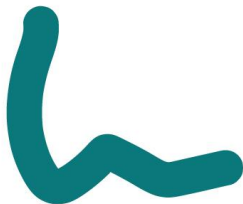




Methodological Guidelines



[March, 2023]

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Theoretical Framework

STEM vs STEAM

Over the last decade, we have witnessed - through research, professional initiatives and funding available - a worldwide fascination with STEM (Science, Technology, Engineering and Mathematics) education, as the solution to the demands of the 21st century. Preparing students for the jobs of the future has required a shift towards building individuals who are strong problem solvers, innovative and creative thinkers, as well as individuals who persist and take risks and are driven by their entrepreneurial capacities. At the same time, essential 21st century skills include the ability for effective collaboration and strong digital competences.

However, STEM has fallen short in achieving better results in terms of students' performances in STEM related subjects and has not produced as many professionals as expected in STEM related professions. An equally important challenge for STEM education has been the preparation of "young people with general capabilities for active participation in community and professional forums for addressing ethical issues associated with the global impact of science and technology" (Taylor, 2016). In addition, STEM has proven limited in terms of the ways multiple viewpoints were integrated in their curriculum, with emphasis mainly being performance driven. Other limitations within STEM education relate to the lack of educational models that combine arts and sciences for encouraging communities to think about sustainability (Clark and Button, 2011) and to the need for a culturally situated approach and a systemic design-thinking perspective (McKeown, 2019).

Responding to such shortcomings, a shift from STEM to STEAM has been witnessed during the last few years. STEAM - an acronym for Science, Technology, Arts and Mathematics - is the educational approach that acknowledges the significance of incorporating the Arts (including the visual arts, performing arts, linguistics and the humanities) in STEM subjects, aiming to offer a more integrated and interdisciplinary approach to teaching and learning. Such emphasis illustrates Arts' potential in contributing to creativity and critical thinking. Scholars declare that "the promise of STEAM approaches is that, by coupling STEM and the Arts, new understandings and artefacts emerge that transcend either discipline" (Peppler & Whlwend, 2018, p.88) and that it "offers contextual learning; utilizing subject overlap for greater understanding" (Gettings, 2016, p.10).

Materiality

The SciArt project begins from these theoretical underpinnings and aims to develop an innovative, inclusive, inquiry-based STEAM approach for the study and teaching of Cultural Heritage. Addressing the need for a culturally situated approach, using material artefacts, the project will identify trends and issues relevant to places and local communities. At the same time the project begins from the premise that objects have re-emerged as a focal point in "the wider explorations of interactions between people and the rest of the material world" (...) Thus, on the one hand, issues of materiality and the wider ontological properties of objects are important in the study of heritage objects, as these carry information relevant to the objects' history, function, uses, and origins. On the other hand, materiality also relates to the types of our engagements with these objects as much as to the ways in which heritage artefacts contribute to knowledge production and narrative formation.

The Notion of Heritage

2018 was named European Year of Cultural Heritage to “encourage more people to discover and engage with Europe’s cultural heritage, and to reinforce a sense of belonging to a common European space”. This emphasis shows the importance given on heritage in discussions of identity and belonging at a both national and transnational level. Indeed, whereas in the past Heritage was mainly studied in relation to materiality and issues of preservation, in recent years we see a shift in the focus towards the various social and political functions of heritage (Charalambous 2019).

For conceptualizing the notion of heritage in this project we draw from Critical Heritage Studies, that understand heritage as a contemporary product, that is shaped by history but serves certain purposes and functions in the present and future (Tunbridge & Ashworth 1996, p.6). Therefore, the emphasis is moved to the social and cultural practices and the narratives accompanying heritage. Such an approach points our attention to issues of choice and selection of what is heritage (and the motives behind it) as well as to the ‘consumption’ or ‘reception’ of heritage (what people do with it). This allows for an exploration of the cultural, political, and emotional functions of heritage and at the same time of power relations and identity politics involved.

Of course, heritage is not always material, as there is also intangible heritage such as languages, music, literature etc. Given this project’s focus on STEAM, we will mainly focus on material artefacts; however, non-material artefacts can also be discussed when exploring the functions and narratives of heritage objects in educational activities.

Educational Inclusion

There are different approaches and perspectives of how inclusion and inclusive education are defined and perceived by scholars and educators. In the context of this project, inclusive education involves all children, regardless of their skills or cultural, ethnic, financial, or linguistic origins. In an inclusive approach, deficit conceptions of diversity and ability are rejected, and involvement in the learning process enriches the experience of every student in the classroom community (Florian, 2009; Kozleski, Artiles, & Waitoller, 2014). For the scope of the SciArt approach, inclusive pedagogy is defined as “an alternative pedagogical approach that has the potential to reduce educational inequality by enhancing learning opportunities for everyone” (Florian, 2015, p.5).

Since one of the priorities of the project is to foster the inclusion of all students to the activities that will be produced during the project. To foster the accessibility of the activities and the material, the development of the activities will be based on Universal Design for Learning (UDL). Universal Design for Learning (UDL) is a framework to improve and optimize teaching and learning for all people (CAST, 2018). Thus, all partners involved in the development of the activities are advised to take into consideration the UDL principles to provide multiple means of engagement, representation, action and expression to students by following the UDL Guidelines.

Teachers, curriculum designers, researchers, parents, and anybody else who wants to utilize the UDL framework in a learning setting can use the UDL Guidelines. UDL Guidelines include a series of

specific recommendations that can be used in any discipline or field to make sure that all learners have access to and can engage in meaningful learning experiences.



Learn more about the points in the graphic designer of UDL at <https://udlguidelines.cast.org> .

The UDL Guidelines are a series of practical recommendations that can be used in instructional design to minimize obstacles and enhance learning opportunities in accordance with particular learning goals rather than a "prescription", Aspects of the Guidelines are already included into many of our practices as educators, but there may still be obstacles we aren't aware of or haven't yet met in our students' educational journeys. The UDL Guidelines provide a methodical framework for overcoming these obstacles and consciously planning for learner diversity. We must continuously refer to the Guidelines as we construct our learning experiences if we are to be purposeful, proactive, and reflective in meeting the needs of all of our learners. The Guidelines are not intended to be used with just one subject area or one set of pupils. Instead, the Guidelines are a tool to aid in the creation of a common language in the design of objectives, tests, procedures, and instructional materials that result in open to all learners difficult learning experiences.

In this section we briefly explained the basic theoretical framework and the main concepts that are used in the project, as well as the theories underpinning them. In the following section we outline the ways in which these concepts are combined and inform the Sci-Art educational approach.

THE SciArt PROJECT

Description of the Project

The SciArt project will develop the theoretical framework of the SciArt approach (described above) in an e-book – expanding on existing literature and current STEAM practices, with particular focus on Cultural Heritage, national and European identity, the use of artifacts in constructing identity narratives, and inclusiveness. The educational resources to be developed based on this e-book will include activities and an online platform to be used in a Master Training event for educators aiming to facilitate the implementation of the activities in schools. Then, further training for Primary and Secondary Education teachers will take place in Cyprus, Greece, and Portugal with at least 60 teachers across the three partner countries, who will then implement the approach in their schools. Hundreds of others will be informed on the SciArt approach and resources in collaboration with the Museum partners of the consortium.

The SciArt Approach

Responding to the gap identified earlier in relation to the integration of the Arts in the STEAM approach, the SciArt project proposes the development of a series of STEAM activities that incorporate creativity, critical thinking, design thinking, visualization of process, problem-solving skills, and collaborative learning, using artefacts: either archaeological, historic or more recent, selected artefacts from the partner museums can include religious icons, coins, pottery, glass or wood objects, and/or paintings.

The rationale of the project is based on the acknowledgement that heritage and its objects can be studied both in relation to their manifested forms and materials, adopting archaeometrical methods and tools used by scientists and archaeologists, and in relation to their cultural, historical and aesthetic dimensions.

Combining the study of these heritage objects' materiality (which also carries information about the object's origins, history, functionality and historical uses) with an approach that emphasizes the practices and multiple narratives surrounding these objects allows us also to initiate discussions on issues of, inclusion, and identity formation, both locally and at a European level.

At the same time, such an approach offers students the opportunity to study heritage across disciplines, to account for multiple perspectives and dimensions, whilst it empowers educators to use innovative educational approaches that give an equal role to all subjects.

More specifically the Sci-Art approach aims to enable students and educators to

- learn about and use scientific methods for the study of artefacts through the employment of emerging technologies (such as augmented laboratory instruments) and inquiry-based activities
- study the (often conflicting) meanings, functions, and narratives surrounding heritage artefacts and the ways in which they relate with local and national identities, including European identity.

- discuss the connections between STEAM related subjects and social and political issues (such as issues of inclusion)
- enhance students' awareness and understanding of the multiple dimensions of cultural heritage and its role and function in contemporary societies.
- enhance students' 21st-century skills such as critical thinking, creativity, assessment of information, and collaboration.

Furthermore, students will get a chance to discuss, debate, and create their own meanings around heritage artefacts at a local as well as European level. Adopting an approach that allows for multiple narratives as well as contested narratives to be heard and discussed, we aim to give voice to all students, including students from migrant or marginalized backgrounds. The study of a range of artefacts is also expected to enhance students' awareness of their sense of identity, and how it is constructed via various semiotic means at different levels (local, national, transnational, European, etc). This will allow students to critically discuss the similarities and differences of the diverse European local cultural heritage artefacts and their respective narratives and the ways in which they have been used or can be used to construct and put forward a common European identity. In this way the project aims to also contribute to educational inclusion, whilst the multiplicity of learning methods and tools align with the principles of Universal Design for Learning.

Main Results

The SciArt project is expected to:

- publish all relevant outcomes, including the methodological guidelines, and the SciArt ebook which provides the theoretical framework of the project, and supports the development of the SciArt educational approach.
- develop educational materials and resources based on STEAM methodologies and their application in Cultural Heritage.
- make available and open to the public the SciArt activities and the SciArt training course material - hosted in an open educational platform.
- train teachers in the participating countries and disseminate the approach to the wider educational community within the countries and to relevant stakeholders worldwide.
- provide teachers with educational resources and the opportunity to enhance their self-efficacy in implementing STEAM activities with a strong A(rts) component.
- offer students the opportunity to engage in meaningful STEAM activities with emphasis on Cultural Heritage.
- contribute to current theoretical debates regarding the significance of an integrated approach to STEAM education.

Structure of the Project

The project is divided into five Work Packages (WP). The first (WP1) and the last (WP5) work packages are related to the Management and Dissemination of the project, and the duration of those two work packages covers the full duration of the project. For the Management (WP1) and Dissemination and Sustainability (WP5), the coordinator of the project has developed the Management plan and the Dissemination and Sustainability plan which will be separate documents from the Methodological Guidelines.

WP2, WP3 and WP4 correspond to the development, design and implementation of the SciArt approach, and each Work Package prepares the ground for the next one. In what follows, the objectives, the expected outcomes, the activities, and the quality indicators of the results for each WP will be described in more detail. For every step of the implementation, the responsibilities of each partner will be explicitly listed in order to ensure that the contribution of all partners is clear.

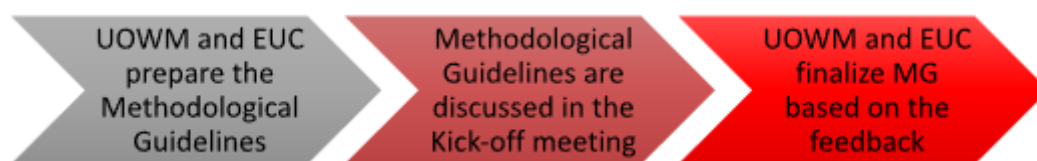
WP2 - Developing the SciArt Approach

The main objective of Work Package 2 is the development of an innovative, inclusive STEAM approach to Cultural Heritage that combines inquiry-based approaches across different school subjects such as Science Education, Arts Education, Technology Education, History, Language etc., as it was described in the project proposal.

Activity 1: Methodological Guidelines development

Methodological Guidelines is an online resource that will guide partners throughout the project and briefly provide the theoretical framework and describe in detail the tasks and actions of every partner in each WP and activity.

Developed by UOWM and EUC staff members, the Methodological Guidelines will act as a guiding map for the implementation of the project both in theory and in practice, explaining the concepts that the project is based on, pointing out important milestones and each partner's responsibilities, and ensuring that all partners follow consistently the same approach. Having discussed an earlier draft at the kick-off meeting, this final version has been agreed on by all partners.



Activity 2: SciArt ebook

The SciArt e-book constitutes the theoretical foundation of the project, on which the training course of the project and the educational resources for educators will be based. The SciArt e-book will be available first for the project partners and the teachers participating in the pilot testing. The final revised version will be publicly available to all interested parties after the pilot implementation.

The EUC as the leading organization of Activity 2 is responsible for providing writing instructions to the authors and editing the whole ebook.

Table 1: The table presents the contents of the SciArt book and the responsibilities of all partners organization

Chapter Title	Description	Authors	Reviewers
The SciArt approach	The chapter will offer an overview of the approach explaining the rationale, the concept and theoretical framework that underpins the project.	UOWM EUC	PSPTH AEEA Falcon
Science knowledge and Cultural Heritage: Connecting artefacts study to school Science Knowledge for primary and secondary education	The chapter will introduce the connection between material science methods used on artefacts to school science and how these connections can provide an opportunity for building inquiry-based methodologies for teaching and learning across different disciplines.	AUTh	PSPTH AEEA Falcon
Cultural Heritage and Identity: Exploring National and European identity through artefacts	The chapter will introduce a critical perspective regarding the role and influence of cultural heritage in the construction of identity.	EUC	PSPTH AEEA Falcon
Museum artefacts and the connection with local narratives	The chapter will particularly focus on how museum artefacts can shape local narratives.	P.PORTO	A.G. Leventis G.&M. M. B. C. Thessaloniki M.M. Esposende PSPTH AEEA Falcon
Inclusion through Multimodality and AR	The chapter will explain the role of multimodality and augmented reality technologies in education and offer practical knowledge on tools that teachers and students can use.	UOWM	PSPTH AEEA Falcon

Results

Methodological Guidelines (online resource) will guide partners throughout the project and describe in detail the tasks and actions needed to be taken by each partner in each WP and activity.

The SciArt e-book constitutes the theoretical framework of the project and will be published as an e-book to be available to the public.

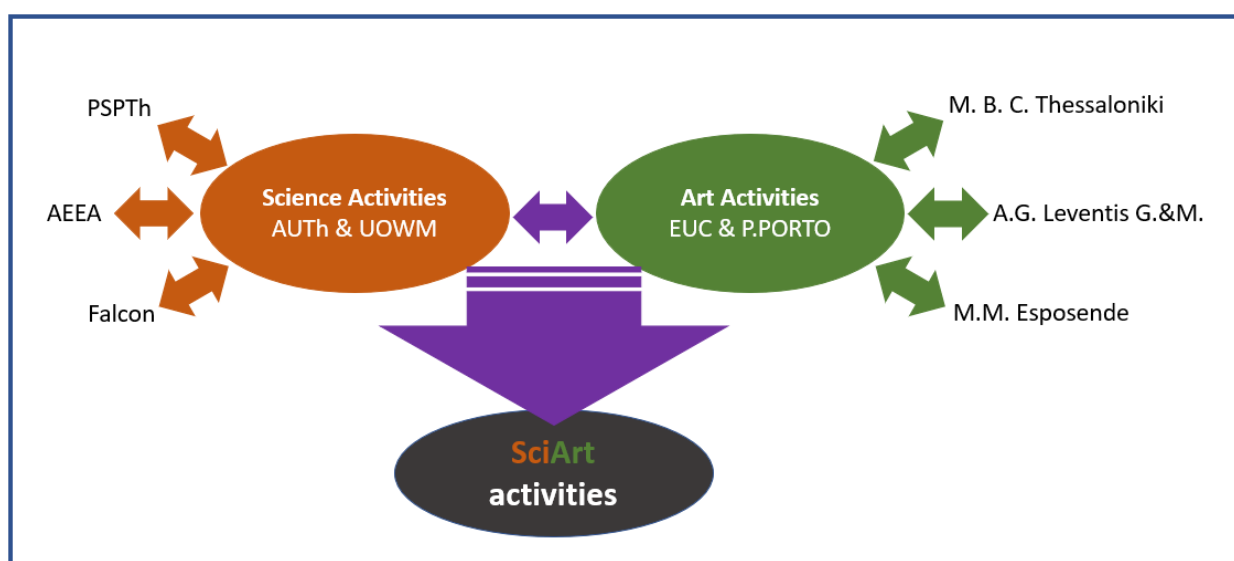
WP3 - SciArt Educational Resources

The objectives of WP3 are the design of the SciArt activities (including the educational resources needed) and the SciArt training course and educational platform.

Activity 1: Designing the SciArt activities

The SciArt consortium will design and develop a series of STEAM inquiry-based activities on studying cultural heritage artefacts. The SciArt activities will be inquiry-based activities that will allow students to investigate the material aspects of the artefacts using their school knowledge and critically explore the role of artefacts in the formation of narratives and identities. The activities will be adjusted for primary and secondary education students based on their knowledge and age. Partners from academia, in collaboration with teachers from the schools, will develop inquiry-based activities across different disciplines. Two versions of the activities will be developed, one for primary and one for secondary education.

For that purpose, partners will form two workgroups, one for the design of activities for Science, Math and Technology classes, and one for the design of activities with emphasis on the Arts and the Humanities (visual arts, music, literature, history etc). The EUC and P.PORTO will collaborate on designing the Arts activities, in which Schools and Museums will give their feedback, while the AUTH and the UOWM will collaborate on designing the Sciences activities, in which Schools will give their feedback. Throughout the designing process, the two groups will be in constant dialogue and collaboration for better establishing the interconnections between activities and different disciplines.



Structure of the SciArt activities

The SciArt activities should be focused on the active participation of students by giving them the opportunity to enhance and/or develop their 21st century skills. Based on that, the activities will be designed based on the inquiry-based and the project-based approach, which are briefly presented below:

- inquiry based approach: As part of the approach of inquiry-based learning, students use techniques and procedures that are similar to those used by professional scientists to create knowledge (Keselman, 2003). According to Pedaste, Mäeots, Leijen, and Sarapuu (2012), it can be described as a process of discovering novel causal relationships in which learners formulate hypotheses and test them through experimentation and/or observation. It is frequently considered as a strategy for solving issues and involves the use of a number of problem-solving techniques (Pedaste & Sarapuu, 2006). The focus of inquiry-based learning is on the learner's responsibility for discovering knowledge that is new to them and students' active participation in that discovery (de Jong & van Joolingen, 1998).
- project based learning: Problem-based learning, in which students address authentic challenges similar to those they will encounter in the industry, has evolved as a method to assist students build soft skills in an environment comparable to where those talents will ultimately be applied. Derived from inquiry-based learning (Hmelo-Silver et al., 2007) and constructivist theory (Jonassen, 1999), the project-based learning approach engages students with serious problems, forcing them to produce a tangible artifact that demonstrates their emerging competence (Blumenfeld et al. 1991).

Activity 2: Development of the activities' resources

During Activity 2, partners will collaborate to develop the educational resources which will include:

Augmented Laboratory Instruments: For each artefact, the project will provide students with four instruments (ALI) to use in order to study the materials, shape, origins (time and location) of each artefact. The ways these instruments can be employed by primary and secondary students for the study of objects -as well as the results from the use of the ALI tools - will be presented through animation and video material in Augmented Reality environments.

For the purposes of designing the ALIs, partners will develop:

1. **Video animations:** Partners will create 8 videos that will introduce students to scientific methods such as XRay, Spectroscopy, SEM etc., that are used by archaeometrists, for the study of the materials of heritage artefacts. These will be designed for primary (4 videos) and secondary (4 videos) education.
2. **Reports:** Partners will prepare the videos presenting the results of each of the archaeometrist's methods (as above) for at least 9 artefacts (3 from each Museum/country). These reports will be included in the videos described above.

The AUTH, UOWM, and the EUC will collaborate on developing all the resources for the science activities. EUC will technically support the creation of the video animation.

Interpretive Material

Partners will develop material that will guide students to explore the narratives of each artefact and how these relate to personal stories and the formation of identity: individual, local and European. The EUC and the P.PORTO will collaborate on developing all the resources for the art activities.

When all the activities and the resources are developed, these will be piloted by members of the consortium (alpha testing) and by university students (beta testing). Based on the results of that small piloting, adjustments will take place based on the observation made.

Activity 3: Developing SciArt training course and SciArt educational platform

The SciArt training course will be developed to provide teachers with the necessary knowledge and skills to implement the approach in their schools and the educational platform that will host the course. The SciArt training course (Activity 3) will consist of five (5) modules, as described above) and will be based on the SciArt e-book. The training course will be blended, and its duration will be 30 hours (15h f-2-f and 15h asynchronous).

The specific objectives of the training involve: Teachers becoming more aware and competent in utilizing the SciArt activities by:

- I. connecting school Science to the scientific study of artefacts through inquiry-based activities,
- II. exploring national and European identity through artefacts and
- III. using multimodality and immersive technologies to promote the inclusion of all students

The SciArt training course will consist of five different modules. The ones shown below are only preliminary suggestions and modifications are possible during implementation:

Module	Title	Author
Module 1	The SciArt Approach	UOWM
Module 2	Connecting Science to cultural heritage artefacts: An inquiry-based approach	AUTh
Module 3	Exploring National and European identity through artefacts: A critical investigation	EUC
Module 4	Promoting inclusion through multimodality and AR: multimodal and AR books	UOWM
Module 5	Practical course task, self-assessment of learning outcomes and self-generation of the SciArt Teacher Certificate	P.PORTO

Between Module 4 and 5, participants will be asked to implement the SciArt approach in their classes and schools. The modules could be adapted based on the feedback and contribution of the partners during the implementation.

The SciArt educational platform will be developed by AUTh to host the training course and support both face-to-face and asynchronous training.

Results

- Two series of SciArt activities consist of inquiry-based activities on the artefacts, one for primary education students and one for secondary education students.
- Educational resources that will support the SciArt activities, including Augmented Laboratory Instruments and information about the selected artefacts, to guide students through the activities.
- The SciArt training course and the educational platform that will host the training.

WP4 - SciArt Educational activities

During work package 4, partners will collaborate to build capacity among all the members of the consortium on the different aspects of the SciArt approach in order to implement the training course with teachers from the implementation countries.

Activity 1: Master Training Event

The first objective of WP is to build capacity among the partners' staff through a Master training event. Through the Master training, trainers will be familiarized with the materials and the SciArt approach so as to support the whole educational process efficiently. They will be in the position to undertake the training of teachers which will take place during the piloting activity. The Master Training participants will give feedback on the content of the training course that all partners will take into account to make adjustments.

The Master Trainer event will take place in Florina (GR), in early October 2024. The core national implementation teams from partners will attend the "Master Trainer" seminar. A total of thirty (30) trainers will participate in the training from each of the following partner countries:

<p style="text-align: center;">Greece</p> <p style="text-align: center;">5p. from AUTH & 3p. from UOWM (two of the above from M.B.C Thessaloniki) 4 teachers</p>	<p style="text-align: center;">Cyprus</p> <p style="text-align: center;">3p. from EUC 2p. from the M.M. Esposende 4 teachers</p>	<p style="text-align: center;">Portugal</p> <p style="text-align: center;">3p. from P.PORTO 2p. from the M.M. Esposende 4 teachers</p>
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The duration of the capacity building training event is twenty (20) face-2-face hours and will last for a total of three (3) days.

The UOWM will organise and host the Master Training Event in Florina, where all the partners will participate. UOWM will also be responsible for the recognition of the learning outcomes of the participants through the Europass tool.

Activity 2: Open call for participation

The partners from academia will collaborate to announce an Open Call for the participation of schools. At least a total of twenty (20) schools from the implementation countries, that is 10 schools from Greece (from both Thessaloniki and Florina), five (5) schools from Portugal, and five (5) schools from Cyprus, will be chosen in order to pilot the SciArt approach. The procedure for the selection of the pilot schools will entail an open call towards all interested schools in the participating countries.

The Universities of the consortium will undertake the Open call for their country or region and the selection of schools that will participate. The Open Call for participation will give the opportunity to schools and teachers that are interested in the training course to participate. The Open Call will be disseminated by all the organizations participating in the project.

Activity 3: Piloting

During the Piloting phase, training courses will be organized in the participating countries whereas the SciArt training course will be piloted in Greece (Thessaloniki and Florina), Cyprus, and Portugal. The trainers who will undertake the training of teachers will be the ones who participated in the Master Training event of the previous activity.

At least sixty (60) teachers from the partner countries will participate in the pilot-testing of the SciArt training course. The teacher groups from each partner country will be representative of the project target audience. Teachers' training will last for thirty (30) hours by using blended learning with fifteen (15) hours of F-2-F training and fifteen (15) hours online/asynchronous. During the implementation of the training course (between Module 4 and Module 5), teachers will implement the SciArt approach with their students in school.

During the piloting, teachers will implement the approach in their Schools. As described above, in the last part of the SciArt activities, each group will be asked to create a multimodal and/or AR-enhanced digital book about the artefact. Teachers and students will have the opportunity to upload these multimodal and/or AR-enhanced digital books on the project website.

Results

- The Master Training Event for building capacity among the project's staff members.
- Partners will select schools that will participate in the project (at least 20 schools)
- Pilot Implementation: At least sixty (60) teachers from the partner countries will participate in the pilot-testing of the SciArt training course. 2. At least 20 multimodal and/or AR-enhanced digital books created by teachers.

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