



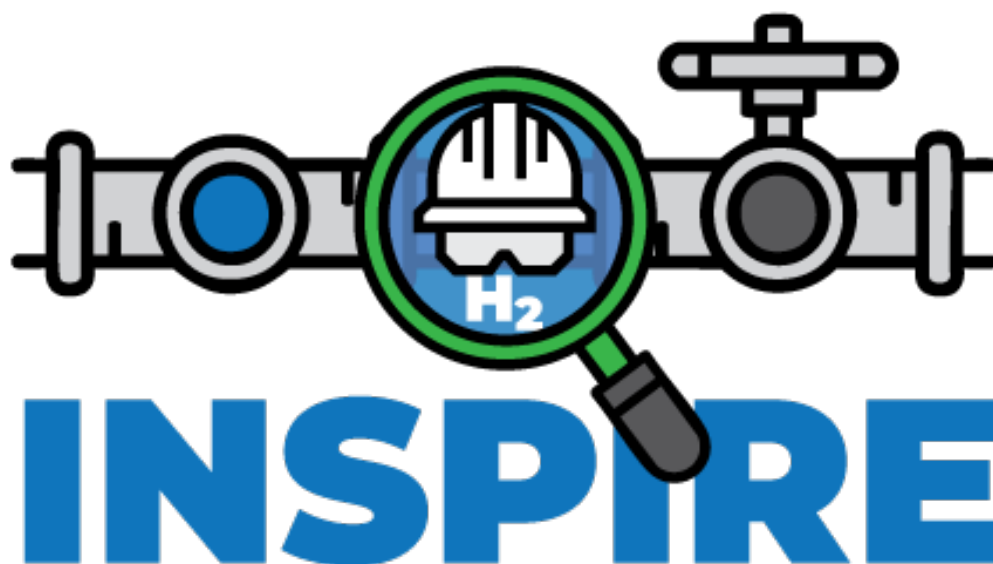
Pilot Courses Evaluation Report and Best Practices for AR-Supported Training

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Executive Summary

The present report summarises the implementation and evaluation of the INSPIRE pilot courses conducted within the framework of the INSPIRE project. The pilot activities represented a critical phase of the project, aiming to validate the effectiveness, relevance, and applicability of the Competence Units (CUs) and training materials developed during the project implementation, and to validate the modularised training approach developed for the European Welding Inspector qualification.

The INSPIRE project focuses on the development of innovative training approaches for welding inspection in hydrogen pipeline infrastructures, integrating modern digital educational methodologies and Augmented Reality (AR) technologies. The development of the Competence Units and training materials was based on the outcomes and identified needs of Work Package 2 (WP2), where extensive research and needs analysis were carried out among industry stakeholders, training providers, and technical experts. The identified skill gaps, technological challenges, and emerging industrial requirements formed the foundation for the educational content developed in Work Package 3 (WP3). The pilots, therefore, served as a validation mechanism to assess whether the developed training programme effectively addressed the priority knowledge and skills gaps previously identified and validated by industry stakeholders.

The main objective of the pilot courses was to verify and evaluate the effectiveness of the developed Competence Units, assess the suitability of the training methodology, and examine the educational value of the digital and AR-based learning approaches introduced by the project. In particular, the pilot implementation aimed to assess whether the developed training content successfully addressed the needs identified during WP2 and whether the proposed educational framework could effectively support the upskilling and reskilling of professionals involved in hydrogen pipeline inspection and welding technologies.

Three pilot courses were successfully organised and implemented in:

- Greece,
- Finland,
- Spain.



The pilots involved participants from different educational and professional backgrounds, including professionals already active in welding inspection, NDT, quality assurance, welding coordination and hydrogen-related industrial activities, such as engineers, welding professionals, inspectors, technicians, researchers, and trainees. Participant attendance exceeded the initial project target, demonstrating strong interest from industry professionals in hydrogen-related welding inspection training. During the implementation phase, participant demographic data, educational background information, and feedback from both trainees and trainers were collected and analysed through structured evaluation questionnaires and qualitative observations.

Across the three pilot courses, a total of 97 professionals were trained (Greece 59, Finland 18, Spain 20), significantly exceeding the initial target of 45 participants. Examination results were strong across all sites, with pass rates on both Competence Units of approximately 78% in Greece, 90% in Spain and 94% in Finland, confirming the effectiveness of the developed training.

The evaluation results demonstrated a high level of participant satisfaction regarding the relevance of the training material, the technical quality of the courses, the expertise of the trainers, and the applicability of the acquired knowledge to industrial practice. Furthermore, the integration of AR technologies was positively evaluated as an innovative educational approach that enhanced learner engagement, practical understanding, and interaction with complex inspection scenarios.

The trainer evaluations additionally confirmed that the developed Competence Units adequately addressed the industrial and educational needs identified during WP2 and provided a strong basis for future implementation and wider exploitation at European level. At the same time, the pilot phase enabled the consortium to identify areas for further improvement concerning digital tools, content optimisation, and future adaptation of the training methodology to different learner profiles and industrial environments.

Overall, the pilot courses successfully validated the INSPIRE training framework and confirmed the relevance and effectiveness of the developed educational materials for hydrogen-related welding inspection training. The outcomes of the pilot implementation provide valuable input for the final optimisation of the training program and support the future sustainability and wider adoption of the INSPIRE educational approach across Europe. The findings also provide valuable guidance for



future integration of the developed Competence Units and digital learning resources within vocational education and professional upskilling programmes.

Introduction

About the INSPIRE Project

The INSPIRE project (modularization of the welding INSPECTor profile to Respond to the needs emerging from hydrogen programmes towards a greener Europe) aims to modernize vocational education and training in welding inspection by addressing the emerging competence requirements associated with hydrogen infrastructure development.

The project responds to the growing demand for qualified professionals capable of supporting the construction, inspection, and maintenance of hydrogen transportation systems, particularly hydrogen pipelines. As hydrogen is expected to play a significant role in the transition towards cleaner energy systems, new challenges related to material integrity, safety, inspection methodologies, and regulatory compliance require the development of updated skills and specialised training pathways for welding inspection personnel.

To address these challenges, INSPIRE focuses on the modernization and modularization of the European Welding Inspector (EWI) qualification framework. The project develops new Competence Units and training materials dedicated to hydrogen-related inspection topics, while promoting flexible learning pathways that can support both upskilling and reskilling of professionals already active in the sector.

In addition to the development of updated educational content, INSPIRE integrates innovative digital learning approaches through the use of Augmented Reality (AR) technologies. These tools are intended to enhance learner engagement, facilitate the visualisation of complex inspection scenarios, and support the acquisition of practical knowledge in a safe and controlled learning environment.

The project brings together organisations with expertise in welding inspection, vocational education and training, hydrogen technologies, and digital learning solutions. Through the development, piloting, evaluation, and dissemination of its results, INSPIRE aims to contribute to the digital transformation of vocational education, support the development of a skilled workforce for hydrogen infrastructure projects, and strengthen the capacity of training providers to address emerging industrial needs.



The pilot courses described in this report represent a key validation stage of the INSPIRE training framework and its developed educational resources.

Purpose of the Pilot Courses

The INSPIRE pilot courses were designed and implemented as a validation activity for the Competence Units (CUs) and training materials developed within Work Package 3 (WP3), based on the needs, gaps, and recommendations identified during the Work Package 2 (WP2). WP2 highlighted the urgent need for specialised training in hydrogen pipeline welding inspection, particularly in the areas of hydrogen embrittlement, advanced non-destructive testing (NDT), safety procedures, material compatibility, and hydrogen-specific inspection practices.

The pilot implementation aimed to evaluate whether the developed training framework successfully addressed the validated industry and training sector needs identified through surveys, desk research, and focus group activities carried out in WP2. The pilots, therefore, served as a practical verification stage for the effectiveness, relevance, and applicability of the newly developed educational content and training methodology.

More specifically, the objectives of the pilot courses were:

- ✓ To validate the technical content and structure of the Competence Units developed in WP3.
- ✓ To assess whether the training materials adequately address the identified hydrogen-related knowledge and skills gaps in welding inspection.
- ✓ To evaluate the effectiveness of the proposed blended learning methodology, including the integration of Augmented Reality (AR) tools for supporting theoretical understanding and inspection visualisation.
- ✓ To verify the relevance of the training content to current industrial practices, standards, and hydrogen pipeline inspection requirements.
- ✓ To assess the suitability of the developed learning outcomes, teaching methods, and assessment procedures for professionals working in welding inspection and hydrogen-related infrastructure.
- ✓ To collect feedback from both trainees and trainers regarding the clarity, usability, technical depth, and practical applicability of the training materials.
- ✓ To evaluate participant satisfaction and measure the extent to which the pilot courses supported knowledge acquisition and professional upskilling.



The pilot courses were based on the two Competence Units developed within WP3:

- CU-H2-01: H₂ Material Integrity and Safety
- CU-H2-02: Inspection and Testing for Hydrogen Pipelines

The Competence Units were developed at EQF Level 5 and were designed to support the upskilling and reskilling of professionals already active in welding inspection and related technical fields. The training programme was intended for learners with previous qualifications and/or professional experience in welding inspection, welding technology, non-destructive testing, quality assurance, or related industrial activities, ensuring an appropriate technical foundation for addressing the specialised hydrogen-related topics covered during the pilot courses.

These Competence Units were specifically designed to respond to the industry needs identified during WP2, including hydrogen embrittlement mechanisms, hydrogen-related health and safety risks, advanced NDT methods, hydrogen-specific welding documentation, inspection planning, and compliance with relevant international standards such as ASME B31.12, ISO 9712, ISO 3834, and ISO 14731.

The table below illustrates how the principal skills gaps identified by industry stakeholders were addressed through the training content piloted during the INSPIRE project:

Table 1 - Alignment Between WP2 Skills Gaps and the Competence Units Piloted within INSPIRE

Skills Gap Identified in WP2	INSPIRE Response
Limited knowledge of hydrogen embrittlement and material degradation mechanisms	CU-H2-01: H ₂ Material Integrity and Safety
Need for improved understanding of hydrogen-related health and safety requirements	CU-H2-01: H ₂ Material Integrity and Safety
Lack of specialised competences in hydrogen pipeline inspection	CU-H2-02: Inspection and Testing for Hydrogen Pipelines
Need for advanced knowledge of inspection planning and defect assessment	CU-H2-02: Inspection and Testing for Hydrogen Pipelines
Limited familiarity with hydrogen-related standards and regulatory requirements	Both Competence Units
Need for flexible upskilling pathways for inspection professionals	Modular EQF Level 5 Competence Units supported by digital learning resources and AR activities



In addition, the pilot phase aimed to verify the applicability of modular and flexible training pathways, as recommended during WP2, while ensuring that hands-on learning and practical understanding remained central components of the educational approach. The implementation of the pilots also provided valuable insight into the readiness of training providers and learners to adopt digitally supported learning methods within hydrogen-related welding inspection education.

Contribution to the Modularisation of the European Welding Inspector Qualification

One of the central objectives of the INSPIRE project is the modernization and modularisation of the European Welding Inspector (EWI) qualification framework in order to improve flexibility, accessibility, and responsiveness to emerging industrial needs. The increasing relevance of hydrogen infrastructure projects has created a demand for specialised knowledge and skills that are not always fully addressed through traditional training pathways.

To respond to these challenges, INSPIRE adopted a competence-based and modular approach to curriculum development. Rather than treating hydrogen-related inspection topics as standalone content additions, the project developed dedicated Competence Units that can be integrated into a modular training structure and combined with existing qualification pathways.

The two Competence Units piloted within the project – H₂ Material Integrity and Safety and Inspection and Testing for Hydrogen Pipelines – represent practical examples of this modularisation approach. Developed at EQF Level 5, these units address specific knowledge and skills requirements associated with hydrogen pipeline inspection while maintaining alignment with the broader European Welding Inspector qualification framework.

The pilot courses, therefore, served not only to validate the technical content and training methodology of the developed Competence Units, but also to assess the applicability of the proposed modular approach in supporting upskilling and reskilling pathways for professionals working in welding inspection and hydrogen-related industries.

Scope of this Report

This report presents the implementation and evaluation of the INSPIRE pilot courses carried out in Greece, Finland, and Spain and includes:



- an overview of the pilot implementation activities,
- participant demographic and educational background analysis,
- the evaluation methodology used during the pilots,
- analysis of feedback collected from trainees and trainers,
- and recommendations for further improvement of the training materials and future implementation activities.

The report also summarises the main findings regarding the effectiveness, relevance, and applicability of the INSPIRE training approach and the use of Augmented Reality (AR) tools within hydrogen pipeline welding inspection training.

Methodology of the Pilot Implementation

Pilot Planning

The pilot implementation took place after the development of both the theoretical and Augmented Reality (AR) training materials, as well as after the completion of the Train-the-Trainers activities, ensuring that all partners were adequately prepared for the delivery of the courses.

Prior to the delivery of the national pilots, a dedicated Capacity Building (Train-the-Trainers) activity was carried out, in which six trainers from the partner organisations were trained on the use of the project's theoretical and AR/VR training materials. This activity was organised by CESOL in Spain (December 2025) and ensured a consistent delivery approach across the three pilot courses.

Selection of Pilot Countries and Training Providers

The selection of Greece, Finland and Spain ensured a broad geographical distribution across Europe and allowed the project to address different educational, industrial, and labour market contexts related to welding inspection and hydrogen infrastructure. Since the identified needs, level of digital readiness, and industrial priorities may vary across European regions, the implementation of pilots in different countries supported a more comprehensive validation of the INSPIRE training approach.

The pilot courses were organised by project partners acting as Vocational Education and Training (VET) providers, with experience in welding education, inspection training, and industrial collaboration. Their participation ensured the effective implementation of the pilots and the evaluation of the training materials under realistic educational conditions.



Target Groups

The pilot courses targeted professionals and learners involved in welding inspection and related technical sectors, particularly those seeking specialization in hydrogen pipeline inspection.

Based on the access conditions defined within the Competence Units, participants were expected to possess previous qualifications or experience related to welding inspection, non-destructive testing (NDT), welding technology, or quality assurance.

The target groups included:

- Welding inspectors,
- NDT personnel,
- Welding engineers and specialists,
- Quality control and quality assurance professionals,
- Technical personnel involved in hydrogen infrastructure projects,
- Professionals seeking upskilling in hydrogen-related inspection technologies

The KPI of 45 in total participants, for all 3 pilots was set.

Evaluation Methodology

The evaluation process combined both quantitative and qualitative data collection methods in order to obtain comprehensive feedback from participants and trainers. Data collection was carried out through the following evaluation tools and activities:

Participant Registration Forms

Before the implementation of the pilot courses, participants completed registration forms providing demographic and professional information, including age group, educational background, professional profile and previous experience in welding inspection and related sectors. This information supported the analysis of the target groups participating in the pilot activities.

Student Satisfaction Questionnaires

At the end of each pilot course, trainees completed evaluation questionnaires designed to assess the quality and relevance of the training content, the clarity of the educational materials, the effectiveness of the trainers, the applicability of the acquired knowledge, the usefulness of the AR-supported learning activities, and the overall satisfaction with the pilot course. The questionnaires included both quantitative scoring and open-ended questions. Where necessary, additional



qualitative feedback was collected through structured discussions and interviews in order to complement the questionnaire results.

Trainer Evaluation Questionnaires

Trainers involved in the pilot implementation also provided feedback regarding the structure and technical depth of the Competence Units, the suitability of the learning outcomes, the effectiveness of the teaching methodology, the usability of the AR tools, and the overall implementation process. Their feedback contributed to the identification of possible improvements for future training delivery.

Observation During Training Activities

Additional evaluation data were collected through direct observation during the pilot implementation. Particular attention was given to participant engagement, interaction with the training materials, participation during practical and discussion activities, and the use of AR-supported educational tools. These observations provided additional evidence regarding the usability and acceptance of digitally supported learning approaches within welding inspection training.

Qualitative Feedback and Comments

Qualitative comments collected from both trainees and trainers provided additional insight into the strengths and limitations of the pilot courses. These comments supported a deeper understanding of participant experience, industrial relevance, and potential areas for further development and optimisation of the INSPIRE training framework.

Data Collection & Analysis

The data collected during the INSPIRE pilot courses were processed and analysed in accordance with GDPR requirements and anonymisation principles, ensuring the confidentiality and protection of participant information.

The evaluation data obtained from registration forms, questionnaires, and training observations were statistically processed in order to identify overall trends, participant satisfaction levels, and the effectiveness of the training activities.

It should be noted that, for the Finnish pilot, 11 valid evaluation questionnaires were collected from the 18 participants who attended, as several participants were unable to access the online questionnaire. The Finnish satisfaction results presented in this



report are therefore based on these 11 valid responses, while the participation, qualification and examination figures refer to all 18 participants.

In addition, a comparative analysis was performed among the pilot implementations in Greece, Finland, and Spain. This comparison supported the evaluation of the INSPIRE training framework across different educational and industrial environments and helped identify common findings, differences, and potential areas for improvement. The analysis also supported the identification of good practices and recommendations for the future implementation of AR-supported training in vocational education and training environments.

Overview of the Pilot Courses

Pilot Course in Greece

The Greek pilot course was organised by the Welding Greek Institute (WGI) and took place on 3 April 2026 at the WGI premises, in Elefsina.

The pilot was delivered over a total duration of 8 training hours and involved 59 participants from different professional and educational backgrounds related to welding inspection, quality control, and technical industries.

During the pilot course, the two Competence Units developed within the INSPIRE project were delivered:

- CU-H2-01: H₂ Material Integrity and Safety
- CU-H2-02: Inspection and Testing for Hydrogen Pipelines

The training combined theoretical instruction with practical learning activities. Participants were involved in practical exercises supported by Augmented Reality (AR) technologies in order to enhance the understanding of inspection procedures and hydrogen-related inspection scenarios.

The AR activities were implemented using the Skillworx platform, allowing participants to interact with digitally supported inspection and training environments.

Photos from the pilot implementation and training activities may be included in the Annex section of this report.



Figure 1 - Pilot course in Greece

Pilot Course in Finland

The Finnish pilot course was organised by SHY and took place on 17 April 2026 at [the SHY premises in Helsinki, Finland].

The pilot course followed the same training structure and methodology described in the Greek pilot implementation. A total of 18 participants attended the Finnish pilot course.



Figure 2 - Finnish Pilot Course in Helsinki

Pilot Course in Spain

The Spanish pilot course was organised by CESOL and took place on 13 May 2026 at the CESOL premises, with a total of 20 participants. The course was delivered

following the same structure and educational methodology approach as the previous pilot courses.



Figure 3 - Pilot Course in Spain

Pilot Courses Participants' Profile

Participant Demographic Analysis

A total of 97 participants attended the INSPIRE pilot courses implemented in Greece, Finland, and Spain. This number significantly exceeded the initial target of 45 participants defined during the proposal phase, demonstrating the strong interest in hydrogen-related welding inspection training and the relevance of the INSPIRE training framework.

The participant distribution per country was the following:

Table 2 - Participants per country

Country	Number of Participants
Greece	59
Finland	18
Spain	20
Total	97

Age Distribution

The age distribution analysis was based on the participant registration forms collected during the pilot implementation. Data were available for the Greek, Spanish and Finnish pilots. For Finland, one registration was excluded from the age analysis due

to an evident date-of-birth entry error, so the Finnish age distribution below is based on 17 of the 18 participants.

The majority of participants belonged to the age groups between 30 and 49 years old, indicating strong participation from active professionals already involved in technical and industrial sectors.

Table 3 - Greece – Age Distribution

Age Range	Participants
20–29	5
30–39	27
40–49	17
50+	10

Table 4 - Spain – Age Distribution

Age Range	Participants
20–29	1
30–39	6
40–49	9
50+	4

Table 5 - Finland -Age Distribution

Age Range	Participants
20–29	1
30–39	9
40–49	4
50+	4

The results indicate that the pilot courses mainly attracted experienced technical professionals seeking upskilling and specialization in hydrogen pipeline inspection technologies.



Educational Background

The participant profiles reflected the target groups defined within the Competence Units access conditions and confirmed the participation of professionals actively involved in welding engineering, welding inspection, non-destructive testing (NDT), and industrial quality assurance activities.

Based on the registration forms collected during the Greek, Finnish and Spanish pilot courses, participants held a variety of internationally recognised qualifications and certifications related to welding inspection and welding coordination.

Participant Qualifications and Certifications

Table 6 - Participant Educational and Working Experience Background

Qualification / Certification	Number of Participants*
IWE / EWE (International / European Welding Engineer)	59
ISO 17024 Welding Inspector	15
ISO 17024 + ISO 9712 Qualifications	6
IWI / EWI (International / European Welding Inspector)	3
IWS / EWS (International / European Welding Specialist)	12
ISO 9712 NDT Qualifications	2
Other equivalent qualifications	1

The collected data demonstrate that the pilot courses successfully reached highly qualified professionals with strong technical backgrounds and direct involvement in welding inspection and industrial quality activities. This participant profile contributed positively to the validation of the INSPIRE Competence Units and training materials under realistic industrial and professional conditions.



Student Satisfaction and Learning Outcomes Evaluation

Evaluation Criteria

The evaluation of the INSPIRE pilot courses was based on structured student satisfaction questionnaires completed by participants after the completion of the training activities. The questionnaires were designed to assess both the educational quality of the pilot courses and the effectiveness of the developed Competence Units (CUs), training materials, and AR-supported learning approach.

The evaluation criteria focused on the following main areas:

Course Structure and Technical Content

Participants evaluated the clarity of the course objectives and structure, the suitability of the technical level according to their professional background, the quality and comprehensibility of the hydrogen-related inspection content and the usefulness of examples and case studies for supporting learning and understanding.

The following questions were addressed to them, for rating from 1= Strongly Disagree to 5 = Strongly Agree

1. The objectives, structure, and technical level of the course were clear and appropriate for my background.
2. The content adequately covered inspection and hydrogen-related topics and was easy to understand.
3. The examples and case studies significantly supported my understanding of the subject.

Trainers and Training Delivery

The questionnaires also assessed the technical expertise and preparedness of the trainers, the clarity of explanations provided during the training, the level of interaction during the courses, the balance between theoretical and practical activities and the adequacy of the course duration and organization.

The following questions were addressed to them, for rating from 1= Strongly Disagree to 5 = Strongly Agree

1. The trainers were knowledgeable, well-prepared, and provided clear explanations.



2. There was sufficient interaction and an appropriate balance between theory and practice.
3. The duration and organisation of the modules were sufficient for understanding the topics

Evaluation of AR and Digital Learning Tools

Special attention was given to the use of digital educational tools and the integration of Augmented Reality (AR) technologies within the pilot courses. Participants evaluated whether the AR-supported activities improved understanding and learning, the effectiveness of digital tools in visualizing inspection procedures and technical concepts and the overall usefulness of digitally supported learning activities.

The following questions were addressed to them, for rating from 1= Strongly Disagree to 5 = Strongly Agree

1. The use of digital tools (AR/VR, videos, simulations) improved my understanding and learning experience.
2. The digital tools helped visualize inspection processes effectively and should be maintained.

Learning Outcomes and Professional Relevance Knowledge and Skills Gained

The questionnaires additionally examined the extent to which participants believed that the pilot courses improved their understanding of hydrogen-related inspection requirements, ability to identify defects and inspection criteria relevant to hydrogen pipelines and finally their confidence in applying standards such as EN ISO and ASME and ability to use the acquired knowledge in professional practice.

The following questions were addressed to them, for rating from 1= Strongly Disagree to 5 = Strongly Agree

1. I improved my understanding of hydrogen-related inspection requirements.
2. I can identify defects and inspection criteria relevant to hydrogen pipelines
3. I feel more confident about applying standards (EN ISO, ASME) and using this knowledge in my professional practice.

Overall Satisfaction

Finally, participants evaluated their overall satisfaction with the pilot courses and whether they would recommend the training to other professionals. Open-ended questions were also included to collect qualitative feedback regarding the most



valuable aspects of the training, suggested improvements for future courses and comments related to digital tools, facilities, and course organisation.

The following question was addressed to them, for rating from 1= Strongly Disagree to 5 = Strongly Agree

1. Overall, I am satisfied with the training and would recommend it.

Open text questions

1. What was the most valuable aspect of the training?
2. What would you suggest improving for future courses?
3. Any comments on digital tools, facilities, or course organisation?

Results from Greece

The evaluation results of the Greek pilot course demonstrated a very high level of participant satisfaction, as the majority of responses were concentrated at scores 4 and 5 across all evaluation categories.

Specifically:

- More than 85% of the responses were evaluated with score of 5 ("Strongly Agree"),
- Approximately 12–14% were evaluated with a score of 4 ("Agree"),
- While only a very small percentage of responses received a score of 3 or below.

The highest-rated areas included trainer expertise and clarity of explanations, relevance of hydrogen-related inspection topics, understanding of hydrogen inspection requirements and overall satisfaction with the course.

The results also showed that participants positively evaluated the use of AR-supported learning tools and considered the training highly relevant for their professional activities in welding inspection and hydrogen-related industries.

Table 7 - Survey Answers for the Greek Pilot with 59 participants, with the number of answers and relevant percentages per rate

Question	Potential Answers									
	5- Strongly Agree		4- Agree		3-Neutral		2- Disagree		1- Strongly Disagree	
	Number of Answers	Percentage	Number of Answers	Percentage	Number of Answers	Percentage	Number of Answers	Percentage	Number of Answers	Percentage
1. The objectives, structure, and technical level of the course were clear and appropriate for my background.	53	89.83%	6	10.17%	0	0.00%	0	0.00%	0	0.00%
2. The content adequately covered inspection and hydrogen-related topics and was easy to understand.	50	84.75%	9	15.25%	0	0.00%	0	0.00%	0	0.00%
3. The examples and case studies significantly supported my understanding of the subject.	45	76.27%	12	20.34%	2	3.39%	0	0.00%	0	0.00%
1. The trainers were knowledgeable, well prepared, and provided clear explanations.	53	89.83%	6	10.17%	0	0.00%	0	0.00%	0	0.00%
2. There was sufficient interaction and an appropriate balance between theory and practice.	45	76.27%	13	22.03%	1	1.69%	0	0.00%	0	0.00%
3. The duration and organization of the modules were sufficient for understanding the topics.	45	76.27%	13	22.03%	1	1.69%	0	0.00%	0	0.00%
1. The use of digital tools (AR/VR, videos, simulations) improved my understanding and learning experience.	35	59.32%	17	28.81%	7	11.86%	0	0.00%	0	0.00%
2. The digital tools helped visualize inspection processes effectively and should be maintained.	37	62.71%	17	28.81%	4	6.78%	1	1.69%	0	0.00%
1. I improved my understanding of hydrogen-related inspection requirements.	49	83.05%	10	16.95%	0	0.00%	0	0.00%	0	0.00%
2. I can identify defects and inspection criteria relevant to hydrogen pipelines.	46	77.97%	10	16.95%	3	5.08%	0	0.00%	0	0.00%
3. I feel more confident applying standards (EN ISO, ASME) and using this knowledge in my professional practice.	48	81.36%	10	16.95%	0	0.00%	1	1.69%	0	0.00%
Overall, I am satisfied with the training and would recommend it.	54	91.53%	5	8.47%	0	0.00%	0	0.00%	0	0.00%

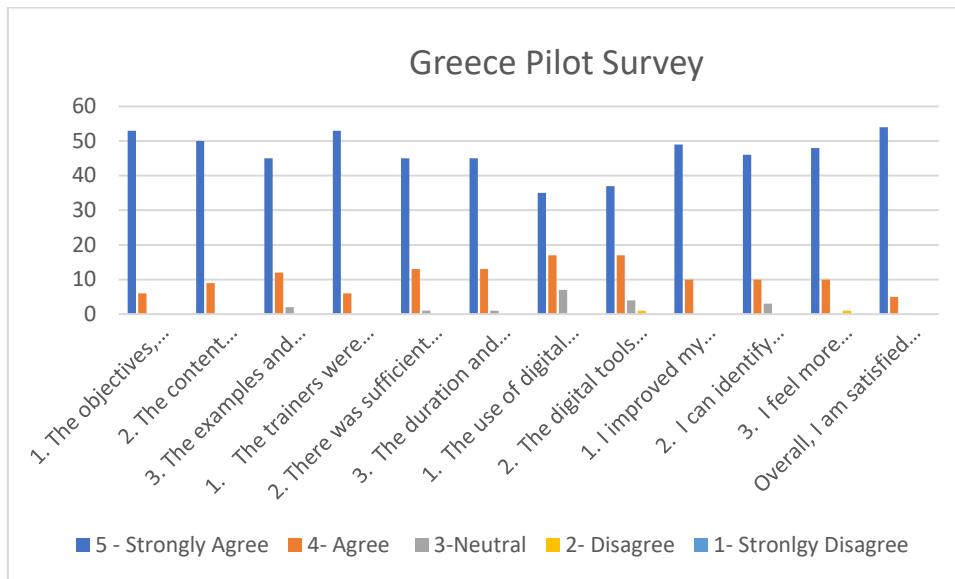


Figure 4 - Diagram of the Greek Satisfaction Survey

Greece Pilot Course / Free Text Question Results

a. What was the most valuable aspect of the training?

The free-text responses collected from participants of the Greek pilot course provided valuable qualitative feedback regarding the strongest aspects of the INSPIRE training implementation.

The majority of participants highlighted:



- the technical competence, experience, and communication skills of the trainers,
- the understanding of hydrogen-related degradation and failure mechanisms,
- the metallurgical aspects of hydrogen interaction with materials,
- and the practical applicability of the acquired knowledge in inspection activities.

Several participants specifically referred to:

- hydrogen corrosion and hydrogen failure mechanisms,
- suitable materials for hydrogen applications,
- NDT methods and inspection procedures,
- references to standards, literature, and inspection practices,
- and the understanding of material behavior and failure phenomena in hydrogen environments.

Representative participant comments included:

- "The technical expertise and communication skills of the trainer."
- "Suitable materials for Hydrogen and NDT."
- "Understanding the mechanisms that make hydrogen destructive to structures and ways to prevent them."
- "Hydrogen-related mechanisms."
- "Understanding of corrosion and failure mechanisms."
- "Immediate application during inspection activities."
- "References to standards, literature, and inspection procedures."
- "Metallurgical knowledge."
- "The interaction based on the presentation content."
- "Visual tools and trainer."
- "Organisation."
- "A deep understanding of the effects of hydrogen on materials."
- "The questions and discussions during the course."
- "Acceptance criteria and on-site inspection."
- "Damage mechanisms."
- "Inspection procedures and material selection."
- "Explanation of the points that should be defined in a WPS."
- "Failure mechanisms."
- "Understanding the use of materials under hydrogen conditions."



- "Interaction with highly qualified professionals with experience in welding projects and inspection."
- "More knowledge about hydrogen and the problems it can create."
- "Hydrogen is a challenge for all levels of the construction industry."
- "Material analysis."
- "Material properties and the behavior of H₂ in materials."

b. What would you suggest improving for future courses?

The responses to this question mainly focused on increasing the practical and visual aspects of the training. The most common suggestions included:

- more practical examples and case studies,
- additional images of real defects and field inspection cases,
- more visual material in the presentations,
- and expanded analysis of NDT methodologies and inspection practices.

Several participants also recommended:

- increasing the course duration in order to allow more time for understanding the concepts,
- including more detailed references to insulation systems and cathodic protection,
- and providing additional practical guidance on points that should be defined within WPS documentation.

Some participants specifically referred to:

- the need for more field photographs showing failures caused by poor design or fabrication,
- more real industrial examples related to hydrogen applications,
- and additional explanation of inspection-critical areas for welding inspectors.

A limited number of comments referred to the digital tools and AR activities, mentioning that:

- the digital training tools were not always easy to use,
- and that the headset equipment occasionally slowed down the seminar activities.



At the same time, many participants expressed overall satisfaction with the course and indicated that:

- “Everything was excellent,”
- “Nothing needs improvement,”
- and “The training was very satisfactory.”

c. Any comments on digital tools, facilities, or course organisation?

The majority of participants provided positive feedback regarding the organisation of the Greek pilot course, the training facilities, and the use of digital tools during the implementation.

Several comments described the overall organisation as:

- “Very well organised,”
- “Everything was very well structured,”
- “Very good overall,”
- and “Satisfactory.”

Participants also expressed general satisfaction with the facilities and training environment, while several respondents indicated that they had no additional comments or observations regarding the course organisation and digital tools.

Results from Finland

The evaluation results of the Finnish pilot course showed a moderate to positive level of participant satisfaction across the different evaluation categories, as most responses were concentrated between scores 3 and 5.

The highest evaluation scores were recorded in:

- trainer expertise and clarity of explanations,
- understanding of hydrogen-related inspection requirements,
- and the overall relevance of the course content.

Approximately:

- 45–50% of the responses were evaluated with score 5 (“Strongly Agree”),
- around 30–35% with score 4 (“Agree”),
- while a smaller percentage of responses were evaluated with scores 1–3.



Participants generally evaluated positively the structure and technical level of the course, the interaction between theory and practice and the contribution of the training to their understanding of hydrogen-related inspection topics.

The learning outcomes section also showed positive results, as most participants agreed that the training improved their understanding of hydrogen inspection requirements, ability to identify defects relevant to hydrogen pipelines and confidence in applying inspection standards and procedures.

The digital and AR-supported learning activities received more mixed evaluations compared to the other pilot courses. While several participants considered the digital tools useful for supporting visualisation and understanding of inspection processes, some lower scores were also recorded regarding usability and learning experience.

Table 8 - Survey Answers for the Finnish Pilot with 11 valid responses (out of 18 participants), with number of answers and relevant percentages per rate.

Question	Potential Answers									
	5 - Strongly Agree		4- Agree		3-Neutral		2- Disagree		1- Strongly Disagree	
	Number of Answers	Percentage	Number of Answers	Percentage	Number of Answers	Percentage	Number of Answers	Percentage	Number of Answers	Percentage
1. The objectives, structure, and technical level of the course were clear and appropriate for my background.	3	27.27%	4	36.36%	4	36.36%	0	0.00%	0	0.00%
2. The content adequately covered inspection and hydrogen-related topics and was easy to understand.	3	27.27%	5	45.45%	2	18.18%	1	9.09%	0	0.00%
3. The examples and case studies significantly supported my understanding of the subject.	3	27.27%	3	27.27%	4	36.36%	1	9.09%	0	0.00%
1. The trainers were knowledgeable, well prepared, and provided clear explanations.	4	36.36%	5	45.45%	2	18.18%	0	0.00%	0	0.00%
2. There was sufficient interaction and an appropriate balance between theory and practice.	5	45.45%	5	45.45%	1	9.09%	0	0.00%	0	0.00%
3. The duration and organization of the modules were sufficient for understanding the topics.	2	18.18%	3	27.27%	1	9.09%	4	36.36%	1	9.09%
1. The use of digital tools (AR/VR, videos, simulations) improved my understanding and learning experience.	1	9.09%	0	0.00%	5	45.45%	2	18.18%	3	27.27%
2. The digital tools helped visualize inspection processes effectively and should be maintained.	1	9.09%	1	9.09%	4	36.36%	3	27.27%	2	18.18%
1. I improved my understanding of hydrogen-related inspection requirements.	6	54.55%	4	36.36%	1	9.09%	0	0.00%	0	0.00%
2. I can identify defects and inspection criteria relevant to hydrogen pipelines.	4	36.36%	5	45.45%	2	18.18%	0	0.00%	0	0.00%
3. I feel more confident applying standards (EN ISO, ASME) and using this knowledge in my professional practice.	2	18.18%	4	36.36%	4	36.36%	1	9.09%	0	0.00%
Overall, I am satisfied with the training and would recommend it.	3	27.27%	3	27.27%	5	45.45%	0	0.00%	0	0.00%

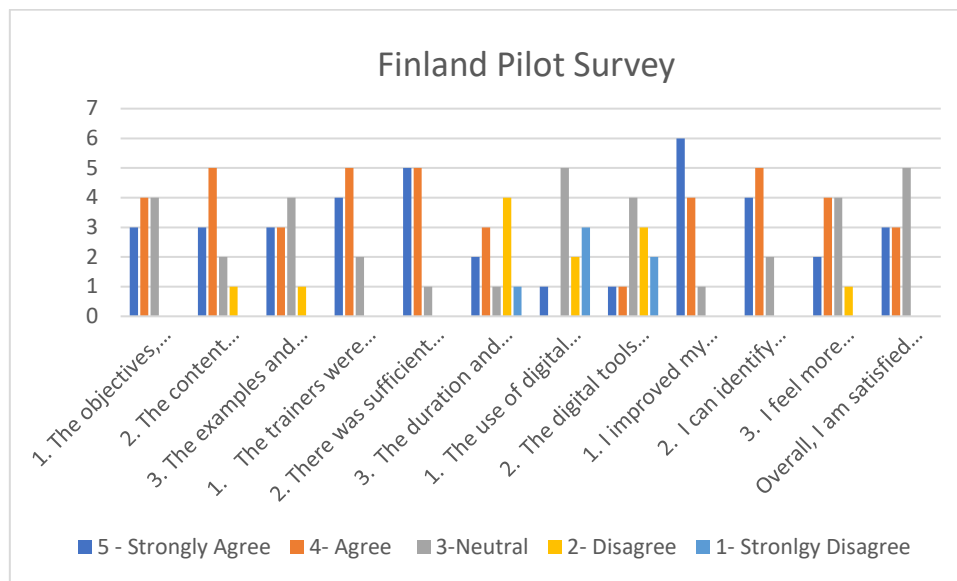


Figure 5 - Diagram of the Finnish Satisfaction Survey

Finland Pilot Course / Free Text Question Results

a. What was the most valuable aspect of the training?

The free-text responses from the Finnish pilot course indicated that participants particularly appreciated the introductory and practical knowledge related to hydrogen pipeline inspection and hydrogen-related degradation mechanisms.

Participants specifically highlighted:

- basic knowledge regarding the challenges associated with hydrogen transportation pipelines,
- and increased awareness of hydrogen-related failure and defect mechanisms.

These responses confirmed that the training successfully introduced important hydrogen-related inspection concepts to participants who had limited previous exposure to the topic.

b. What would you suggest improving for future courses?

The feedback collected from Finnish participants indicated that future training activities could benefit from additional clarification regarding standards, regulations, and practical implementation requirements related to hydrogen infrastructure.

One participant specifically noted that:

- standards and legislation are still developing,
- requirements are not yet fully clear,



- and there is uncertainty regarding how hydrogen-related inspection activities will be implemented in practice in the future.

This feedback highlighted the importance of continuously updating the training material according to evolving European and international hydrogen standards and regulatory developments.

c. Any comments on digital tools, facilities, or course organisation?

The feedback regarding the course organisation and facilities was generally positive. One participant commented that:

- a one-day course duration was relatively short,
- but that the training still provided useful basic and general knowledge that participants did not previously possess.

This response suggested that participants considered the training valuable as an introductory educational activity and indicated potential interest in longer or more advanced future training sessions.

Results from Spain

The evaluation results of the Spanish pilot course demonstrated a generally positive level of participant satisfaction across all evaluation categories, confirming the positive acceptance of the INSPIRE training content, trainers, and learning methodology.

The highest evaluation scores were recorded in trainer expertise and clarity of explanations, overall satisfaction with the training, understanding of hydrogen-related inspection requirements, and relevance of the technical content.

Participants also positively evaluated the practical examples and case studies, the balance between theory and practice, and the contribution of the course to improving knowledge related to hydrogen inspection and defect identification.

The digital and AR-supported learning tools received overall positive feedback, although some participants provided more neutral evaluations regarding the usability and effectiveness of the digital tools compared to the other evaluation categories.

Table 9 - Survey Answers for the Spanish Pilot with 16 participants, with the number of answers and relevant percentages per rate

Question	Potential Answers									
	5- Strongly Agree		4- Agree		3-Neutral		2- Disagree		1- Strongly Disagree	
	Number of Answers	Percentage	Number of Answers	Percentage	Number of Answers	Percentage	Number of Answers	Percentage	Number of Answers	Percentage
1. The objectives, structure, and technical level of the course were clear and appropriate for my background.	8	50.00%	5	31.25%	2	12.50%	1	6.25%	0	0.00%
2. The content adequately covered inspection and hydrogen-related topics and was easy to understand.	6	37.50%	7	43.75%	2	12.50%	1	6.25%	0	0.00%
3. The examples and case studies significantly supported my understanding of the subject.	4	25.00%	6	37.50%	5	31.25%	1	6.25%	0	0.00%
1. The trainers were knowledgeable, well prepared, and provided clear explanations.	9	56.25%	5	31.25%	2	12.50%		0.00%	0	0.00%
2. There was sufficient interaction and an appropriate balance between theory and practice.	1	6.25%	8	50.00%	2	12.50%	4	25.00%	1	6.25%
3. The duration and organization of the modules were sufficient for understanding the topics.	4	25.00%	5	31.25%	6	37.50%		0.00%	1	6.25%
1. The use of digital tools (AR/VR, videos, simulations) improved my understanding and learning experience.	2	12.50%	6	37.50%	6	37.50%	2	12.50%	0	0.00%
2. The digital tools helped visualize inspection processes effectively and should be maintained.	2	12.50%	6	37.50%	8	50.00%		0.00%	0	0.00%
1. I improved my understanding of hydrogen-related inspection requirements.	8	50.00%	5	31.25%	2	12.50%	1	6.25%	0	0.00%
2. I can identify defects and inspection criteria relevant to hydrogen pipelines.	6	37.50%	7	43.75%	2	12.50%	1	6.25%	0	0.00%
3. I feel more confident applying standards (EN ISO, ASME) and using this knowledge in my professional practice.	3	18.75%	7	43.75%	5	31.25%		0.00%	1	6.25%
Overall, I am satisfied with the training and would recommend it.	5	31.25%	9	56.25%	1	6.25%	1	6.25%	0	0.00%

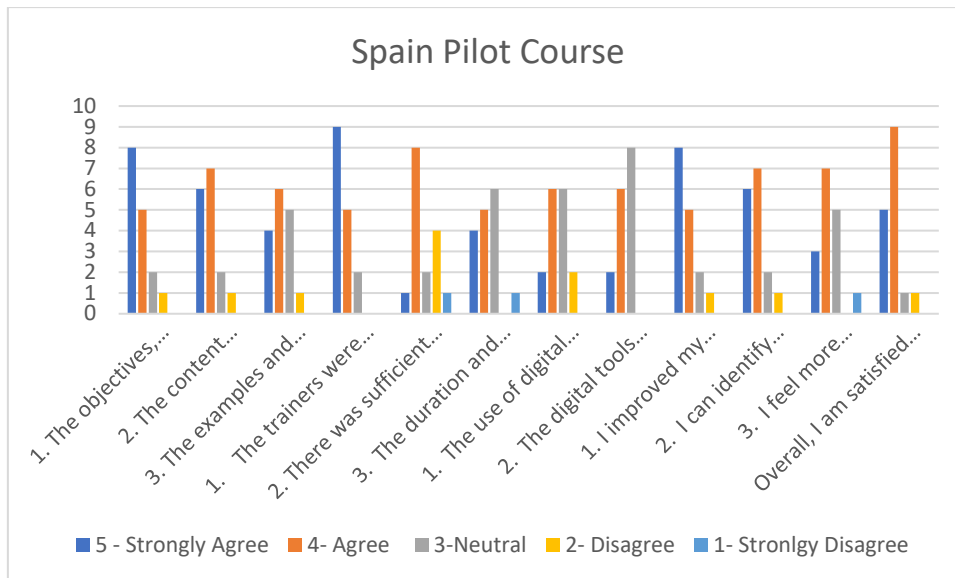


Figure 6 - Diagram of the Spanish Satisfaction Survey

Learning Outcomes and Examination Results

Following the completion of the pilot courses, participants were required to complete two assessment tests, one for each Competence Unit delivered during the training:

- CU-H2-01: H₂ Material Integrity and Safety



- CU-H2-02: Inspection and Testing for Hydrogen Pipelines

Each examination consisted of 10 multiple-choice questions designed to evaluate participants' understanding of hydrogen-related inspection concepts, degradation mechanisms, standards, and inspection methodologies. The minimum passing score for each examination was set at 60%.

The examination results demonstrated a high level of learning achievement and confirmed the effectiveness of the INSPIRE training materials and educational methodology.

Table 10 - Results of the 2 CUs examination procedure

Country	Total participants	CU-H2-01 successfully passed		CU-H2-02 successfully passed		Both CUs successfully passed	
		No	%	No	%	No	%
Greece	59	49	83.05%	49	83.05%	46	77.96%
Finland	18	17	94.44%	18	100%	17	94.44%
Spain	20	18	90%	18	90%	18	90%
Total	97	84	86.60%	85	87.63%	81	83.50%

The results indicate that the majority of participants successfully achieved the intended learning outcomes in both Competence Units. The highest success rate was observed in the Finnish-Spanish pilot course, where 94.44% of participants successfully passed both examinations.

The Greek pilot course also demonstrated strong learning performance, with more than 83% of participants successfully passing each individual Competence Unit and nearly 78% successfully completing both examinations.

The Finnish pilot course also demonstrated strong learning performance, with 17 of the 18 participants passing CU-H2-01 (94.44%) and all 18 passing CU-H2-02 (100%); 17 participants (94.44%) successfully completed both examinations.

Considering the three pilots together, 84 of the 97 participants (86.6%) successfully passed the CU-H2-01 examination and 85 (87.6%) passed the CU-H2-02 examination, while 81 participants (83.5%) successfully completed both Competence Units. Participants received a Record of Achievement for each Competence Unit they successfully passed.



The examination outcomes confirmed the effectiveness of the developed Competence Units, the relevance of the technical content, the suitability of the educational methodology and the successful transfer of hydrogen-related inspection knowledge to the participants.

Comparative Analysis

The evaluation results from the three pilot courses demonstrated an overall positive acceptance of the INSPIRE training framework and confirmed the relevance of the developed Competence Units in different European training environments. In all countries, participants evaluated positively the technical content, the trainers, and the contribution of the course to improving knowledge related to hydrogen inspection and welding technologies.

The Greek and Spanish pilot courses received the highest overall satisfaction scores, with most responses concentrated at “Agree” and “Strongly Agree.” Participants in both countries particularly appreciated the technical depth of the training, the practical relevance of the content, and the expertise of the trainers. The Finnish pilot course also received positive evaluations, although the scores were generally more moderate compared to the other pilots.

Across all pilot implementations, trainer expertise and the hydrogen-related technical content were consistently among the strongest evaluated areas. Participants highly appreciated the explanations related to hydrogen degradation mechanisms, material behavior, inspection requirements, and practical industrial applications.

The main areas identified for further improvement were related to the duration of the training, the need for more practical examples and industrial case studies, and the further enhancement of digital and AR-supported learning activities. Several participants also suggested additional visual material, field inspection examples, and expanded NDT-related practical content.

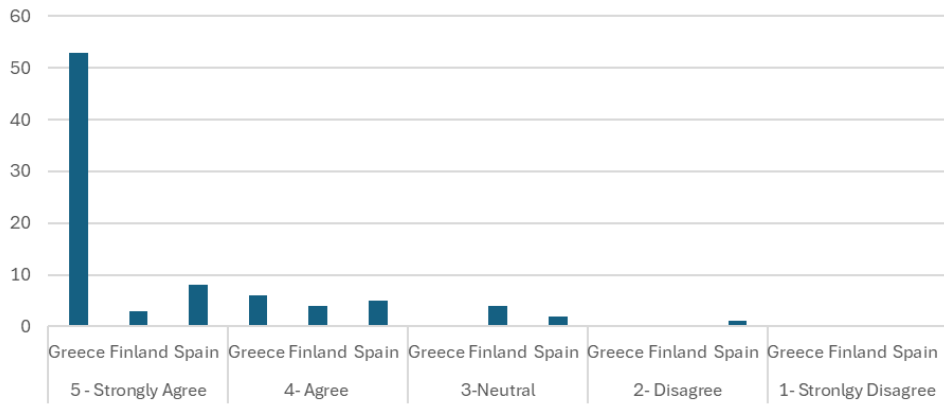
Table 11 - Summary of the INSPIRE Pilot Courses

Indicator	Greece	Finland	Spain
Participants	59	18*	20
Valid Survey Responses	59	11	16
Overall Satisfaction	Very High	Positive	High
CU Pass Rate	78%	94%* (both CUs)	90%
AR Evaluation	Positive	Mixed-Positive	Positive
Main Strength	Technical depth and trainer expertise	Introduction to hydrogen inspection concepts	Trainer expertise and practical relevance
Main Improvement Area	More practical examples	Longer duration and clearer standards guidance	More AR equipment and practical exercises

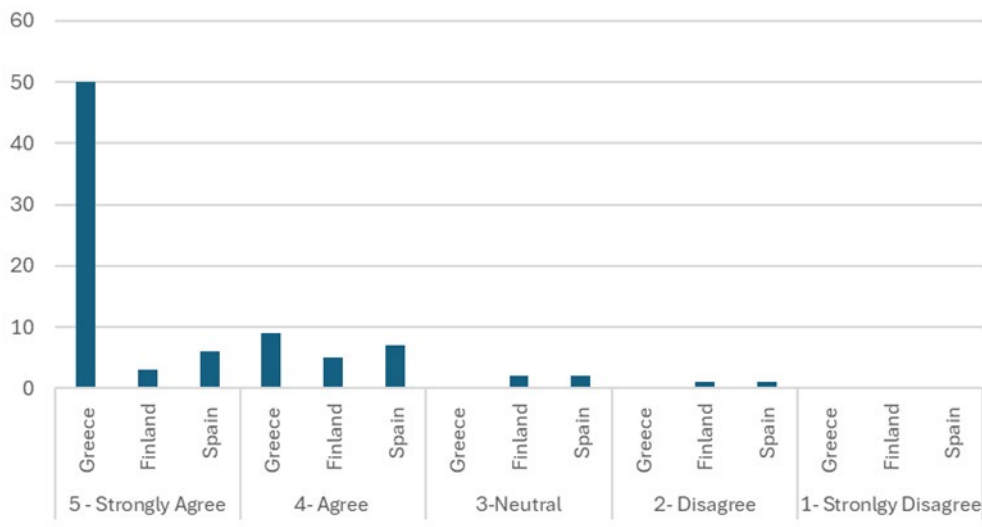
*18 participants attended; 11 valid questionnaires were collected.

The following diagrams present the evaluation results of the pilot courses per country, illustrating the distribution of participant responses for each question according to the five-point evaluation scale. The charts provide a comparative overview of participant satisfaction and learning experience across the different evaluation categories.

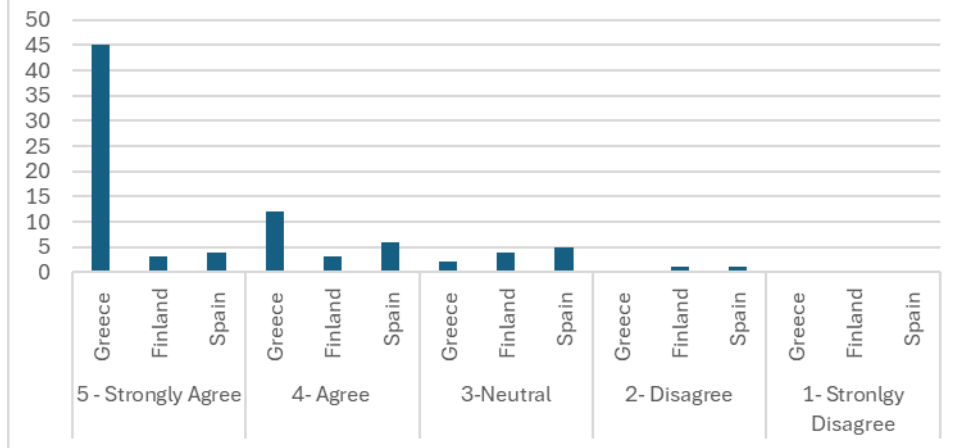
1. The objectives, structure, and technical level of the course were clear and appropriate for my background.



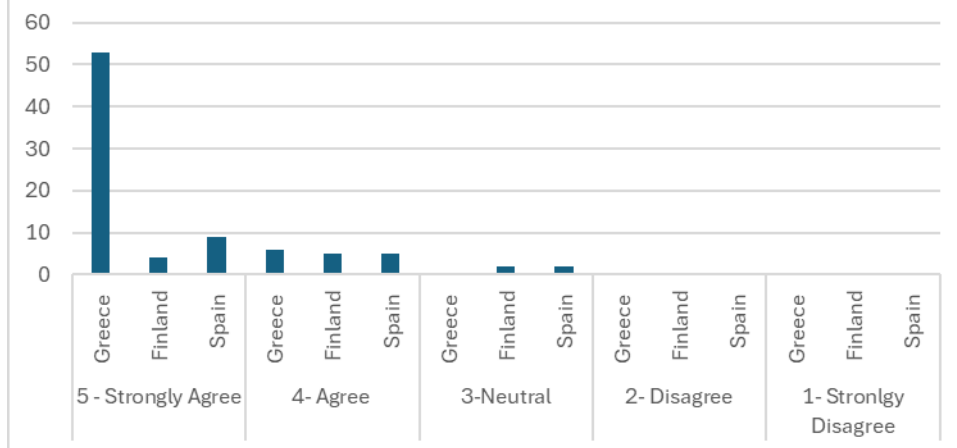
2. The content adequately covered inspection and hydrogen-related topics and was easy to understand.



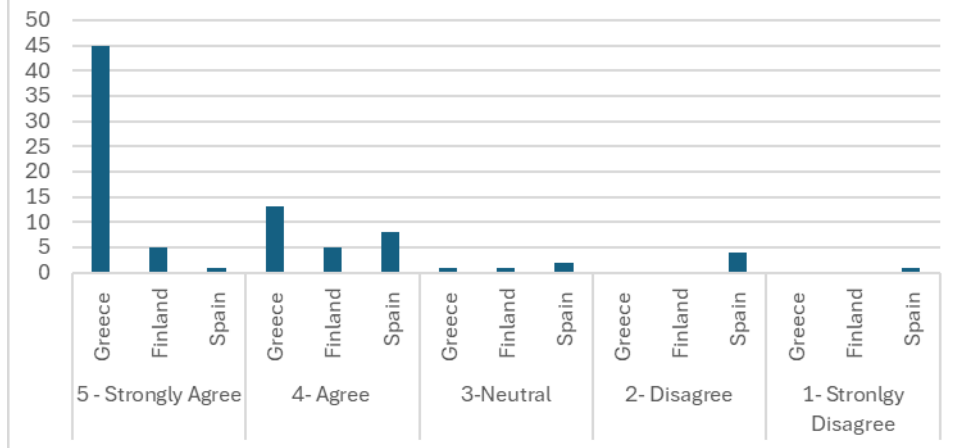
3. The examples and case studies significantly supported my understanding of the subject.



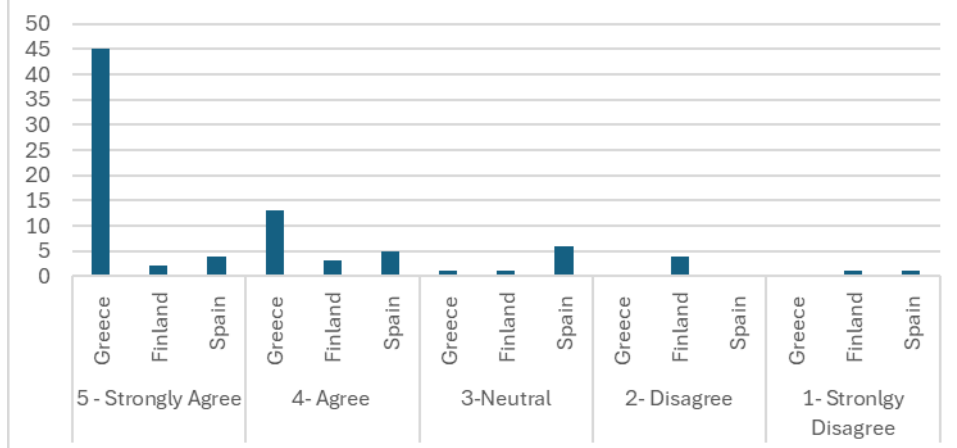
1. The trainers were knowledgeable, well prepared, and provided clear explanations.



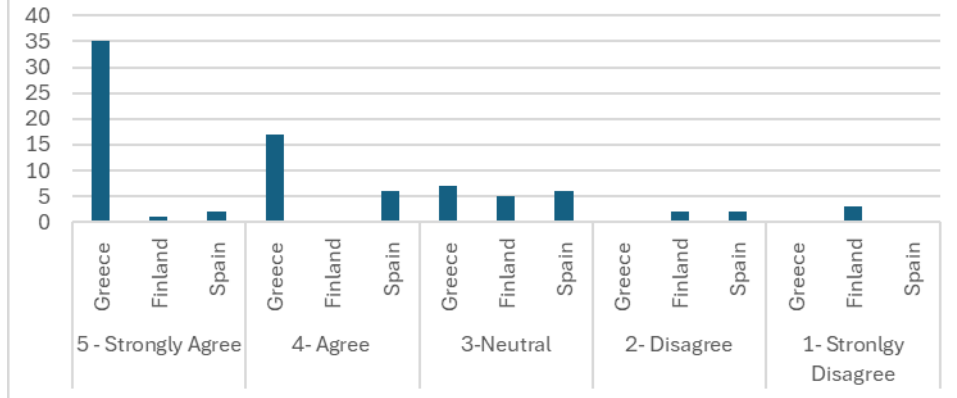
2. There was sufficient interaction and an appropriate balance between theory and practice.



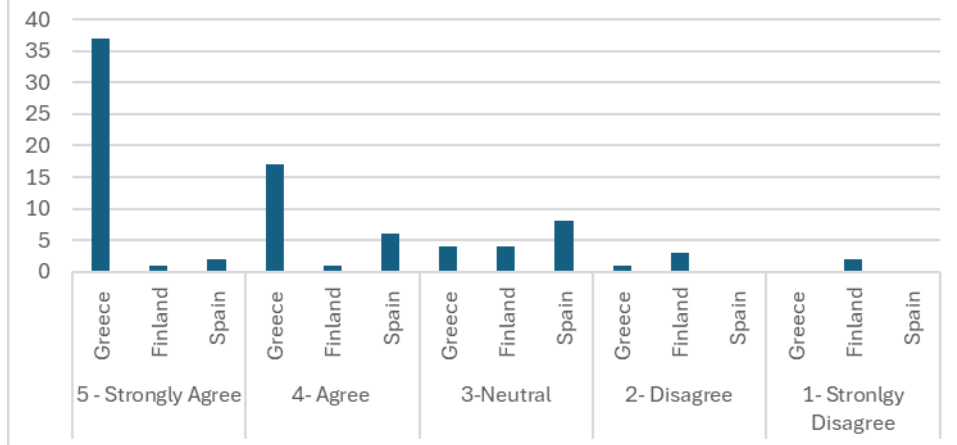
3. The duration and organization of the modules were sufficient for understanding the topics.



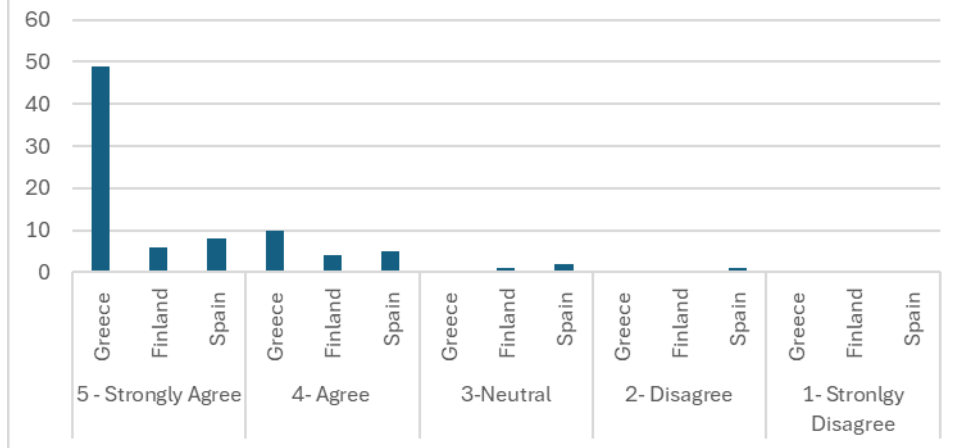
1. The use of digital tools (AR/VR, videos, simulations) improved my understanding and learning experience.



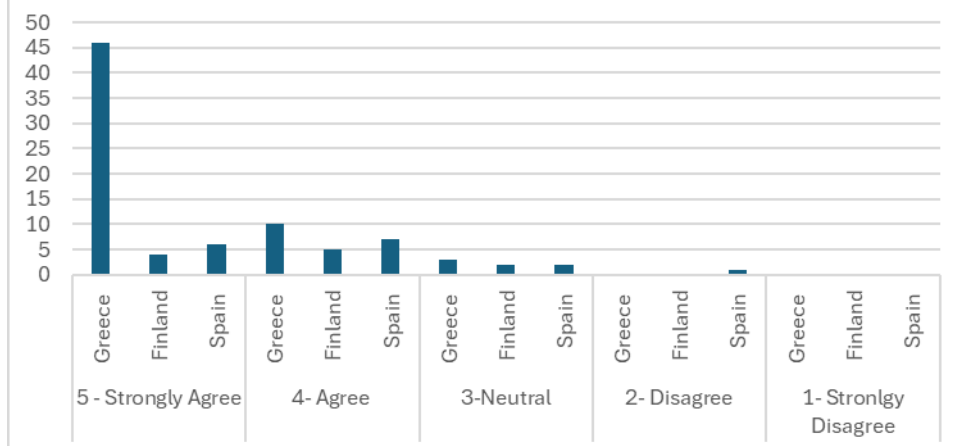
2. The digital tools helped visualize inspection processes effectively and should be maintained.



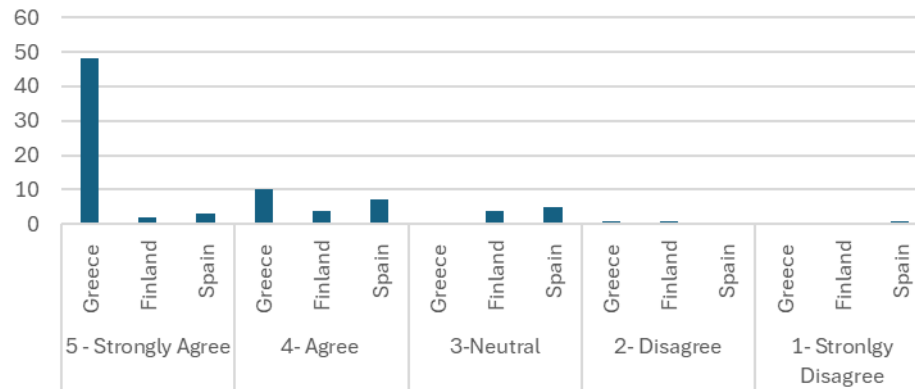
1. I improved my understanding of hydrogen-related inspection requirements.



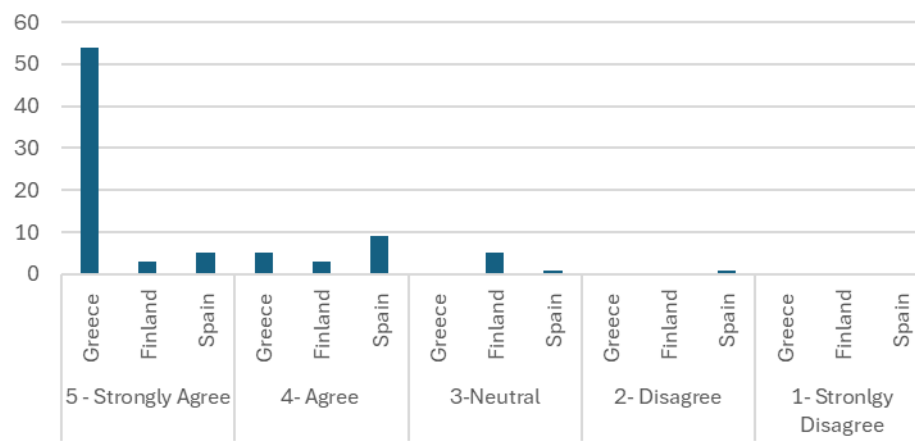
2. I can identify defects and inspection criteria relevant to hydrogen pipelines.

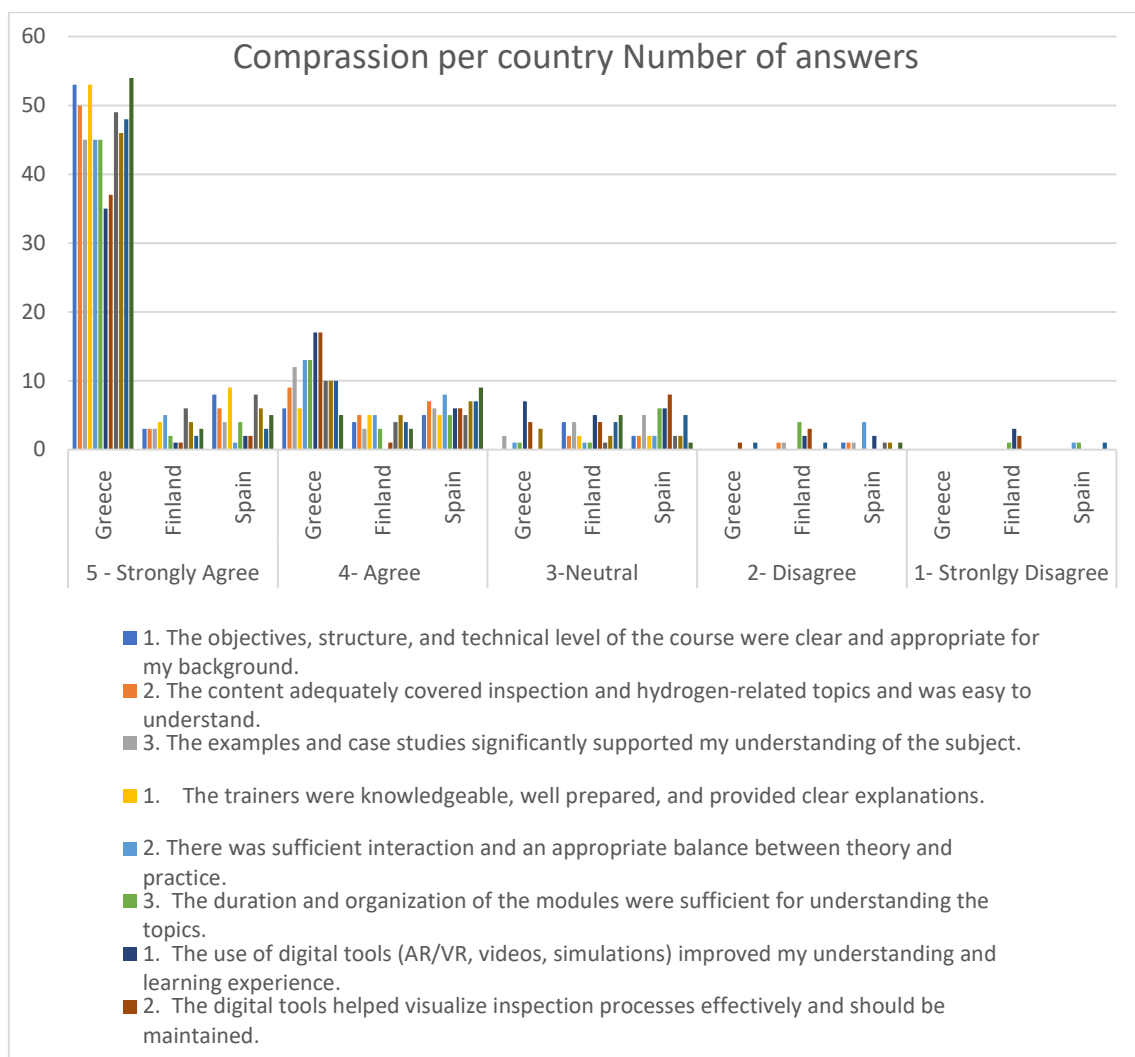
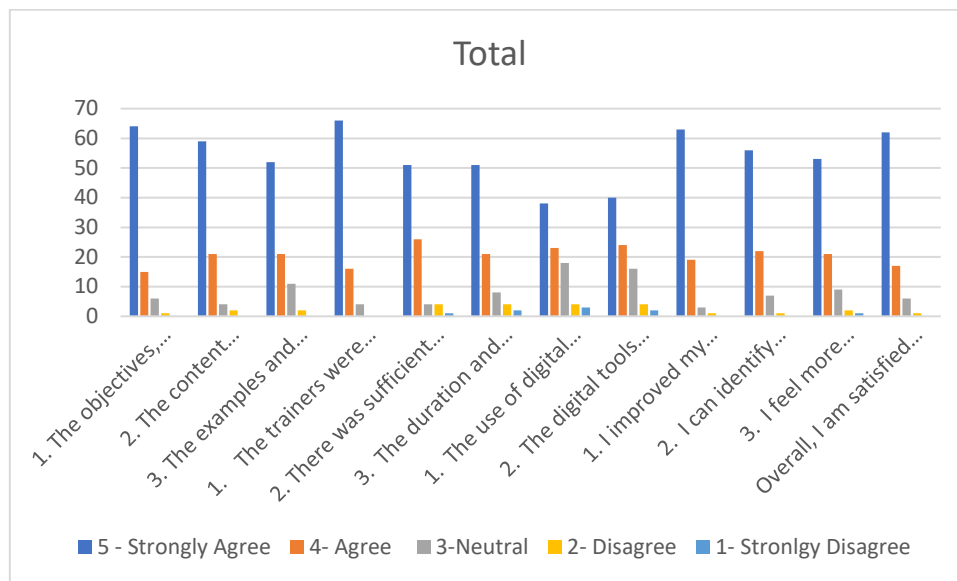


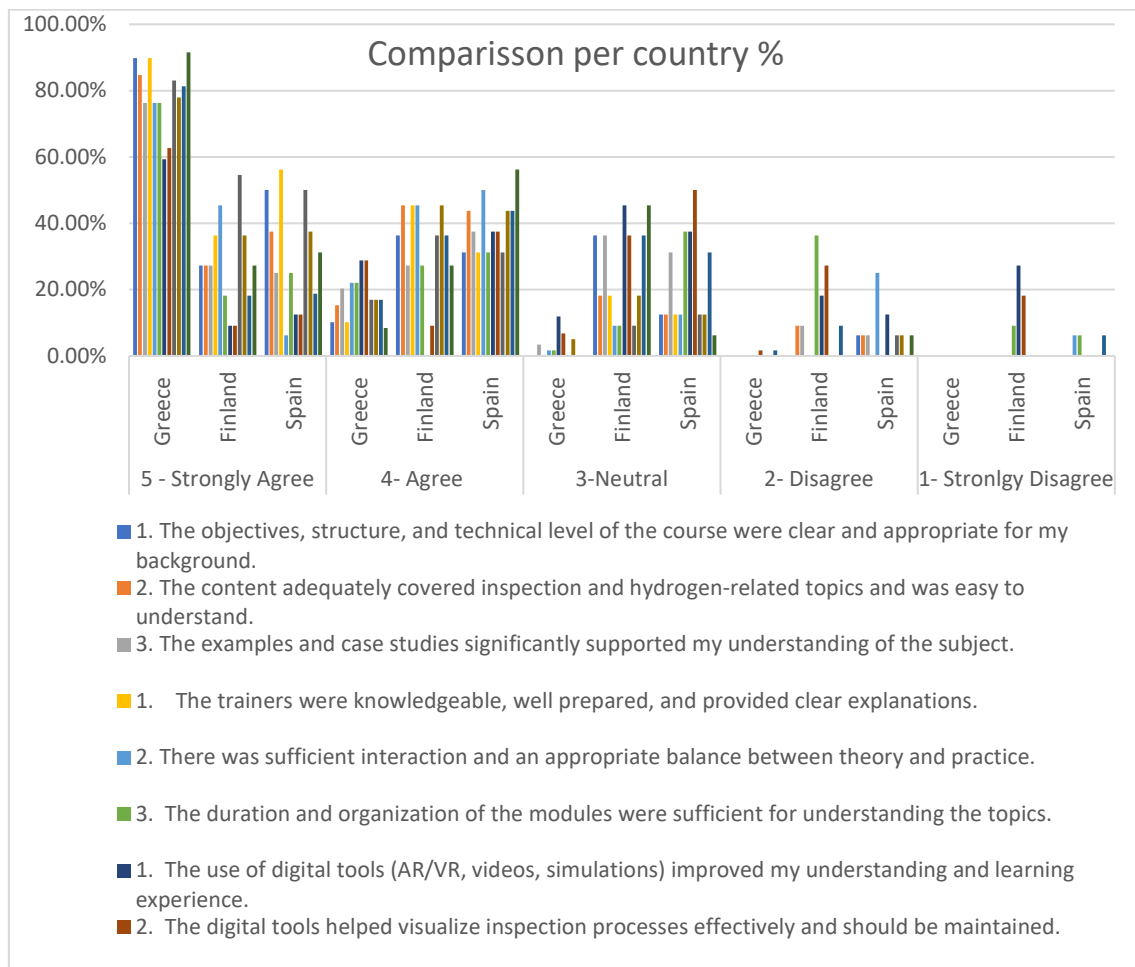
3. I feel more confident applying standards (EN ISO, ASME) and using this knowledge in my professional practice.



Overall, I am satisfied with the training and would recommend it.







Trainers' Feedback Evaluation

Trainers' Assessment of the Training Material

The trainers from both Greece and Spain evaluated the INSPIRE training materials positively and confirmed that the developed Competence Units adequately addressed the intended learning objectives and the identified industry needs related to hydrogen pipeline inspection.

The Greek trainers provided very high evaluation scores regarding the structure and organisation of the training materials, the technical depth of the content, the relevance of the hydrogen inspection topics and the effectiveness of the discussions during the pilot courses.

The Greek trainers also considered that the educational material successfully combined theoretical knowledge with practical industrial relevance and that the



balance between EN/ISO and ASME references was appropriate for the target audience.

The Spanish trainer also positively evaluated the organisation of the pilot course, communication with the project team and student participation during the implementation.

However, lower scores were recorded in Spain regarding the sufficiency of the provided educational resources, the adequacy of the AR/VR material and the technical depth of some training sections.

The Spanish trainer noted that additional practical material and more inspection-oriented exercises would further improve the educational effectiveness of the training.

The Finnish trainer (SHY) evaluated the training materials positively, confirming that the CU-H2-01 and CU-H2-02 materials corresponded to the intended learning outcomes and that the technical depth was appropriate for the target group. The hydrogen-related inspection content was considered up to date and relevant, the balance between EN/ISO and ASME references was assessed as suitable, and the discussions during the pilot were rated as effective.

Trainers' Assessment of AR Tools

The trainers' evaluation of the AR and digital learning tools showed different levels of acceptance between the pilot implementations.

The Greek trainers evaluated the digital tools positively and considered that the AR-supported activities contributed to participant engagement and supported the visualisation of inspection concepts and hydrogen-related mechanisms. However, they also noted that digital tools should continue to evolve and become more connected with practical industrial inspection scenarios.

The Spanish trainer provided more moderate evaluations regarding the AR and digital learning tools. Lower scores were recorded concerning the effectiveness of the AR tools for explaining complex concepts and the adequacy of the digital resources provided during the pilot implementation.

The trainer specifically recommended more equipment, more practical exercises, and stronger integration between digital activities and the technical content of the course.

The Finnish trainer evaluated the digital and AR-supported tools positively overall, noting that the hybrid/digital format supported learner interaction and that the tools



assisted the understanding of complex hydrogen-related concepts. As in the other pilots, usability was identified as an area for further improvement.

Technical Challenges Observed

The Greek pilot implementation did not report significant technical difficulties during the delivery of the training activities. The trainers considered that the pilot courses were effectively organised and that the educational methodology functioned successfully during the implementation.

In contrast, the Spanish trainer identified several technical and practical limitations mainly related to the digital and AR-supported learning activities. The feedback indicated that additional AR equipment would be beneficial, more practical inspection-oriented exercises should be included, and the digital tools should be more directly connected to realistic inspection applications and industrial use cases.

The Spanish feedback also highlighted that some complex concepts were not always effectively supported through the available AR tools and digital resources.

The Finnish pilot did not report significant technical difficulties within the learning environment itself. However, several participants experienced difficulties in accessing the online evaluation questionnaire; for this reason, 11 valid questionnaires were collected out of the 18 participants who attended the course.

Recommendations from Trainers

The trainers from Greece recommended maintaining the strong technical focus of the INSPIRE training materials while continuing to expand the practical and industrial aspects of the course. Particular emphasis was placed on maintaining the balance between theoretical knowledge, standards, inspection methodologies, and practical examples.

The Spanish trainer recommended the inclusion of additional practical exercises, the use of more equipment and visual training material and the further enhancement of AR-supported learning activities directly related to inspection applications.

Both pilot implementations highlighted the importance of continuously updating the educational materials according to evolving hydrogen standards, regulations, and industrial requirements. Overall, the trainers confirmed the strong educational and industrial relevance of the INSPIRE training framework and supported its future implementation and wider exploitation.



The Finnish trainer considered that the pilot achieved the intended learning outcomes and that the course is ready to be delivered as a full INSPIRE competence module. It was recommended to keep the training content continuously updated in line with the still-evolving hydrogen standards and legislation, since requirements for hydrogen-related inspection are not yet fully defined.

Key Findings and Lessons Learned

The implementation of the INSPIRE pilot courses successfully validated the developed Competence Units, training materials, and educational methodology. The pilot activities confirmed that the training content effectively addressed the needs and skills gaps identified during WP2, particularly in the areas of hydrogen-related degradation mechanisms, material integrity, inspection requirements, and applicable standards.

A total of 97 participants attended the pilot courses, significantly exceeding the initial project target of 45 participants. This result demonstrates the strong interest of industry professionals and technical personnel in hydrogen-related inspection training and confirms the relevance of the INSPIRE educational framework.

The evaluation results showed high levels of participant satisfaction across all pilot countries. Both trainees and trainers positively evaluated the technical content, the expertise of the trainers, and the overall organisation of the courses. The examination results further confirmed that the majority of participants successfully achieved the intended learning outcomes and acquired the knowledge and competencies targeted by the Competence Units.

The pilot implementation also demonstrated the potential of AR-supported learning activities to enhance participant engagement and facilitate the understanding of complex technical concepts. At the same time, feedback from both trainees and trainers indicated that additional practical exercises, real industrial case studies, and further development of digital learning tools would increase the effectiveness of future training activities.

An important lesson learned was the need to continuously update the educational content in line with the rapidly evolving hydrogen sector, including new standards, regulations, inspection methodologies, and industrial practices. Participants and trainers also highlighted the importance of maintaining a strong connection between theoretical knowledge and practical industrial applications.



Best Practices for AR-Supported Welding Inspection Training

The implementation of the INSPIRE pilot courses provided valuable insights into the use of Augmented Reality (AR) technologies within vocational education and training for welding inspection. The observations collected during the pilot activities, together with the feedback received from both trainees and trainers, allowed the partnership to identify a number of good practices that can support the future implementation of AR-supported training programmes in the hydrogen and welding sectors.

The pilot results demonstrated that AR technologies are most effective when used as a complementary learning tool rather than as a standalone educational solution. Participants generally appreciated the possibility of visualizing inspection scenarios, equipment, and technical concepts that are often difficult to demonstrate in a traditional classroom environment. The combination of theoretical instruction, trainer-led explanations, practical discussions, and AR-supported activities contributed positively to learner engagement and knowledge acquisition.

Another important finding concerned the integration of AR activities within a broader industrial context. Participants showed greater interest and engagement when digital exercises were directly linked to real inspection challenges, industrial case studies, and applicable standards.

The experience gained during the pilot implementation also highlighted the importance of preparing learners before introducing AR-supported activities. While most participants adapted easily to the digital learning environment, some users required additional guidance to become familiar with the equipment and digital interfaces. Providing a short introduction to the technology before starting the technical exercises was found to improve usability and participant confidence.

The trainers further highlighted the importance of maintaining a strong connection between digital learning activities and established inspection practices. AR-supported training should reinforce, rather than replace, the practical knowledge, critical thinking, standards interpretation, and decision-making skills required by welding inspection professionals. For this reason, future implementations should continue to combine digital tools with practical examples, industrial documentation, inspection procedures, and opportunities for discussion among participants.



The pilot activities also demonstrated that AR-supported learning can contribute positively to the understanding of complex technical concepts, particularly those related to hydrogen-material interactions, degradation mechanisms, inspection planning, and defect assessment. These topics often involve processes that are not easily observable in real industrial environments and therefore benefit significantly from enhanced visualisation and interactive learning approaches.

Based on the pilot implementation and evaluation activities, the following good practices were identified for future AR-supported welding inspection training initiatives:

Table 12 - Good Practices Identified During the INSPIRE Pilot Implementation for AR-Supported Welding Inspection Training

Area	Identified Good Practice
Training Design	Combine AR-supported activities with theoretical instruction and trainer-led discussions.
Learning Content	Link digital exercises to real industrial inspection scenarios and practical case studies.
Learner Preparation	Provide introductory guidance on the use of AR equipment and digital learning tools.
Technical Relevance	Maintain strong alignment with applicable standards, inspection procedures, and industrial practices.
Engagement	Encourage interaction, discussion, and experience-sharing between participants.
Visualisation	Use AR technologies to support the understanding of complex technical concepts and inspection situations.
Continuous Improvement	Regularly update digital content to reflect evolving hydrogen technologies, standards, and regulatory requirements.

The experience gathered during the INSPIRE pilots confirms that AR technologies can play an important role in the modernization of welding inspection training when integrated within a well-structured pedagogical framework. The identified good practices provide useful guidance for training providers, industrial organisations, and educational institutions seeking to implement digitally supported learning approaches in the field of hydrogen infrastructure inspection and related industrial sectors.



Exploitation and Sustainability of the INSPIRE Training Framework

The pilot implementation represented an important step in validating the INSPIRE training framework and preparing its future exploitation beyond the project lifetime. The positive feedback received from participants and trainers, together with the successful achievement of the learning outcomes, confirmed the relevance of the developed Competence Units and their potential application within vocational education and professional training environments.

The modular structure of the Competence Units provides a flexible basis for future integration into existing welding inspection training pathways and continuous professional development programmes. The EQF Level 5 approach adopted within the project supports the adaptation of the training to different educational and industrial contexts while addressing emerging competence needs related to hydrogen infrastructure.

The pilot activities also demonstrated the potential of digitally supported learning methodologies, including Augmented Reality technologies, to complement traditional training approaches and enhance learner engagement. The experience gained during the pilots will support the further refinement and future implementation of these learning resources by training providers, industrial organisations, and other stakeholders involved in workforce development for the hydrogen sector.

The partnership will continue to promote the project results through dissemination activities, stakeholder engagement, multiplier events, conferences, and cooperation with industry and training networks. The partnership will continue to promote and exploit the project results through the established European Welding Federation network and governance structures. Particular attention will be given to presenting the project outcomes to EWF members, including Authorised National Bodies (ANBs), Authorized Training Bodies (ATBs), certification bodies, training providers, industrial representatives, and technical experts involved in welding, joining, inspection, and related manufacturing sectors.

In addition, the developed Competence Units will be submitted to the relevant EWF technical and educational working groups for review and evaluation. The objective is to assess their potential integration into the existing portfolio of complementary training solutions offered within the EWF harmonized qualification system, including their possible alignment with the European Welding Inspection training programme. This process may provide a durable and European-recognised route for maintaining



and delivering the hydrogen pipeline inspection content developed within INSPIRE after the end of the project, through harmonised implementation by approved training organisations

The Competence Units, learning outcomes, assessment approach, and supporting training materials were developed in accordance with the EWF methodology for qualification and curriculum development, which is based on learning outcomes, industry needs, harmonised training requirements, and quality-assured implementation procedures. This alignment facilitates future evaluation and potential adoption within the EWF education, training, qualification, and certification framework.

Based on the positive results obtained during the pilot implementation and the demonstrated relevance of the hydrogen-related inspection topics, the partnership expects that the developed training framework will provide a valuable contribution to future qualification and professional development activities supporting the hydrogen transition across Europe.

The outcomes of the INSPIRE project contribute to the wider objective of supporting the development of a skilled workforce capable of responding to the technological and inspection challenges associated with the growing deployment of hydrogen infrastructure across Europe. The pilot phase has provided valuable evidence that the developed training framework can serve as a sustainable foundation for future upskilling and reskilling initiatives in welding inspection and related industrial sectors.

Conclusions and Recommendations

The INSPIRE pilot phase provided the consortium with valuable evidence regarding the applicability of the developed training framework in different European contexts. The implementation of the pilots demonstrated that there is a clear demand for specialised training related to hydrogen infrastructure, particularly in areas combining welding technologies, inspection practices, material integrity, and emerging hydrogen-specific challenges.

The pilot activities confirmed that the competency-based approach adopted by the project provides a suitable structure for addressing the current and future skills requirements of professionals involved in hydrogen pipeline construction, operation, and inspection. The developed Competence Units offer a flexible and modular training solution that can be adapted to different educational environments and target groups.



The pilot implementation also highlighted the importance of combining technical knowledge with practical learning activities. Future training initiatives should continue to strengthen the connection between theoretical concepts, industrial applications, and real inspection scenarios in order to maximize knowledge transfer and professional impact.

Particular attention should be given to the continuous updating of the training materials, as hydrogen technologies, regulations, standards, and inspection practices are evolving rapidly. Maintaining the technical relevance of the content will be essential for ensuring the long-term sustainability and exploitation of the INSPIRE training framework.

The experience gained during the pilot phase indicates that the developed training programme has the potential to be integrated into vocational education and professional development schemes at national and European level. The consortium therefore recommends further dissemination, exploitation, and adaptation of the INSPIRE training framework by VET providers, industry stakeholders, and organisations active in hydrogen infrastructure projects. The results of the pilot phase provide a strong foundation for the future integration of the developed Competence Units within professional development and qualification pathways supporting the hydrogen transition across Europe.

