communities of heritage experts	<p>ERIHS Collaborative Research Training Module on Youtube. Explanation of the interdisciplinary nature of Heritage Science research. Highlights importance of collaboration, sharing tips for successful collaborative environments.</p> <p>DARIAH – How do we Design Infrastructure that Connects? (webinar)</p>	<p>Training has covered the theoretical bases of relationship building but many of the skills that are required for successful relationship building are acquired through experiential learning.</p>
Innovation skills	<p>DARIAH – Cultural innovation (webinar)</p> <p>Rltrain Plus - Innovation, Entrepreneurship and Engagement with Industry. Five-day free course with CPD recognition. Course focuses on the interplay between research and entrepreneurship when creating innovations with a societal impact.</p>	<p>Little ‘light touch’ accessible training on innovation aimed at heritage research or explaining innovation within the context of research infrastructures available.</p> <p>Resources exist outside the context of heritage or research infrastructures but may be too far removed to be useful.</p>
Commercialisation skills	<p>Rltrain Plus - Innovation, Entrepreneurship and Engagement with Industry. Five-day free course with CPD recognition. Course focuses on the interplay between research and entrepreneurship when creating innovations with a societal impact.</p>	<p>Little ‘light touch’ accessible training on commercialisation aimed at heritage research or explaining innovation within the context of research infrastructures available.</p> <p>Resources exist outside the context of heritage or research infrastructures but may be too far removed to be useful.</p>
Using the E-RIHS brand	<p>E-RIHS website information about the meaning and standards associated with the brand</p>	<p>No training currently exists around brand awareness.</p>

Table 8: The results of the training review for the skills within the domain of Knowledge and intellectual abilities.

Competency to be developed	What resources already exist	Where are the gaps
Developing proposals for access to E-RIHS	IPERION HS Youtube video – How to successfully submit a proposal, only 2 minutes but very informative.	Existing E-RIHS video is short but informative – might need to be updated so branding is E-RIHS.
Specialist and cross-disciplinary knowledge, skills and expertise required to use and provide access to the E-RIHS research infrastructure and facilities	<p>Relevant master's and doctoral programs</p> <p>HS Academy training camps</p> <p>Doctoral Summer Schools</p> <p>HS Academy current topics lecture series provides non-academic training online on fundamental aspects of heritage science, such as techniques and methodologies, as well as on specific heritage typologies and other topics of interest to the field, e.g., painting, model based research, chemistry for conservation, holography, non-destructive structural diagnostics, chromatography, natural dyes, citizen heritage science, human evolution, radiocarbon dating, synchrotron light, proteomics, x-ray imaging, ethics of sampling, digital data, multidisciplinary knowledge, optical coherence tomography, artificial intelligence methods, cultural property protection, palaeoanthropology, chronological tools, Open and Fair Science, phytoliths, portable nmr, structural diagnostics, dendrochronology, digitalisation of built heritage, electrochemical techniques, metal corrosion, and human evolution.</p>	<p>As indicated in D7.1, specialist skills and expertise to facilitate access or use E-RIHS services are expected to be delivered by the service provider.</p> <p>There is a growing bank of 'light touch' online training regarding HS techniques and methodologies. This cannot be expected to facilitate the development of practical research skills but does provide familiarity with common methods and issues within HS.</p>
Research skills in conservation to enhance collaboration with heritage practitioners	Relevant masters and doctoral programs	Little 'light touch' accessible training on conservation research aimed at heritage scientists coming from a STEM background.
Humanities and social sciences research skills to enhance collaboration with heritage practitioners	Relevant masters and doctoral programs	Little 'light touch' accessible training on humanities or social sciences research aimed at heritage scientists coming from a STEM background.

Digital research skills	<p>E-RIHS Current Topics HS – Towards cathedrals of digital data and multidisciplinary knowledge (webinar)</p> <p>DARIAH – Cultural Big Data - Building a European Internet of Cultural Things (webinar)</p> <p>DARIAH – Computational Museology - Experimental Interfaces to Cultural Big Data (webinar)</p> <p>DARIAH – Crowdsourcing Methods with Cultural Heritage and Academic Datasets (webinar)</p> <p>DARIAH – Shaping the Unseen - Behind the Scenes of Data Visualization (webinar)</p> <p>DARIAH – Visual Analytics - Enabling Images to Speak for Themselves (webinar)</p> <p>DARIAH – Transformations: What are the Big Challenges and Opportunities for Data-intensive Research? (webinar)</p> <p>DARIAH Teach – Remaking Material Culture in 3D (short course)</p> <p>DARIAH Teach – Design, Development and Deployment of Augmented Reality Applications (short course)</p> <p>DARIAH Teach – Introduction to Data Analysis with Python (short course)</p> <p>DARIAH Teach – Spatial Image Analytics (short course)</p> <p>DARIAH Teach – Digitizing Dictionaries (short course)</p> <p>Parthenos – Make It Happen - Carrying Out Research and Analysing Data (webinar)</p> <p>Una Europa – MOOC: AI in Society (online short course)</p>	<p>There is already a large number of resources focused upon the development of digital research skills for heritage that E-RIHS can make use of.</p> <p>The resources that exist may not be completely relevant to the skills that are required for working with heritage science datasets.</p>
Object handling skills	<p>Museum of London – e-learning modules on object handling. Gives basic overview of object handling considerations in a structured format.</p>	<p>The guides that have been produced by the Museum of London and the National</p>

	<p>National Museum of Scotland – Object Handling guide (training guide).</p>	<p>Museum of Scotland provide good theoretical guidance as to how to handle important cultural objects with care – all scientists within E-RIHS should be encouraged to undertake this learning.</p> <p>It may be difficult to learn correct object handling without kinaesthetic and visual cues.</p>
Research ethics	<p>HS Current Topics – Ethical sampling</p> <p>Parthenos – Manage, Improve, and Open up your research and data (training guide)</p> <p>Parthenos – Citizen Science in the (Digital) Arts and Humanities (training guide)</p> <p>DARIAH – FAIR Data in Social Sciences and Humanities (webinar)</p> <p>DARIAH – Open Science is Just Good Science (webinar)</p> <p>Eutopia – Why Open Science and where to get started (webinar).</p> <p>Eutopia – Open Science in Horizon Europe. A quick guide for researchers (training guide).</p> <p>Eutopia – Open and reproducible research. An introduction to practical measures (training guide).</p> <p>Eutopia – Open Science in Horizon Europe - training for EUTOPIA postdoctoral fellows (training guide).</p> <p>Eutopia – Making research reproducible and replicable (webinar).</p> <p>Eutopia – Publishing contracts and Open Access. A navigation guide for researchers (training guide).</p>	<p>There is already a large number of training resources focused upon research ethics within academia.</p> <p>There is no training specific to E-RIHS and its own internal guidelines.</p>

Table 9: The results of the training review for the skills within the domain of Research governance and organisation.

Competency to be developed	What resources already exist	Where are the gaps
Compliance	<p>DARIAH - Intellectual Property Rights in Ethically Open Science (webinar)</p> <p>DARIAH - Copyright and Academia in the Digital Era (webinar)</p> <p>DARIAH - Data Protection in Research Practice (a tutorial)</p> <p>DARIAH – Dealing with third party data coming from cultural heritage institutions (webinar)</p> <p>Rltrain – Public procurement rules and policy for Research Infrastructures (webinar)</p> <p>Rltrain Plus - Ethical, Legal and Social implications in Research Infrastructures and Core Facilities. Three-day free course with CPD recognition. Entrance closed for summer 2023, but further intakes expected.</p>	<p>There are already some training resources focused upon compliance within a research infrastructure setting.</p> <p>No resources available on E-RIHS' internal legal policies.</p>
Purpose and strategic vision of E-RIHS	<p>E-RIHS website explains the purpose and vision of E-RIHS in light detail</p> <p>Iperion HS DSS 2021 – What IPERION HS is video. Gives an overview of the development and structure of a research infrastructure.</p> <p>Parthenos – Introduction to research infrastructures. Provides quite a useful overview.</p> <p>Rltrain Plus - Socio-economic impact of RIs. Five-day free course with CPD recognition. Entrance closed for summer 2023, but further intakes expected.</p>	<p>Some resources available that explain the function and vision of E-RIHS and research infrastructures more generally.</p>
Governance	<p>Rltrain – Governance Issues in Managing Ris (webinar)</p> <p>Rltrain – Governance challenges in setting up and running a research ERIC (webinar)</p> <p>Rltrain – Governance of Ris: Managing the Unity of Purpose (webinar)</p>	<p>Some resources covering management challenges within Ris.</p> <p>No resources available on how E-RIHS is governed and the relationship between different governing bodies.</p>

	Parthenos – Management Challenges in Research Infrastructures (training guide)	
Financial management	<p>RItrain – Financial Management Challenges in Research Infrastructures (webinar)</p> <p>RItrain – Financial Statements: Basic Concepts (webinar)</p> <p>RItrain – Budgeting and Financial Reporting (webinar)</p> <p>DARIAH – Planning to meet the costs of managing research data to be FAIR (webinar)</p>	<p>Some resources about financial management within RIs that should generalise to E-RIHS fairly well.</p> <p>No training resources readily available on the funding structure of E-RIHS and future economic sustainability.</p>
Service management	RItrain – Service Management in RIs (webinar)	<p>Few resources on service management within RIs.</p> <p>No training resources readily available on the service management within E-RIHS.</p>
Data science skills for managing DIGILAB	<p>HS Academy – FAIR data: the challenges of Interoperability</p> <p>DARIAH - EOSC for Arts and Humanities Scholars (webinar)</p> <p>DARIAH – The Importance of User-Centred Design for Open Science Training (webinar)</p> <p>DARIAH – Introduction to Persistent Identifiers (webinar)</p> <p>DARIAH – EOSC Architecture (webinar)</p> <p>DARIAH – EOSC State of the Art and Perspectives (webinar)</p> <p>DARIAH – Cultural Heritage: Some Observations on Collecting and Curating in the Digital Age (webinar)</p> <p>DARIAH – Shaping new approaches to data management in arts and humanities (webinar series)</p>	<p>There is already a large number of resources focused on data management skills for heritage that E-RIHS can make use of for training heritage scientists in skills required for maintaining DIGILAB.</p>

	<p>Eutopia – Understanding Metadata: A Beginners' Guide for Researchers & Data Stewards (training guide).</p> <p>Eutopia – Understanding Data Repositories: A Beginners' Guide for Researchers & Data Stewards (training guide).</p> <p>Eutopia – Planning for research data management: the basics (webinar).</p> <p>Eutopia – A deeper look into RDM practices: the FAIR principles and the role of metadata (webinar).</p> <p>Eutopia – Navigating Open Science in Horizon Europe (webinar).</p> <p>RItrain – Data and resource management in Research Infrastructures</p> <p>RItrain Plus – Data Management. Four-day free course with CPD recognition. Entrance closed for 2023, but further intakes expected.</p>	
Quality Assessment	<p>HS Academy video – Monitoring of ESFRI Infrastructures (webinar). Discusses impact assessment and monitoring as relevant elements of long-term sustainability of research infrastructures.</p>	<p>Existing video explains the importance of ongoing quality monitoring in RIs and discusses the development of KPIs.</p> <p>A more compact video or guide is required to explain the process to service providers.</p>
Resourcing and recruitment		<p>Few resources on resource management within RIs.</p> <p>No training on human resources readily available on the resource management within E-RIHS</p>

Table 10: The results of the training review for the skills within the domain of personal effectiveness.

Competency to be developed	What resources already exist	Where are the gaps
Interdisciplinary collaboration skills	<p>ERIHS Collaborative Research Training Module on Youtube. Explanation of the interdisciplinary nature of Heritage Science</p>	<p>There are already some training resources focused upon interdisciplinary collaboration</p>

	<p>research. Highlighting importance of collaboration, sharing tips for successful collaborative environments</p> <p>E-RIHS – Transatlantic cooperation in Heritage Science (webinar series)</p> <p>Parthenos – Introduction to collaborations in research infrastructures. Describes challenges of cross-disciplinary work well, focused on DH, some parts not entirely relevant</p> <p>DARIAH – Researchers Have to Talk a Lot, Exchange Ideas - to Try to Understand Each Other (webinar)</p> <p>Rltrain Plus – Team Building and Development Course. Four-day free course with CPD recognition. Entrance closed for 2023, but further intakes expected.</p>	<p>skills within a research infrastructure setting.</p> <p>Training has covered the theoretical bases of interdisciplinary collaborations skills but many of the skills that are required for successful collaboration are acquired through experiential learning.</p>
Leadership skills	<p>Rltrain – Leading an established RI (webinar)</p> <p>Rltrain – Leadership issues involved in establishing a new RI (webinar)</p>	<p>There are already some training resources focused upon leadership skills within a research infrastructure setting.</p>
Equality and diversity awareness		<p>Few resources on equality and diversity within RIs</p>
Emotional intelligence		<p>Few resources on emotional intelligence within RIs</p>
Integrity		<p>Few resources on integrity within RIs</p>

Training Offer

To bridge the different skill domains, the E-RIHS training offer will diversify delivery such that it is suited to different training aims and trainee communities by:

1. Signposting to educational and training opportunities available among E-RIHS members and partner organisations such as DARIAH, ICCROM, ICON, IIC, PARTHENOS, and RITRAIN
2. Building on the established strengths of partners by galvanising stakeholders, and highlighting existing training facilities and opportunities offered by E-RIHS members and partner organisations for specialist and localised training
3. Establishing physical facilities for E-RIHS-wide group learning at the central E-RIHS hub

4. Enabling hands-on and research-based learning including on-the-job training
5. Building online training resources and courses (including MOOC course offers)
6. Generating opportunities to meet in person and promote peer-to-peer learning
7. Producing publicly available resources and material for hands-on training
8. Creating courses that can provide “micro-certificates” that can contribute to the career development of participants
9. Facilitating internal and external personnel exchanges to continue the development of skilled individuals with the aim of upgrading access provision

By consulting relevancy levels for different skills as per the skills profile and using the information within the training review, it has been possible to create a targeted approach for the generation of new training resources, addressing the areas where there is most need first. This has culminated in a structured plan with direction for the delivery of further training within 2024 and a program to follow into the future of E-RIHS ERIC.

The training plan has been split into three priority levels: Very high priority level (Table 11); High priority level (Table 12); and Medium priority level (Table 13). It may be that there are certain training modules, particularly within the very high relevance category, that are mandatory for access providers to complete before they are allowed to facilitate access to services but these have yet to be decided. For each identified training requirement, informed suggestions for training content have been made based on the training provision that already exists (as described within the training review). In order to create a complementary and coherent course series or course, it may be useful to group associated subjects – meaning that not all the highest priority skills will necessarily be addressed first. For some of these subjects, there is specific expertise/a body of knowledge that needs to be developed first, before training can be made available (for example, ethics).

An important element of the training plan is making sure the delivery of training is efficient and accessible. This means focusing on online training and striving to make all training hybrid or recorded; as a result, there will be less barriers to learning and so access is more equitable. Where necessary, it is still important to consider in-person training content where there is a practical element within the development of the skill. Within the training plan, access considerations are provided for the suggested training content for each skill.

Table 11: Very high priority level topics and suggested content

Identified training requirement	Suggestions for training content	Access considerations
Using the E-RIHS brand effectively	E-RIHS could develop a short training guide or interactive module based on the document “E-RIHS Brand guidelines” explaining how to use the brand responsibly and effectively.	Online resource, video content, interactive module
Purpose and strategic vision of E-RIHS	The video focused on IPERION HS could be updated and delivered in a condensed format to explain the development of E-RIHS, what it hopes to achieve, and how it operates.	Online resource, video content
Specialist and cross-disciplinary knowledge, skills and expertise required to use and provide access to the E-RIHS research	The nature of this training will differ depending on the role of the individual. Facilities should ensure that in-depth training is given to access providers, while less comprehensive training that covers only relevant skills for specific research questions can be given to users.	In-person training HS-DSS or HS-TC that could be hybrid video content

infrastructure and facilities	E-RIHS could facilitate personnel swaps between E-RIHS partners to top up understanding or learn about new scientific techniques and instruments.	
Quality Assessment procedures	A short video or interactive module could be produced introducing the steps of quality monitoring within E-RIHS. This would also be useful for institutions that would like to become partners.	Online resource, video content, interactive module
Equality and diversity awareness for RIs	E-RIHS could produce a short video or interactive module on equality and diversity in RIs to reinforce its position and make providers and users aware of expectations.	Online resource, video content, interactive module
Compliance	E-RIHS could produce some short videos/guides or an interactive module based on the internal policies regarding compliance to reinforce its position on these issues and make providers and users aware of their legal obligations.	Online resource, video or written content, Interactive module
Research ethics	E-RIHS could produce short videos/guides or interactive module based on the internal ethics statement to reinforce its position on these issues and make providers and users aware of expectations.	Online resource, video or written content, Interactive module
Interdisciplinary collaboration skills	E-RIHS could hold virtual workshops with participants from the HS community that promote networking and understanding between participants of different backgrounds.	Online training

Table 12: High priority level topics and suggested content

Identified training requirement	Suggestions for training content	Access considerations
Communicating the public benefits and significance of Heritage Science	<p>An additional webinar directed around exploring the concept and value of heritage, as well as understanding the impact that heritage research can have on wider societal, economic, and environmental issues.</p> <p>Further training needed in how to communicate with the public and other stakeholders about heritage science, i.e., at dissemination events, conferences and within media channels. The format of this might be best within an in-person workshop.</p> <p>Most of the CON members don't have trained communication skills. For this reason, it will be</p>	<p>Online resource, video content</p> <p>Workshop within HS-DSS or HS-TC</p>

	fundamental to organise online, and in-person training events focused on communication with practical sessions. It will also be possible to customize them according to the needs of each national node.	
Relationship building skills to grow and draw upon different communities of heritage experts	May be necessary for E-RIHS to hold virtual or in-person workshops that promote networking and understanding between participants of different backgrounds.	Online training Workshop within HS-DSS or HS-TC
Developing proposals for access to E-RIHS	E-RIHS could create new short tutorial on how to plan and develop a research proposal for Heritage Science in more detail, taking into account all relevant considerations, e.g., designing for impact, sampling, technique selection, timeframe, post access duties, and what is expected/required of users.	Online resource, video content
Object handling skills	Hands-on practical training opportunities are likely necessary to reinforce the importance of specific handling techniques for different materials and objects.	In-person training
Service management skills	E-RIHS will likely need to produce a set of internal technical guides for service management procedures that can be passed onto future management. E-RIHS could set up a mentorship program for future leaders of heritage science research infrastructures that matches a candidate with someone in a service management position in E-RIHS, providing direct access into the inner workings of the RI.	Online resource, written content
Emotional intelligence	May be necessary for E-RIHS to hold a workshop on emotional intelligence skills for working within RIs.	Online resource, video content
Integrity	E-RIHS may want to include this within short videos based on the internal ethics statement to reinforce its position on integrity and make providers and users aware of expectations.	Online resource, video content
Digital research skills	The resources that exist may not be completely relevant to the skills that are required for working with heritage science datasets. This may require...	Online resource, video content
Financial management skills	E-RIHS will likely need to produce a set of internal technical guides for financial processes, the funding structure of E-RIHS, and future economic	Online resource, written content

	<p>sustainability that can be passed onto future management.</p> <p>E-RIHS could set up a mentorship program for future leaders of heritage science research infrastructures that matches a candidate with someone in a financial management position in E-RIHS, providing direct access into the inner workings of the RI.</p>	
Governance	<p>A training guide could be produced to explain the governance of E-RIHS in simple terms.</p> <p>E-RIHS could set up a mentorship program for future leaders of heritage science research infrastructures that matches a candidate with someone in an organisational management position in E-RIHS, providing direct access into the inner workings of the RI.</p>	Online resource, written content

Table 13: Medium priority level topics and suggested content

Identified training requirement	Suggestions for training content	Access considerations
Designing and delivering high quality training events	Training aimed at developing skills for individuals within the dedicated training team.	Online resource, written content
Innovation skills	Heritage science specific training regarding innovation within research infrastructures is needed.	Online resource, video content
Commercialisation skills	Heritage science specific training regarding commercialisation within research infrastructures is needed.	Online resource, video content
Research skills in conservation to enhance collaboration with heritage practitioners	E-RIHS could develop a training module that provides an overview of the purpose and nature of conservation science research – although relatively basic, this needs to be communicated in a professional, scientific way	Online resource, video content
Humanities and social sciences research skills to enhance collaboration with heritage practitioners	E-RIHS could develop a training module that provides an overview of the purpose and nature of humanities and social sciences research – although relatively basic, this needs to be communicated in a professional, scientific way.	Online resource, video content
Resourcing and recruitment	E-RIHS will likely need to produce a set of internal technical guides for human resource management procedures that can be passed onto future management.	Online resource, written content

Data science skills for managing DIGILAB	<p>E-RIHS will likely need to produce a set of internal technical guides for some of the digital infrastructure and data management processes that require input from service providers.</p> <p>E-RIHS could set up a mentorship program for future leaders of heritage science research infrastructures that matches a candidate with someone in a data management position in E-RIHS, providing direct access into the inner workings of the RI.</p>	Online resource, written content
Leadership skills	E-RIHS could hold a workshop on leadership skills within the context of RIs.	<p>Online training</p> <p>Workshop within HS-DSS or HS-TC</p>

Methodology to deliver training activities

The delivery of training events, e.g. webinars, lectures or user meeting events, is organised into series (called editions for lectures). Commonly, the series comprises from 5 to 10 singular events, each of them dedicated to a specific topic, organized regularly (e.g., monthly) over a year/academic year. The in-presence training events of HS Academy include on-site training camps, doctoral summer schools and workshops. The developed framework of activities for launching a series of online training events with the steps to follow, as well as the framework of activities applying to the organization and delivery of the following training events can be found in Deliverable 2.5 of E-RIHS IP (Guidelines for the E-RIHS Central Hub Management Practices).

While it is likely that the organisation of the training events described above will often originate within the Central Hub, it is possible that National Nodes may want to organise their own training events under HS Academy branding, sometimes within national languages. It is clear that there needs to be a process for ensuring the quality and conformity of these events; this has been set out in more detail within Deliverable 3.5 of E-RIHS IP (Quality System Implementation Plan).

PROVIDE INFRASTRUCTURE TO ENSURE CONTINUOUS SKILLS DEVELOPMENT

As exemplified in the proceeding sections, it is a key aim of E-RIHS to embed continuous learning and drive the development of future-proof skills in a complex, rapidly changing research field. To achieve this, the E-RIHS community will require access to state-of-the-art training opportunities through diverse delivery methods. The realisation of these ambitions is dependent on the effective use of resources and infrastructure. E-RIHS learning environments, physical and digital, and teaching facilities will be accessible and will support the RI community. In order to support and make available the training resources suggested within the training plan, there must be resource allocated to the development and maintenance of training activities and digital infrastructure.

Organisation and Partnerships

Most training will be delivered in the same way as a service, i.e., as an in-kind contribution from national nodes and service providers. Therefore, if E-RIHS takes part in educational initiatives, the role it assumes will need to be carefully considered. It could coordinate the delivery of specialised training across an array of access providers, or act as a match-making service for students seeking facilities and specialised supervision. To facilitate this, it will be essential to have training staff at the central hub that are dedicated to implementing the above training plan and acting as a point of contact for training activities, e.g., managing a training helpdesk or email address. At very least, a training coordinator, or even a Deputy Director of Training, will be necessary, as very quickly, a multitude of complex training activities could develop.

E-RIHS will endeavour to create partnerships with existing providers of heritage science education and specialist training on a national and international level. To share best practice in the development of the training offer, E-RIHS will draw on the experience, and collaborate with a number of training initiatives, projects and organisations. Given that ECHOES (ECCCH project), as well as the EU Partnership in Resilient CH both plan the development of training content, efforts should be directed towards the linking up these initiatives with the E-RIHS training plan. As training offer develops, the RI will seek further opportunities for training partnerships. This will enable the RI to utilise experience and innovative approaches developed by partners, avoid duplication and ensure an efficient use of resources.

Digital infrastructure

Presently, HS Academy Training activities and online modules are uploaded and promoted on the E-RIHS website in the HS Academy section; here, the user can find news about the upcoming events and register in them, and consult separate webpages dedicated to each training event. It is necessary to decide how training is presented and organised on the RI website. It could either continue to be delivered through the HS Academy webpage within the E-RIHS website or via a separate HS Academy platform, similar to DARIAH-CAMPUS. The creation of a webpage to host HS Academy resources would require less development and could connect learners to available content through written pieces and links to the E-RIHS and Iperion HS Youtube accounts or other useful external resources. However, this setup would not permit a large number of videos to be embedded and would not support interactive training content due to the size of this content and the impact this would have on the functioning of the E-RIHS website. Considering that the video resources of HS Academy will continue to grow under the prospective training plan, it is important that E-RIHS is able to provide a system that will be able to host this content. It may be that DIGILAB is able to fulfil this function, which would require training resources to become digitally identifiable objects with PIDs, enabling them to also be shared with ECCCH (European Collaborative Cloud for Heritage).

Regardless of the type of platform, it would be beneficial if resources could be navigated either through a structured pathway and by a search function. The structured pathway could be based around the skills profile. Training content could be accessed by first selecting the relevant skills domain (as set out in the skills catalogue) and then the desired individual skills components within this. Sometimes these links would lead to content produced by E-RIHS and sometimes to resources developed by other providers (as long as permissions to embed content can be obtained). As already exemplified throughout this document, there are many areas for which there is not sufficient training provision; until relevant training has been developed, these pages should be populated with a message suggesting that training content is still under development. The search function will allow learners to skip this navigation pathway by using keywords to identify training resources that may be relevant to their needs.

The long-term vision for this digital infrastructure is a platform that contains training for many of the skills that heritage scientists working within and engaging with E-RIHS will need to form an effective relationship with the research infrastructure. The eventual fulfilment of this comprehensive training resource will cement

E-RIHS' position in terms of being a leader in lifelong training for heritage scientists working within the context of RIs.

Funding Opportunities

The availability of funding for dedicated training positions and for the organisation of training activities, at a central level, is fundamental. To be able to provide the training programmes and resources suggested above and throughout this document, it may be necessary to investigate additional funding sources. When E-RIHS becomes an ERIC, it can become a partner in funding initiatives and can become a beneficiary. National nodes and service facilities could look into the option of receiving Marie Skłodowska-Curie Actions to fund projects that aid the development of early career researchers through the establishment of doctoral networks, staff exchanges, and innovative doctoral and postdoctoral training.

E-RIHS should look to actively partner in ERASMUS+ projects. The ERIC may have the opportunity to participate in the ERASMUS+ programme by playing an active role in the CHARTER project as a stakeholder, helping to describe heritage science training needs, and committing to participating in training programmes. The ERASMUS+ funding may be relevant for E-RIHS national nodes and service facilities to create training resources for masters, doctoral students or continuing professional development courses, like the modules suggested within the training plan. ERASMUS+ funding requires several institutions to partner together. As a general rule, organisations participating in Erasmus+ projects must be established in an EU Member State or third country associated with the Programme.

Table 14: Summary of the infrastructure that will support the delivery of training.

Organisational	<p>E-RIHS will invest in a training facility within the central hub where there will be a dedicated training coordinator working to ensure that training goals are met.</p> <p>Training delivery will build on already existing training activity and capacity within the E-RIHS community. To avoid duplication of training opportunities, the RI will endeavour to highlight existing training facilities and offerings by E-RIHS members and partner organisations for specialist, national and localised training.</p> <p>E-RIHS will use resources available nationally and within the central hub.</p> <p>E-RIHS will continuously maintain, update and improve the range of training environments and resources that encourage innovative teaching and learning.</p>
Technological	<p>State-of-the-art training will require technological resources to deliver the required scientific and digital training such as an E-RIHS-wide learning platform.</p> <p>E-RIHS will continue to develop online courses for users and providers. In order to facilitate this, the RI will invest in digital capabilities to enable the delivery of online, hybrid, and blended courses, combining online digital learning with facility- or classroom-based training methods.</p>

Financial	<p>E-RIHS will build on already existing training activity at E-RIHS partner sites.</p> <p>E-RIHS will focus on partnerships with other initiatives, organisations and projects to share best practice, avoid duplication and attain maximum impact.</p> <p>E-RIHS will explore opportunities for funding for joint courses within the European training programmes such as ERASMUS+. Such courses could be advanced training courses or even masters courses (there are many options available). In some countries, courses that can provide “micro-certificates” are also funded.</p>
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BUILD A STRONG HERITAGE SCIENCE TRAINING COMMUNITY

E-RIHS will work to create a culture of interdisciplinary heritage science learning, research, and leadership. Key aspects of this will involve growing engagement with HS Academy via the advertisement of training activities and establishing a self-reinforcing community of E-RIHS alumni with unique and competitive heritage science skills. The approaches suggested here are closely linked to those outlined in D6.2 Dissemination, Exploitation, and Communication strategy.

Continuing the legacy of HS Academy

E-RIHS will continue the development of HS Academy for those with core heritage science skills and who may have accessed E-RIHS infrastructures or undertaken training organised by E-RIHS, to provide a mutually reinforcing environment where heritage science skills are appropriately recognised and promoted to the community and potential employers. This will enable alumni to continue to explore collaborative ties and organise a programme of follow up activities, thus feeding into the wider advocacy, communication and dissemination mission of the research infrastructure. In return, this network will represent a rich pool of users and supporters of E-RIHS: a mature, global, cross disciplinary heritage science community.

To consolidate the E-RIHS training community, it will be necessary to hold some events with a high level of interaction between participants, such as conferences, to provide opportunities for peer-to-peer learning, and to continue to host service user meetings so that those accessing services feel part of a larger ecosystem of researchers and learners. If needed, a service could be provided to connect users amongst themselves.

Contact with trainees will be maintained after the end of the initial training in order to strengthen the relationships with specialist colleagues nationally and internationally, and permanently consolidate academic collaboration. Maintaining contact with trainees and resource persons also offers an opportunity for evaluation over time regarding training outcomes, prospective needs and future skills.

E-RIHS will establish and develop links with organisations, professional bodies and networks to ensure that training objectives are harmonised and E-RIHS activities feed into the wider scientific ecosystem. It is HS Academy's aim to support training providers with advice on strategic training needs and delivery.

Another area of development should be related to monitoring, researching, and emphasising the growing consolidation of the Heritage Scientist identity. This work should aim to reinforce the development of the field, providing legitimacy regarding its impact and reach, encouraging those pursuing formal education or professional development within HS.

Engagement with HS Academy

Engagement with training content will rely on the Communication Officers Network scheduling communications that are consistent in terms of voice, branding, messaging and frequency at the central and national level. E-RIHS should continue to promote available HS Academy training, as well as relevant training our partners have developed. As already identified in the training plan, it is of high importance that Communication Officers receive training regarding how to effectively communicate with the E-RIHS community and other stakeholders, i.e., brand awareness, using social media channels. E-RIHS will need to continue to use and develop a wide range of channels, e.g., verbal, written, visual, and digital, to target different groups with varying communication preferences. There is an obvious overlap between E-RIHS training and E-RIHS promotion/comms, e.g., conferences are events that serve both.

So that communication can be aligned with their characteristics, encouraging more effective engagement, it is necessary to establish the audiences within the HS Academy community. The average number of live participants in HS Academy online training webinars reached 100 participants, coming from more than 70 countries on 6 continents. The participants are researchers and/or teaching staff of all levels, practitioners, and officers, as well as many PhD, postgraduate and undergraduate students. They have different backgrounds and study/work/specialize in various disciplines in the field of heritage science. The in-person events of HS Academy are organized for approximately 20-30 participants at a time. Doctoral summer schools are attended mainly by PhD students, while on-site Training Camps by participants of various expertise levels. E-RIHS will need to continue to analyse the demographics of the type of audience engaging with different types of HS Academy activities within a HS Academy questionnaire conducted every 3-4 years, adapting the communication medium and tone to emerging audiences.

Measuring Success

To investigate how well the HS Academy is performing and delivering on expectations, E-RIHS will need to monitor the performance of training events and activities. This will indicate how many training activities the RI is delivering and whether individuals engaging with these activities are satisfied. More generally, it will suggest the health of the E-RIHS learning community in terms of whether participants see value in the training they are receiving, which may have implications for how likely they are to remain a part of the community. Possible KPIs that will be used to monitor the performance of HS Academy can be found below.

Table 15: Key Performance Indicators for monitoring training activities and events.

Name	Definition	Rationale
Number of participants in education events	Yearly no. attendees in education events (Training camps and summer schools)	Indicator of the reach and engagement the RI commands with which it is able to attract participants to attend training events.
Number of webinar hours	Yearly no. of webinar hours offered by E-RIHS	Indicator of how much accessible training E-RIHS is able to offer the Heritage Science community.
Educational event quality	What educational events did the research group organise (in which E-RIHS is involved), nationally or internationally, during the previous year. What was the	Appraise the quality of the event and its organisation from the perspective of participants.

	associated participant satisfaction rating (%) for each event.	
Number of masters and PhD students using the RI	Number of master and PhD students who have performed some of their studies at or using the services of the RI in a particular year regardless of whether they are funded/hosted by the RI or access it as a user.	Indicator of the extent of the education and training of the external academic community, comprising both experienced and potential users.
Training of people who are not RI staff	The total number of person hours for which people external to the RI have made use of training opportunities provided by the RI, through both real (e.g., face to face) events and on-line services.	Education and training of the external academic community, comprising both experienced and potential users

SUPPORT HIGHER EDUCATION PROGRAMMES ENGAGING WITH HERITAGE SCIENCE

There are a several possible modes of interaction in which E-RIHS will be able to contribute to the development of heritage scientists within Higher Education programmes. The conversations held within Ljubljana in October 2023 and Bologna in January 2024 were essential for establishing how these modes of interaction between RIs and Higher Education might manifest. Interactions have been conceptualised quite differently for undergraduate/Masters and PhD, so taught programmes and research orientated programmes are discussed separately below.

Undergraduate and Masters Programmes

Heritage science training delivered at undergraduate and Masters level will be necessary to begin to build understanding of the field and the career paths that are available, aiding the development of individuals that may, ultimately, go on to fill the positions within the infrastructure. Therefore, it is mutually beneficial for universities delivering HS-related undergraduate/Masters programmes and E-RIHS to be involved with one another, even when positive benefits may materialise over long timescales. The types of support that the research infrastructure may offer universities within the context of undergraduate/Masters programmes could be:

- Helping to provide topics for Masters dissertations;
- Co-supervising Masters projects;
- Designing Moodle courses;
- Co-funding and organising summer schools;
- Providing occasional guest speakers for lectures.

Doctoral Students

Co-funding and initiation of projects

The types of interactions that may occur between E-RIHS and PhD students within the field of Heritage Science will likely be transformed throughout the PhD journey. At the start of the PhD journey, infrastructure can be involved in providing funding and setting up projects (in the form of scholarships), which are a direct investment in the development of future heritage scientists that may be needed to ensure the sustainability of E-RIHS in the future. There are several ways in which E-RIHS could be involved in funding PhD students, for which there are precedents listed in the Appendix. Different access agreements may be put in place with institutions involved in co-funded projects. Some students may be funded by E-RIHS, but sit on PhD programmes in Higher Education institutions, while some students may be funded by universities but attend E-RIHS PhD for part of their programme. There may also be an option for co-supervision, with E-RIHS staff acting as subsidiary supervisors. Where there is no financial reward for participating institutions, the help given to PhD projects that amounts to some level of collaboration may represent in-kind contributions.

Supervising PhD Students

Many doctoral students accessing the research infrastructure, whether they are receiving funding or require only a one-off access, will not come with fully formed ideas about the direction of their research project and the methods that should be applied. This should be reflected within the evaluation of their requests for access, which will need to be considerate of this and have a stronger emphasis on guidance. Collaboration between E-RIHS access providers and students at the early stages of the project will have many associated benefits, both for the student and for the research infrastructure; for example, the student will gain real-world expertise, both sides will contribute to bi-directional learning, and there may be the potential to develop new ideas and techniques that may go on to benefit the HS community. With or without financial assistance from E-RIHS, academics and access providers that work within the research infrastructure might form the supervisory panel for the PhD project. It will be important to establish guidelines for how PhD students are to acknowledge the contributions of E-RIHS in the training of doctoral students.

Access needs of PhD students

Different doctoral students may have different levels of engagement with E-RIHS during their PhDs. Many will likely come from programmes not associated with E-RIHS and may only require access to services, which could range from one-off instances to a long-term relationship between the PhD student and the research infrastructure. It is very likely that long-term arrangement of access offered to PhD students will be different from the types of traditional access set out within access policies. PhD students will develop applications throughout their three- or four-year programme, which will require longer-term planning of resources to meet their needs and simplified access over this time. It may be useful to adopt a “Student Access Route” as a particular form of access that enables several sequential instances over several years and enables the student to seek out a supervisor amongst access staff. PhD students may need additional support to undertake their research. Hence, this will require access providers to have an awareness of the difference between PhD students and other types of users. It might be useful to offer some specific training for access providers covering how to work with PhD students. At the same time, PhD students will need to understand how to use the relationship with the RI most effectively, so that they can get the most out of the experience.

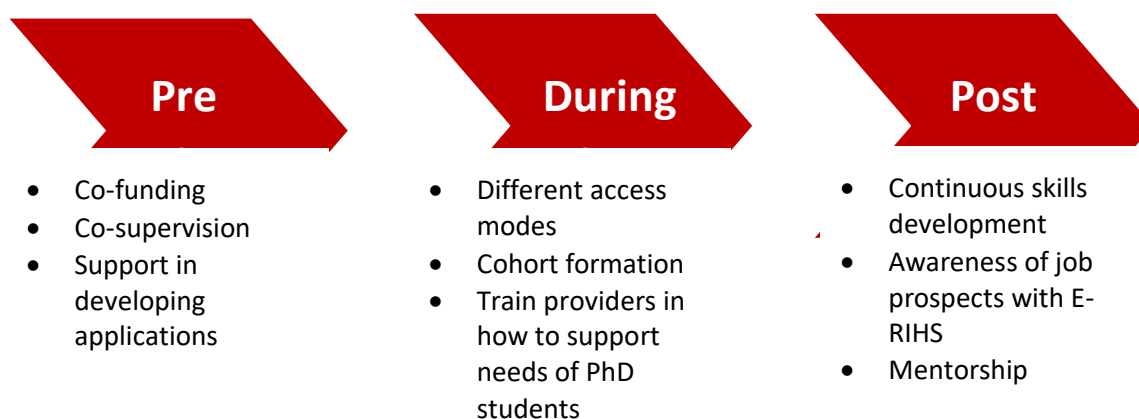
E-RIHS and the PhD community

Apart from directly aiding the research and professional development of PhD students, the research infrastructure could act as an important player in cohort formation. PhD students undertaking research

within heritage science can feel isolated, especially if they are situated within an institution that has relatively few students embarking on this type of research. The interdisciplinary nature of heritage science means that PhD students get to engage with a range of colleagues within different fields, which is excellent for widening their outlook; however, they may struggle to find many peers who truly understand the context or value of the work that they are undertaking. For the same reason, it can be difficult for PhD students to disseminate their research via the correct channels. Through events that are aimed at PhD students, i.e., Doctoral Summer Schools, conferences only for ECRs, or online meetings, E-RIHS may help to unify HS PhD students across Europe or further afield. This will connect researchers aiming to solve similar problems, providing opportunities for future collaboration and build a community of practice around HS. E-RIHS can become an international meeting point for Early Career Researchers.

E-RIHS and skills development for PhD students

Any training material developed by E-RIHS has to be developed with the certainty that PhD students will be one of the main audiences. PhD students may be able to use the resources E-RIHS has produced to understand how they can maximise the impact of their research. For example, they may consult webinars on research ethics, open access, and completing post-access duties. They may also choose to start undertaking additional training offered by the research infrastructure to make them more employable after their graduate studies have finished. E-RIHS could also offer mentorship programmes that early career researchers can sign up for to deepen their understanding of how the RI works and prepare them for a career that could include working within E-RIHS. Ultimately, collaboration with E-RIHS at any one of the possible contact points suggested throughout this section will make students of heritage science aware of the potential job prospects that may be available within the RI.



NEXT STEPS

- The skills profile developed here-in provides an example of the way that the required skills, competencies, and knowledge of access providers and managers can be defined and measured. Further differentiation of the skills profile will be necessary to tailor it to the different career pathways available within E-RIHS, providing clear progression routes.
- The strategy advocates for the use of existing resources developed by members and partners, as well as other RIs and external organisations; to ensure a full training offer is available, existing resources indicated in the training review need to be highlighted and clearly signposted.
- The training plan sets out a clear priority list for future training, with specialised training options that demarcate HS Academy training from resources that already exists and prioritise equitable access.

- E-RIHS must make a strong commitment to embed continuous learning within the organisation and structure of the RI, with a member of dedicated training staff who can advocate for and address training needs, leverage partnerships with providers of Heritage Science training, organisations and industry, and ensure that platforms for training are optimised.
- Steadily growing engagement with HS Academy and encouraging network formation will be key for generating a self-reinforcing community that reflects the ambitions of the RI.
- The long-term future of E-RIHS sits with those currently attending Heritage Science programmes in Higher Education; this strategy has set out multiple modes of interaction that the RI should explore to engage and support students.

APPENDIX

Examples of different co-funding structures

CERIC-ERIC

In 2020, CERIC-ERIC opened call for 20 PhD positions across the scientific specialisms of its partner facilities. The PhD topics were proposed by the partner facilities, along with a description of the intended research and required budget. One supervisor had to work for the RI within the service facility, and the other had to be situated within a university. It was a stipulation of the PhD that students should spend time across multiple service facilities. While much of the PhD research is conducted in the partner service facilities, the affiliated university awards the PhD. CERIC-ERIC continues to open up further PhD and postdoc positions, now without having to have topics finalised beforehand.

SEAHA diamond light source

The SEAHA CDT, a doctoral training centre supported by EPSRC (Engineering and Physical Sciences Research Council), operated under a unique tripartite model for scholarship funding and supervision. Each PhD student received partial funding from both industry partners and the EPSRC grant, with academic, heritage, and technological industry professionals serving as supervisors. Notably, the Diamond Light Source, a prominent national synchrotron facility, played a dual role in the CDT by providing financial support and contributing to supervisory activities. The candidate benefiting from this arrangement split their time between the academic institution and Diamond. Others also benefited from similar arrangements. The research conducted within this framework aimed to advance technologies relevant to the funding partners while also addressing key archaeological research questions.

REFERENCES

- Baatz, W. De Luca, M. Drda-Kühn, K. Hegedüs-Gravina, J. M. Hofland-Mol, M. Karatas, K. Lavarello, C. Marçal, E. Marcuccio, M. Mignosa, A. Musso, S. F. Piccininno, M. Pirri Valentini, A. Sani, M. Schlott, F. (2023). Report: Identifying gaps and needs in the educational and training programmes. CHARTER Consortium.
- Benassi, L., Strlič, M., Chaban, A., Bertasa, M., Di Gianvincenzo, F., Rijavec, T., Novotný, J., & Striova, J. (2023). IPERION HS D8.3 Report on existing RI centralised procedures (1.4). Zenodo. <https://doi.org/10.5281/zenodo.7844538>
- Bertrand, L., Charbonnel, B., Castillejo M., David, S. de Clercq, H. and Spring, M. (2018). D.9.1 First version of the E-RIHS scientific vision.
- Brown A. Jean E. (2017) Conservation now, Journal of the Institute of Conservation, 40:2, 133-151.
- Dillon, Catherine, et al. "Mind the gap: rigour and relevance in collaborative heritage science research." Heritage Science 2.1 (2014): 1-22.
- European Commission (EC). (2020). European Skills Agenda.
- ESFRI (2021). Roadmap 2021. Strategy report on research infrastructures. <https://roadmap2021.esfri.eu/strategy-report/>
- Golfomitsou, S. (2015). Educating future professionals in conservation science: The challenges of an interdisciplinary field. Studies in Conservation, 60(sup2), 39-47.
- European Skills Agenda for sustainable competitiveness, social fairness and resilience (2020). Available at: <https://ec.europa.eu/social/main.jsp?catId=1223&langId=en>.
- European Union. Report of the OMC (Open Method of Coordination) working group of member states' experts Fostering cooperation in the European Union on skills, training and knowledge transfer in cultural heritage professions, 2019. Available at: <https://op.europa.eu/pt/publication%20detail/-/publication/e38e8bb3-867b-11e9-9f05-01aa75ed71a1>.
- Pacheco, C., Miliani, C., De Clercq, H., Szikszai, Z., Schmidle, W., Doherty, B., Niccolucci, F., De Giacomo, O., Bertrand, L., Detalle, V., Petitcol, R., Menu, M., Pallot-Frossard, I., Lemasson, Q., Castillejo, M., Striova, J., & Pezzati, L. (2020). E-RIHS PP D5.1 User strategy and access policy (1.0). Zenodo. <https://doi.org/10.5281/zenodo.3946180>
- RITRAIN, (2016). The Ritrain organisational competency profile. <http://ritrain.eu/competency-profile>
- Ropret, P., Strlic, M., Buchczyk, M., Legan, L., Retko, K., Liang, H., Drdáký, M., Vopálenský, M. (2018) D.7.1 Report on education and training needs.
- Strlic, M., Buchczyk, M., Heritage, A., Liang, H., Ropret, P., & Vopálenský, M. (2020). E-RIHS PP D7.2 E-RIHS Training strategy (1.0). Zenodo. <https://doi.org/10.5281/zenodo.3949504>
- Vitae Researcher Development Framework (2010). Available: <https://www.vitae.ac.uk/vitae-publications/rdfrelated/researcher-development-framework-rdf-vitae.pdf/view> Accessed: 21 June 2018.