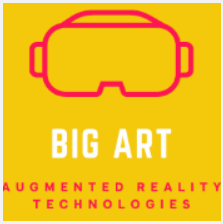

Bootcamps in Greece with

Augmented Reality Technologies

Deliverable 5.5

Learning Impact and Assessment

Funded by the European Union

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Contents

1. Introduction

The BIG ART project (Bootcamps in Greece with Augmented Reality Technologies for VET Centers in Israel and Albania) aims to introduce innovative educational approaches in Vocational Education and Training (VET) through the integration of immersive technologies such as Augmented Reality (AR), Virtual Reality (VR), and Digital Twin applications.

In recent years, immersive technologies have increasingly been recognised as powerful tools for supporting experiential learning and improving the acquisition of technical competences in vocational education. Technologies such as 3D scanning, digital twins, and virtual environments enable learners to explore complex infrastructures and real-world environments in interactive ways that are difficult to achieve through traditional teaching methods. These technologies allow students to visualise spaces, processes, and technical systems while developing practical skills that are directly relevant to modern digital workplaces.

Within this context, the BIG ART project aimed to develop and implement an innovative educational methodology that combines immersive technologies with project-based learning approaches. The project focused particularly on the use of Matterport technology and digital twin applications, enabling students to document and digitally reproduce real environments through interactive virtual tours.

The educational framework of the project was developed progressively across several work packages, each contributing to different stages of the learning process.

Within **Work Package 2**, the project partners developed a structured training curriculum and syllabus focusing on digital twin technologies and immersive environments. The syllabus defined the learning objectives, educational content, and pedagogical approach of the training activities implemented within the project. This educational framework provided the theoretical

foundation for the subsequent training phases and ensured that the learning activities were aligned with the needs of vocational education students.

Following the development of the training materials, **Work Package 3** focused on strengthening the capacity of educators through a Train-the-Trainer programme. During this phase, teachers and trainers from the participating institutions attended a specialised bootcamp organised in Athens, where they received training in the use of Matterport equipment, digital twin technologies, and immersive learning methodologies. In addition to the in-person bootcamp, a series of online mentoring sessions were organised in order to further support educators in applying the training methodology within their institutions.

The knowledge and competences developed during the Train-the-Trainer phase enabled the implementation of the student training activities organised within **Work Package 4**. During this phase, pilot training courses were delivered in Greece, Albania, and Israel, introducing vocational education students to the principles and applications of immersive technologies. These courses combined theoretical instruction with practical demonstrations and hands-on activities using specialised equipment and digital tools.

A central component of the training methodology was the integration of **Project-Based Learning (PBL)** activities. Through this approach, student teams worked collaboratively to design and develop digital twin representations of real environments. These projects required students to apply the knowledge acquired during the training sessions in practical contexts while also developing important transversal skills such as teamwork, communication, problem-solving, and project management.

The learning process culminated in the organisation of **national bootcamps and competitions** in the participating countries, where student teams presented the digital twin projects they had developed during the project-based learning activities. The national competitions provided students with

the opportunity to demonstrate their work, receive feedback from evaluation committees, and further develop their presentation and communication skills.

The highest-ranked teams from each partner country were subsequently invited to participate in the **International BIG ART Bootcamp and Student Competition**, organised in Athens, Greece, within the framework of **Work Package 5**. The international bootcamp brought together students, educators, and experts from the participating institutions and created a collaborative environment for presenting, discussing, and evaluating the student projects.

The purpose of this deliverable is to assess the **learning impact of the BIG ART project** and evaluate the effectiveness of the educational methodology implemented across the different phases of the project. The report examines the learning outcomes achieved by participating students and educators, focusing on the development of digital competences, practical technical skills, and transversal abilities such as teamwork and communication.

The analysis presented in this deliverable is based on feedback collected through evaluation questionnaires completed by students participating in the training activities and bootcamps, as well as qualitative observations regarding the learning process and the collaboration among participants.

Through this evaluation, the deliverable aims to demonstrate the educational value of the BIG ART training methodology and highlight the contribution of immersive technologies to innovation in vocational education and training.

2. Evaluation Methodology

2.1 Evaluation Approach

In order to assess the educational impact of the BIG ART project, a structured evaluation framework was applied throughout the implementation of the project activities. The purpose of the evaluation was to examine the effectiveness of the training methodology, the development of technical and transversal skills among participants, and the overall learning experience of the students involved in the project.

The evaluation approach combined both **quantitative and qualitative methods** in order to provide a comprehensive understanding of the learning outcomes generated through the project activities.

Quantitative data were collected through structured evaluation questionnaires distributed to students after the completion of the main training and bootcamp activities. These questionnaires included Likert-scale questions designed to measure participants' perceptions regarding different aspects of the learning experience, including the organisation of the activities, the quality of mentoring support, the development of technical competences, and the overall satisfaction with the training programme.

In addition to questionnaire data, qualitative insights were obtained through observations made by trainers and project coordinators during the implementation of the training sessions, project-based learning activities, and bootcamp events. Discussions with students during project presentations and mentoring sessions also provided valuable information regarding the learning process, the challenges encountered by participants, and the effectiveness of the immersive technologies used in the training activities.

By combining these quantitative and qualitative data sources, the evaluation framework allows for a comprehensive analysis of the educational impact of

the BIG ART project and provides evidence regarding the effectiveness of the innovative learning approach implemented.

2.2 Learning Pathway of the BIG ART Project

The educational methodology of the BIG ART project was designed as a progressive learning pathway implemented across several work packages. Each stage of the project contributed to the development of the competences required for the successful integration of immersive technologies in vocational education.

The learning pathway began with the development of the educational framework of the project. Within **Work Package 2**, the project partners designed the training curriculum and syllabus focusing on digital twin technologies, virtual environments, and immersive learning approaches. The syllabus defined the learning objectives, training modules, and pedagogical methodology that would guide the implementation of the educational activities of the project.

Following the development of the training materials, **Work Package 3** focused on strengthening the capacity of educators through a Train-the-Trainer programme. Teachers and trainers from the participating institutions attended a specialised bootcamp in Athens where they received training in the use of Matterport technology and immersive learning tools. In addition, a series of online mentoring sessions were organised to further support educators in implementing the training methodology within their institutions.

Building on the knowledge developed during these phases, **Work Package 4** focused on the implementation of the pilot training courses for vocational education students. These courses introduced students to the principles and practical applications of AR/VR technologies and digital twin creation. The training activities also included project-based learning exercises, during

which students collaborated in teams to develop digital twin projects documenting real environments.

Finally, the learning process culminated in **Work Package 5**, which included the organisation of national bootcamps and the International BIG ART Bootcamp and Student Competition in Athens. These events provided students with the opportunity to present their projects, receive feedback from experts, and exchange knowledge with participants from other countries.

Through this progressive learning pathway, the project ensured that both educators and students were gradually introduced to immersive technologies and were able to develop the necessary competences through a combination of theoretical instruction, practical activities, and collaborative project development.

2.3 Data Sources

The analysis presented in this deliverable is based on multiple sources of evaluation data collected during the implementation of the project activities. These data sources provide insights into the learning experience of the participants and the educational outcomes achieved through the project.

The main sources of evaluation data include:

- feedback questionnaires completed by students participating in the pilot training courses,
- evaluation questionnaires completed during the project-based learning activities,
- feedback collected during the national bootcamps organised in Greece, Albania, and Israel,
- evaluation questionnaires completed by participants of the International BIG ART Bootcamp and Student Competition.

In addition, the analysis presented in this deliverable is complemented by the evaluation results documented in Deliverable 4.4 – Evaluation of Skills, which analysed the feedback questionnaires collected during the Project-Based Learning activities and the national bootcamp competitions.

The results of Deliverable 4.4 provide additional insights regarding the development of technical and transversal skills among students participating in the BIG ART training activities and therefore contribute to the overall assessment of the educational impact of the project.

In total, the evaluation data cover the learning experience of students who participated in different phases of the project, including training sessions, collaborative project development activities, and competition events.

The analysis of these datasets allows for the identification of key trends regarding participants' perceptions of the learning activities, the development of technical competences, and the overall educational value of the project.

2.4 Evaluation Criteria

The evaluation of the learning impact of the BIG ART project was structured around a set of key criteria designed to measure both educational outcomes and participant satisfaction.

The main evaluation dimensions included:

- organisation and structure of the learning activities,
- quality of mentoring and support provided during the training and bootcamp sessions,
- development of knowledge related to AR/VR technologies and digital twin applications,

- acquisition of practical skills through hands-on project-based learning activities,
- effectiveness of teamwork and collaboration among students,
- overall satisfaction of participants with the training experience.

These criteria reflect the main objectives of the project and provide a structured framework for analysing the educational impact of the activities implemented.

3. Participants Overview

The educational activities implemented within the BIG ART project involved a diverse group of students, educators, and project coordinators from the three participating partner countries: Greece, Albania, and Israel. The participation of learners and trainers from different vocational education systems created a collaborative and multicultural learning environment that encouraged knowledge exchange and international cooperation.

The training methodology of the project was implemented across several phases, including pilot training courses, project-based learning activities, national bootcamps, and the international bootcamp and student competition. These activities allowed participants to progressively develop technical competences related to immersive technologies and digital twin applications.

3.1 Students Participating in the Pilot Training

The pilot training activities were implemented within Work Package 4 of the project and aimed to introduce students to the fundamental concepts of Augmented Reality (AR), Virtual Reality (VR), and Digital Twin technologies.

A total of **89 VET students** participated in the pilot training activities across the three partner countries. The distribution of participants per country was as follows:

- **Greece:** 20 students
- **Albania:** 20 students
- **Israel:** 49 students

These students participated in both the **pilot training course** and the **project-based learning activities**, as the practical component of the training programme was designed to complement the theoretical instruction.

The multinational composition of the student group contributed to the development of an international learning environment, encouraging the exchange of ideas and experiences among students from different educational and cultural contexts.

3.2 Students Participating in the Project-Based Learning Activities

Following the implementation of the pilot training sessions, students participated in **Project-Based Learning (PBL) activities**, which constituted the practical component of the training methodology.

During this phase, students worked in teams to design and develop digital twin projects documenting real environments. The projects involved the use of Matterport technology and other digital tools to create interactive virtual tours of educational facilities, laboratories, industrial environments, and other spaces.

Through this collaborative process, students applied the knowledge acquired during the training sessions while also developing important transversal skills such as teamwork, communication, and problem solving.

The digital twin projects developed during this phase were later presented during the national bootcamp competitions organised in each partner country.

3.3 Participation in the National Bootcamps

Following the completion of the pilot training courses, students participated in **national bootcamps and competitions** organised in each partner country. These events constituted the final stage of the project-based learning activities and provided students with the opportunity to present the digital twin projects they had developed during the training programme.

During the national bootcamps, student teams demonstrated the technical implementation of their projects, explained the educational or industrial context of the environments they documented, and answered questions from the evaluation committees.

The national bootcamps served several important educational purposes:

- encouraging students to present and communicate their work,
- providing feedback from teachers and experts in digital technologies,
- evaluating the quality and innovation of the developed virtual tours,
- selecting the teams that would represent each country in the international competition.

Through this process, students gained valuable experience in presenting technical projects and engaging in constructive discussions with evaluation panels.

3.4 Participation in the International Bootcamp

The highest-ranked student teams from the national competitions were invited to participate in the **International BIG ART Bootcamp and Student Competition**, which took place in Athens, Greece.

The international bootcamp brought together students, educators, and experts from all partner countries. During the event, student teams presented their projects to an international jury composed of representatives from the participating institutions and a technical expert specialising in AR/VR technologies.

The international bootcamp served as a platform for:

- showcasing the digital twin projects developed by students,

- encouraging international collaboration among participants,
- exchanging knowledge and experiences related to immersive technologies,
- evaluating the projects using a common evaluation framework.

The event also provided students with the opportunity to interact with experts in the field of immersive technologies and to receive feedback regarding the technical and educational value of their projects.

4. Learning Impact of the Pilot Training (WP4.1)

The pilot training course constituted the first stage of the educational activities implemented within the BIG ART project. The main objective of this phase was to introduce students to the concepts and technologies related to immersive digital environments, including Augmented Reality, Virtual Reality, and Digital Twin technologies.

The training combined theoretical instruction with practical demonstrations and hands-on activities. Students were introduced to the use of 3D scanning equipment, virtual tour creation tools, and cloud-based platforms used for processing and presenting digital twin models.

The pilot training also aimed to familiarise students with the potential applications of immersive technologies in vocational education and industry. Through the training sessions, learners explored how digital twins can be used to document industrial infrastructures, educational spaces, and production environments.

4.1 Development of Knowledge in AR/VR Technologies

One of the main learning objectives of the pilot training was to improve students' understanding of immersive technologies and their applications. The evaluation results indicate that the training successfully introduced students to the basic principles of digital twin technology and virtual environment creation.

Participants reported increased familiarity with the tools and methodologies used for capturing and processing spatial data, as well as greater awareness of how immersive technologies can be applied in real-world professional contexts.

The results of the evaluation questionnaire demonstrate a very positive perception of the training programme, with the majority of students

indicating that the course significantly improved their understanding of AR/VR technologies and digital twin applications.

4.2 Confidence in Using Digital Tools

Another important objective of the pilot training was to enhance students' confidence in using specialised digital tools and software applications related to immersive technologies.

The results of the evaluation questionnaire indicate that most participants reported increased confidence in using digital tools such as 3D scanning equipment, virtual tour creation platforms, and multimedia documentation tools.

This increase in confidence is particularly important in the context of vocational education, as it enables students to apply digital technologies in professional environments and strengthens their readiness for employment in sectors that increasingly rely on digital documentation and immersive visualisation tools.

4.3 Overall Satisfaction with the Training Experience

The feedback collected from students indicates a very high level of satisfaction with the pilot training activities. Participants highlighted the combination of theoretical instruction and practical exercises as one of the most valuable aspects of the learning experience.

The integration of hands-on activities allowed students to directly apply the knowledge acquired during the training sessions, while the collaborative nature of the exercises encouraged teamwork and peer learning.

Overall, the evaluation results confirm that the pilot training course successfully introduced students to innovative technologies and created a

strong foundation for the project-based learning activities that followed in the next phase of the project.

5. Learning Impact of Project-Based Learning Activities (WP4.2)

Project-Based Learning (PBL) constituted a central component of the educational methodology implemented within the BIG ART project. Following the completion of the pilot training sessions, students participated in collaborative project development activities designed to allow them to apply the theoretical knowledge acquired during the course in real-world contexts.

Through the PBL approach, student teams were tasked with designing and developing **digital twin representations of real environments** using Matterport technology and related immersive tools. The projects involved the documentation and virtual modelling of different types of spaces, including educational facilities, industrial infrastructures, laboratories, and other technical environments.

The objective of this activity was not only to enhance students' technical competences but also to support the development of transversal skills such as teamwork, problem-solving, communication, and project management.

By engaging in the full lifecycle of a digital twin project—from planning and scanning to editing, documentation, and presentation—students were able to experience a realistic workflow similar to that encountered in professional environments.

5.1 Development of Technical Skills

One of the most significant outcomes of the project-based learning activities was the development of practical technical skills related to immersive technologies.

During the implementation of their projects, students gained hands-on experience in several technical areas, including:

- operation of 3D scanning equipment and Matterport cameras,
- planning and execution of spatial scanning processes,
- processing and editing of captured spatial data,
- integration of multimedia elements such as images, annotations, and information tags within virtual environments,
- presentation and documentation of digital twin projects.

The experience gained through these activities enabled students to better understand the technical processes involved in the creation of immersive digital environments and strengthened their ability to use specialised digital tools.

Moreover, the practical nature of the activities helped bridge the gap between theoretical knowledge and real-world application, which is a key objective in vocational education and training.

5.2 Development of Transversal Skills

In addition to technical competences, the project-based learning activities contributed significantly to the development of several transversal skills that are essential for professional success.

Students worked in teams to design and implement their digital twin projects. This collaborative environment required participants to distribute tasks, coordinate their activities, and communicate effectively in order to achieve common goals.

As a result, students developed skills in:

- teamwork and collaboration,
- communication and presentation,
- problem solving and critical thinking,

- project planning and time management.

The collaborative nature of the projects also encouraged peer learning, as students exchanged ideas, supported each other in solving technical challenges, and jointly reflected on the outcomes of their work.

These transversal skills are particularly valuable in modern professional environments where interdisciplinary collaboration and digital competences play an increasingly important role.

5.3 Real-World Learning Experience

A key characteristic of the project-based learning approach implemented in the BIG ART project was its strong connection with real-world environments.

Rather than working on purely theoretical exercises, students were asked to document and digitally reproduce real spaces. This approach provided learners with the opportunity to explore how immersive technologies can be used in practical contexts such as:

- industrial documentation,
- architectural visualisation,
- educational infrastructure presentation,
- tourism promotion and cultural heritage documentation.

By working with real environments, students were able to understand the practical challenges associated with spatial documentation and digital modelling. These challenges included selecting appropriate scanning positions, ensuring adequate coverage of the environment, and organising the digital content in a way that facilitates navigation and understanding for users.

This authentic learning experience contributed significantly to increasing students' motivation and engagement with the project activities.

5.4 Preparation for the Bootcamp Competitions

The digital twin projects developed during the project-based learning activities formed the basis for the **national bootcamp competitions** organised in each partner country.

Students were required not only to develop technically accurate virtual tours but also to prepare presentations explaining:

- the objective of the project,
- the environment that was documented,
- the scanning methodology used,
- the potential educational or industrial applications of the digital twin.

This preparation process helped students develop presentation and communication skills while also encouraging them to critically reflect on the design and implementation of their projects.

The most successful projects from each country were selected during the national bootcamps and invited to participate in the **International BIG ART Bootcamp and Student Competition** in Athens.

Through this process, the project-based learning activities served as an essential preparatory stage for the final international event and contributed significantly to the overall learning experience of the participating students.

5.5 Feedback from the Project-Based Learning Activities

The learning experience of the students participating in the Project-Based Learning activities was also evaluated through a structured feedback

questionnaire distributed after the completion of the pilot course and project development phase.

The results of this evaluation, which are presented in detail in **Deliverable 4.4 – Evaluation of Skills**, indicate a very positive perception of the project-based learning methodology. Students reported that the collaborative project development activities significantly supported the development of practical skills and helped them better understand the real-world applications of digital twin technologies.

Participants also highlighted the importance of teamwork and the opportunity to work on real environments as key factors contributing to their engagement and motivation during the learning process.

6. Learning Impact of the National Bootcamps (WP4.3)

The national bootcamps organised within the BIG ART project constituted a key stage in the learning process, as they provided students with the opportunity to present and evaluate the digital twin projects they had developed during the project-based learning activities.

The national bootcamps were organised in each partner country following the completion of the pilot training courses and the project-based learning phase. These events served as a bridge between the training activities and the final international competition, allowing students to demonstrate the results of their work in a structured and collaborative environment.

During the national bootcamps, student teams presented their digital twin projects to evaluation committees composed of teachers, project coordinators, and technical experts. The presentations included an overview of the documented environment, the scanning methodology used, and the potential applications of the virtual tour created by the students.

The evaluation process provided participants with constructive feedback regarding the technical quality, educational value, and creativity of their projects. This feedback played an important role in helping students reflect on their work and further improve their projects before the international competition.

6.1 Presentation and Evaluation of Student Projects

The national bootcamps were designed as interactive events where student teams had the opportunity to present their projects and explain the technical and educational aspects of their work.

Each team delivered a structured presentation describing:

- the objective of the project,
- the environment that was scanned and documented,
- the scanning process and tools used,
- the features and functionalities integrated into the virtual tour,
- the potential applications of the digital twin in education or industry.

Following each presentation, the evaluation committee engaged in a discussion with the students, asking questions related to the technical implementation of the project, the challenges encountered during the scanning process, and the decisions made during the development of the virtual tour.

This interaction between students and evaluators contributed to a deeper understanding of the technological and methodological aspects of digital twin creation.

6.2 Evaluation Framework

In order to ensure a transparent and consistent evaluation process, the projects presented during the national bootcamps were assessed according to a common set of evaluation criteria developed within the BIG ART project.

The evaluation framework considered several key dimensions, including:

- technical quality of the virtual tour,
- pedagogical value and educational relevance of the project,
- creativity and innovation in the presentation of the digital environment,
- quality of collaboration between students and external partners,
- level of student engagement and teamwork.

These criteria allowed the evaluation committees to assess the projects in a structured manner and ensured that all teams were evaluated using the same standards.

The evaluation framework also reflected the broader learning objectives of the project, emphasising not only technical performance but also collaboration, creativity, and educational impact.

6.3 Development of Presentation and Communication Skills

One of the most important learning outcomes of the national bootcamps was the development of students' presentation and communication skills.

Preparing for the competition required students to organise their work, clearly explain the objectives of their projects, and present the technical aspects of their digital twin models to an audience composed of teachers and experts.

This process encouraged students to reflect critically on their work and to articulate the value of their projects in a structured and convincing manner.

The experience of presenting their projects in front of an evaluation committee also helped students gain confidence in discussing technical topics and responding to questions related to their work.

These communication and presentation skills are particularly valuable in professional environments where technical specialists are often required to explain complex concepts to diverse audiences.

6.4 Selection of the National Winning Teams

At the end of the national bootcamps, the evaluation committees reviewed the scores assigned to each project and selected the teams that achieved the highest overall evaluation.

The selected teams were invited to represent their respective countries at the **International BIG ART Bootcamp and Student Competition**, which was organised in Athens, Greece.

This selection process added an additional level of motivation for the participating students, as it provided them with the opportunity to present their projects at an international level and to interact with students and experts from other countries.

The national bootcamps therefore played a dual role within the project: they functioned both as an evaluation mechanism for the student projects and as an important educational experience that strengthened students' confidence, communication skills, and ability to present technical work in a professional context.

6.5 Feedback from the National Bootcamps

In addition to the evaluation of the student projects, feedback questionnaires were distributed to participants during the national bootcamps in order to collect insights regarding the educational value of the activity.

The analysis of these questionnaires, presented in detail in **Deliverable 4.4 – Evaluation of Skills**, indicates that students considered the bootcamp competitions to be an important opportunity for presenting their work and receiving feedback from experts.

Participants reported that the preparation for the competition and the presentation of their projects helped them improve their communication

skills and strengthened their confidence in discussing technical topics related to immersive technologies.

The bootcamps were therefore perceived not only as evaluation events but also as valuable learning experiences that supported reflection, knowledge exchange, and collaborative learning.

7. Learning Impact of the International Bootcamp (WP5.4)

The International BIG ART Bootcamp and Student Competition represented the final stage of the educational activities implemented within the project. The event brought together students, educators, and experts from the participating partner countries and provided a collaborative learning environment where students had the opportunity to present the digital twin projects they had developed during the project-based learning activities.

The international bootcamp took place in Athens, Greece, and gathered the teams that had been selected during the national bootcamps organised in Greece, Albania, and Israel. The event combined project presentations, mentoring sessions, discussions with experts, and the final evaluation of the student projects.

The main objective of the international bootcamp was to provide students with an opportunity to present their work in an international context and to exchange experiences with peers from different countries and educational systems. Through this process, students were able to gain valuable insights into different approaches to the use of immersive technologies in vocational education.

7.1 Collaborative Learning Environment

One of the most important aspects of the international bootcamp was the collaborative learning environment created during the event. Students from different countries had the opportunity to interact, exchange ideas, and discuss the technical and methodological aspects of their projects.

This international interaction encouraged participants to reflect on different approaches to digital twin creation and allowed them to explore alternative

ways of using immersive technologies in educational and professional contexts.

The discussions that took place during the presentations and mentoring sessions created a dynamic learning atmosphere in which students could learn not only from the feedback provided by the experts but also from the experiences of their peers.

Such intercultural learning experiences are particularly valuable in vocational education, as they prepare students to operate in increasingly international and technology-driven professional environments.

7.2 Mentoring and Expert Support

During the international bootcamp, students received guidance and feedback from mentors and experts specialising in immersive technologies and digital twin applications.

The mentoring sessions allowed participants to discuss the technical aspects of their projects, explore potential improvements, and better understand the practical applications of the technologies they had used.

Experts provided feedback on several aspects of the projects, including:

- the scanning methodology used by the teams,
- the quality and structure of the virtual environments created,
- the integration of multimedia elements within the virtual tours,
- the potential educational or industrial applications of the projects.

This interaction between students and experts created an important learning opportunity, as it allowed participants to gain insights from professionals with experience in the field of immersive technologies.

7.3 Presentation of Projects to the International Jury

A central element of the international bootcamp was the presentation of the student projects to the international evaluation jury.

Each team was invited to present its digital twin project, explaining the objectives of the work, the environment that had been documented, and the methodology used for capturing and processing the spatial data.

The presentations were followed by discussion sessions during which jury members asked questions regarding the technical implementation of the projects and the decisions made during the development process.

This process encouraged students to reflect critically on their work and to demonstrate their understanding of the technologies and methodologies involved in the creation of digital twin environments.

Participating in this evaluation process also helped students develop valuable skills related to public speaking, technical communication, and professional presentation.

7.4 Educational Value of the Competition

The competition element of the international bootcamp added an additional level of motivation and engagement for the participating students.

Knowing that their projects would be evaluated by an international jury encouraged students to further refine their work and to prepare carefully for their presentations.

However, beyond the competitive aspect, the event primarily functioned as a learning experience. The feedback provided by the jury and the discussions among participants allowed students to better understand the strengths and limitations of their projects and to explore potential improvements.

The competition therefore served not only as a mechanism for selecting the winning teams but also as an important pedagogical tool that stimulated reflection, critical thinking, and knowledge exchange.

7.5 Evaluation of the Learning Experience

In order to assess the educational impact of the international bootcamp, participants were invited to complete an evaluation questionnaire after the completion of the event.

The questionnaire aimed to capture students' perceptions regarding:

- the organisation of the bootcamp activities,
- the quality of mentoring and expert guidance,
- the learning opportunities provided during the event,
- the development of technical and transversal skills,
- the overall satisfaction with the international experience.

The questionnaire included Likert-scale questions that allowed participants to rate different aspects of the bootcamp experience. The responses collected provide valuable insights into the effectiveness of the international event and its contribution to the overall learning outcomes of the BIG ART project.

The statistical analysis of the questionnaire responses is presented in the following section of this report.

8. Questionnaire Results and Statistical Analysis

In order to assess the educational impact of the International BIG ART Bootcamp and Student Competition, participants were invited to complete a structured evaluation questionnaire at the end of the event.

The questionnaire was designed to evaluate multiple dimensions of the learning experience, including:

- the organisation of the bootcamp,
- the quality of mentoring and guidance provided by trainers,
- the effectiveness of the learning activities,
- the development of practical and transversal skills,
- the value of international collaboration,
- the clarity and fairness of the competition format.

The questionnaire used a **five-point Likert scale** ranging from **1 (Very Poor) to 5 (Excellent)**. In addition, open-ended questions were included to allow participants to share qualitative feedback regarding the most valuable aspects of the bootcamp and suggestions for improvement.

A total of **23 participants** completed the questionnaire, 18 students & 5 trainers, providing a representative dataset for analysing the learning impact of the international event.

8.1 Evaluation of Bootcamp Organisation

Participants were asked to evaluate several aspects related to the organisation of the bootcamp, including the overall structure of the event, the clarity of the agenda, the guidance provided by mentors, and the adequacy of the facilities used during the activities.

The results indicate a **very high level of satisfaction** with the organisation of the event.

The average scores were as follows:

Evaluation Dimension	Average Score
Overall organisation of the bootcamp	4.96
Structure of the agenda and activities	4.96
Guidance provided by mentors and trainers	4.96
Facilities and AR/VR laboratory environment	4.87

These results demonstrate that participants considered the organisation of the bootcamp to be highly effective and well structured.

The slightly lower score related to the facilities does not indicate dissatisfaction but reflects minor logistical limitations that are typical in intensive training events.

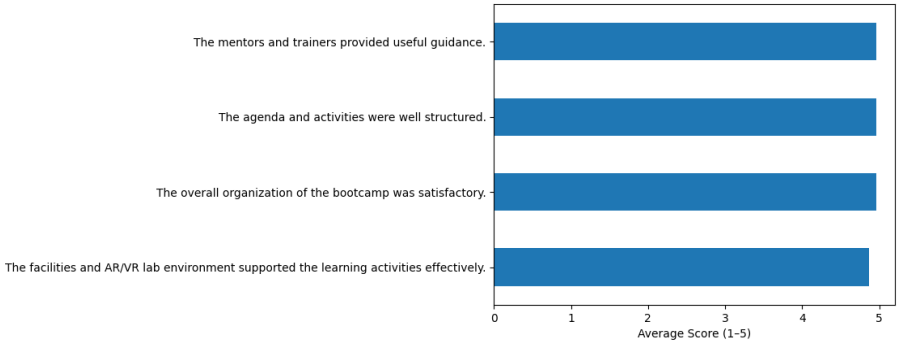

Figure 1 Evaluation of Bootcamp Organisation (Average Scores)

8.2 Evaluation of the Learning Experience

The questionnaire also examined the educational impact of the bootcamp, particularly regarding the development of knowledge related to immersive technologies and the effectiveness of the project-based learning methodology.

The results indicate that the bootcamp significantly contributed to improving students' understanding of AR/VR technologies and digital twin applications.

Learning Dimension	Average Score
Understanding of AR/VR and Digital Twin technologies	4.87
Development of practical skills through project-based learning	4.87
Improvement of problem-solving and creativity skills	4.87

These results confirm that the bootcamp successfully supported the development of both technical and cognitive competences.

The high evaluation scores demonstrate that the project-based learning methodology implemented within the BIG ART project was particularly effective in helping students apply theoretical knowledge in practical contexts.

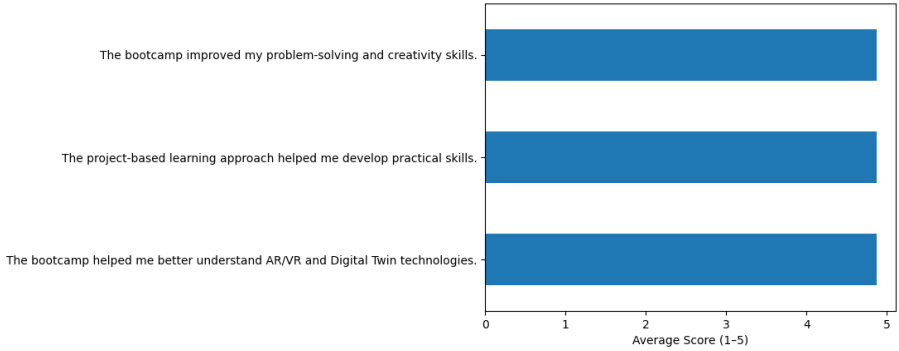

Figure 2 Evaluation of the Learning Experience during the Bootcamp

8.3 International Collaboration Experience

One of the central objectives of the international bootcamp was to promote collaboration among students from different countries and educational systems.

Participants were asked to evaluate the impact of the international collaboration environment on their learning experience.

The results show that students highly valued the opportunity to work with peers from other countries.

Collaboration Dimension	Average Score
Improvement of communication and teamwork skills	4.91
Value of the intercultural learning experience	4.96

These findings indicate that the international dimension of the bootcamp played an important role in enhancing students' interpersonal and intercultural competences.

Such experiences are particularly important in modern vocational education environments, where professionals are often required to collaborate with colleagues from different cultural and professional backgrounds.

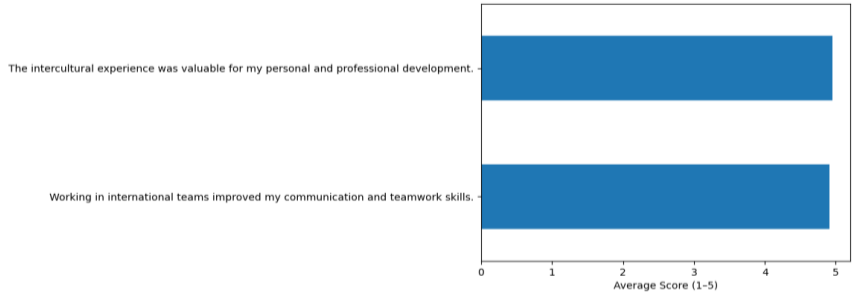

Figure 3 Impact of International Collaboration on Students' Learning Experience

8.4 Evaluation of the Competition Experience

Participants also evaluated the competition format used during the international bootcamp, including the clarity of the presentation process and the evaluation criteria applied by the jury.

The results indicate a very positive perception of the competition framework.

Competition Dimension	Average Score
Clarity and fairness of the competition format	4.91
Clarity of the evaluation criteria	4.91

These results demonstrate that the evaluation process was perceived as transparent and well structured, contributing to a fair and constructive competition environment.

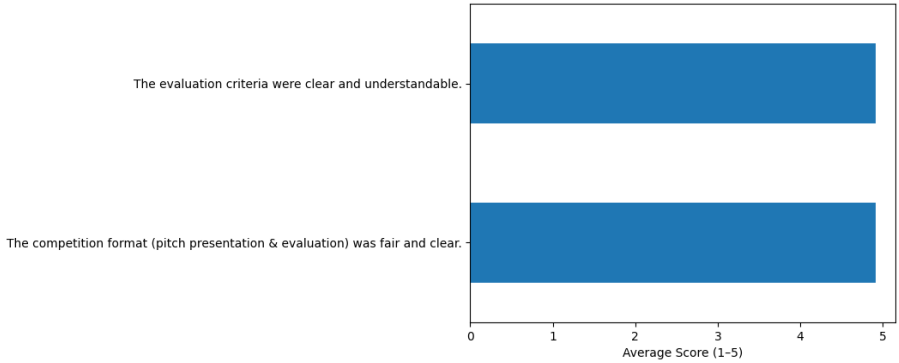

Figure 4 Participants' Perceptions of the Competition Format and Evaluation Process

8.5 Overall Satisfaction and Recommendation

The final question of the questionnaire examined whether participants would recommend participating in a similar international bootcamp in the future.

The results were extremely positive:

- **Yes:** 23 responses
- **No:** 0 responses

This means that **100% of participants would recommend the experience**, confirming the strong educational value of the international bootcamp.

Such a high recommendation rate provides strong evidence that the BIG ART bootcamp model represents an effective approach for combining immersive technologies with experiential learning in vocational education.

8.6 Overall Interpretation of the Results

The analysis of the questionnaire responses shows that participants reported very high levels of satisfaction across all evaluated dimensions, with average scores ranging between **4.87 and 4.96 out of 5**. These results highlight the strong educational value of the international bootcamp and confirm the effectiveness of the learning methodology implemented within the BIG ART project.

The results highlight several key strengths of the BIG ART educational approach:

- effective organisation of the training activities,
- strong mentoring support from trainers and experts,
- successful integration of project-based learning methodologies,
- significant development of digital and technical competences,
- valuable international collaboration experience.

Overall, the findings confirm that the international bootcamp successfully achieved its educational objectives and contributed significantly to the learning outcomes of the BIG ART project.

9. Overall Learning Impact of the BIG ART Project

The educational activities implemented within the BIG ART project created a comprehensive learning environment that enabled both educators and students to develop new competences related to immersive technologies and digital twin applications.

Through the combination of curriculum development, teacher training, pilot courses, project-based learning activities, and international collaboration events, the project established a structured learning pathway that gradually introduced participants to the concepts and practical applications of AR/VR technologies.

The evaluation results collected throughout the project confirm that the training methodology adopted in BIG ART was highly effective in supporting the development of both technical and transversal skills among participants.

9.1 Development of Digital and Technical Competences

One of the main objectives of the project was to improve students' knowledge and practical skills related to immersive technologies and digital twin applications.

The results of the evaluation questionnaires and the observation of the project activities demonstrate that students successfully developed competences in several technical areas, including:

- operation of 3D scanning equipment and digital capture technologies,
- creation and editing of digital twin models,
- development of virtual tours using specialised software tools,
- integration of multimedia elements in immersive digital environments.

Through hands-on project development activities, students were able to apply theoretical knowledge in real-world contexts and gain practical experience in the use of emerging digital technologies.

These competences are particularly relevant in sectors such as engineering, architecture, tourism, and industrial documentation, where digital twin technologies are increasingly used for visualisation and training purposes.

9.2 Development of Transversal Skills

In addition to technical competences, the BIG ART training methodology significantly contributed to the development of transversal skills that are essential in modern professional environments.

The collaborative nature of the project-based learning activities required students to work in teams, coordinate tasks, and communicate effectively with their peers. Through this process, participants strengthened their abilities in:

- teamwork and collaboration,
- communication and presentation of technical projects,
- problem-solving and critical thinking,
- organisation and time management.

The opportunity to present their projects during national and international bootcamps further enhanced students' confidence in explaining technical concepts and responding to questions from experts and evaluators.

These skills are highly valued in contemporary labour markets, where professionals are often required to work in multidisciplinary teams and communicate complex information clearly and effectively.

9.3 Impact of International Collaboration

The international dimension of the BIG ART project played a key role in enhancing the learning experience of the participants.

Through the national and international bootcamps, students had the opportunity to collaborate with peers from different countries and educational systems. This interaction created a dynamic environment for exchanging ideas, discussing technological approaches, and learning from diverse perspectives.

The evaluation results indicate that participants particularly valued the intercultural dimension of the project and recognised the importance of international collaboration in developing communication skills and broadening their professional outlook.

Experiences of this kind contribute significantly to preparing vocational education students for careers in increasingly global and technology-driven professional environments.

9.4 Innovation in Vocational Education and Training

The BIG ART project demonstrates the potential of immersive technologies to transform traditional vocational education approaches by introducing interactive and experiential learning environments.

By integrating digital twin technologies into the training activities, the project enabled students to explore real environments through virtual models and to develop practical skills in spatial documentation and digital visualisation.

The use of project-based learning further strengthened this innovative approach, as students were actively involved in designing and implementing their own projects rather than passively receiving information.

This combination of immersive technologies and experiential learning represents an important step toward modernising vocational education and making it more aligned with the digital transformation of industry.

9.5 Contribution to the Professional Readiness of Students

Another important impact of the project relates to the preparation of students for the evolving requirements of the labour market.

By working with technologies that are increasingly used in professional contexts, students gained valuable insights into emerging digital tools and methodologies.

The project activities also provided opportunities for students to engage in realistic project development processes, simulate professional workflows, and present their work to expert audiences.

These experiences contribute to strengthening students' employability and provide them with practical competences that can support their future professional development.

10. Lessons Learned

The implementation of the BIG ART project provided valuable insights regarding the integration of immersive technologies in vocational education and training.

One of the key lessons learned from the project is the importance of combining theoretical instruction with practical learning activities. The integration of project-based learning proved particularly effective in helping students apply new technologies in real-world contexts and develop both technical and transversal competences.

Another important finding concerns the role of international collaboration in enriching the learning experience. The interaction between students from different countries encouraged the exchange of ideas and perspectives, contributing to a deeper understanding of the technological and professional applications of digital twin technologies.

The project also demonstrated the importance of continuous mentoring and expert guidance during the implementation of innovative training activities. The support provided by trainers and experts during the bootcamps helped students overcome technical challenges and refine their projects.

Finally, the experience of organising both national and international bootcamp competitions showed that such events can serve as powerful learning environments where students are motivated to present their work, reflect on their learning process, and engage in constructive discussions with experts and peers.

11. Conclusions

The BIG ART project successfully introduced immersive technologies and digital twin applications into vocational education and training environments across the participating partner countries.

Through a structured educational pathway that included curriculum development, teacher training, pilot courses, project-based learning activities, and international collaboration events, the project created a comprehensive learning ecosystem that supported the development of digital competences among students and educators.

The evaluation results collected throughout the project indicate a very high level of participant satisfaction and demonstrate the effectiveness of the training methodology implemented.

Students reported significant improvements in their understanding of AR/VR technologies, their ability to develop digital twin models, and their confidence in using specialised digital tools. At the same time, the collaborative learning environment fostered the development of transversal skills such as teamwork, communication, and problem-solving.

The international bootcamp and student competition represented the culmination of the learning process, providing students with the opportunity to present their projects in an international context and receive feedback from experts and peers.

Overall, the results of the evaluation confirm that the BIG ART project has made a meaningful contribution to the innovation of vocational education and training by demonstrating how immersive technologies can be effectively integrated into educational programmes.

The experiences and methodologies developed through the project provide a valuable framework that can support future initiatives aiming to modernise vocational education through the use of digital technologies and experiential learning approaches.