Creating School Seismology Labs For the Development of Students’ Competences (SEISMO-Lab)

SEISMO-LAB

Project Result 5

SEISMO-Lab Evaluation Methodology, Analysis of Results and Policy Report

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Abstract	The SEISMO-Lab project is a pioneering initiative aimed at integrating seismology into school curricula to enhance scientific literacy and foster critical thinking among students. This comprehensive deliverable encompasses the project's evaluation methodology, analysis of results, and a policy report, offering insights into its overarching goals, methodologies employed, and the insights gleaned from its implementation. Through a blend of qualitative and quantitative techniques, the evaluation captures nuanced insights into the project's impact on participants' engagement, learning outcomes, and overall experience. The analysis reveals pivotal findings across all participation levels, highlighting the empowerment of educators, increased interest in STEM disciplines among students, and the promotion of cross-border collaboration. Recommendations address challenges and prioritize sustaining student participation, promoting interest in STEM fields, and advocating for increased investment and policy support to advance science education. Overall, the SEISMO-Lab project represents a transformative endeavor in science education, aiming to nurture a new generation of scientifically literate individuals prepared for success in the modern world.
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Executive Summary

The SEISMO-Lab project is a groundbreaking initiative that aims to reshape education by integrating seismology into school curricula across multiple countries. It seeks to elevate scientific literacy, foster critical thinking, and promote interdisciplinary learning among students. This comprehensive deliverable encompasses the project's evaluation methodology, analysis of results, and a policy report, offering insights into its overarching goals, methodologies employed, and the insights gained from its implementation.

The project's evaluation methodology employs a mix of qualitative and quantitative techniques across three key levels: school, teacher, and student. Through tools like the School's Report, Teacher's Questionnaire, and Student's Questionnaire, the evaluation captures nuanced insights into the project's impact on participants' engagement, learning outcomes, and overall experience.

Analysis of results reveals pivotal findings across all participation levels. SEISMO-Lab has empowered educators through comprehensive training events, equipping them with the necessary knowledge and skills to implement engaging seismology activities in their classrooms, and fostering a culture of innovation and collaboration among teachers. Students have shown increased interest in STEM disciplines, improved problem-solving abilities, and enhanced proficiency in scientific inquiry, driven by hands-on activities and real-time data analysis. Cross-border collaboration has promoted cultural exchange and international cooperation, enabling students to construct seismographs, analyze seismic data, and cultivate lasting friendships across geographical boundaries. Additionally, SEISMO-Lab's expansion of its seismograph network, coupled with 3D printing technology and student involvement, has democratized access to scientific instrumentation and bolstered interdisciplinary collaboration in seismology education.

The policy report serves as a guiding beacon for educators, policymakers, and stakeholders, offering insights into the project's successes, challenges, and recommendations for future initiatives. Despite significant progress, SEISMO-Lab has encountered challenges related to time constraints, resource accessibility, and sustainability. Recommendations include optimizing scheduling, enhancing resource accessibility, providing continuous professional development opportunities for teachers, and promoting interdisciplinary collaboration. Sustaining student participation and promoting interest in STEM fields are identified as key priorities, with recommendations focusing on offering engaging educational activities, promoting gender diversity, and empowering students through data analysis and hands-on learning experiences. Policymakers play a crucial role in advancing science education, with recommendations emphasizing increased investment, curriculum alignment with 21st-century skills, and facilitating knowledge sharing and research initiatives.

In summary, the SEISMO-Lab project represents a transformative effort in science education, aiming to cultivate scientifically literate individuals prepared for success in a complex world. Embracing the recommendations outlined in this deliverable will contribute to the continued evolution and impact of educational seismology, ensuring equitable access to quality STEM education for all.

1. Evaluation Methodology

This section provides a detailed overview of the comprehensive evaluation plan and methodology designed to assess the progress, achieved results, and overall effectiveness of the SEISMO-Lab project throughout its duration. The evaluation procedures were specifically tailored to systematically map the impact of the project at three distinct levels: school level, teacher level, and student level.

To ensure a thorough assessment of the project's impact, the development and implementation of the evaluation methodology were structured into three distinct phases, as outlined in Table 1.1. The initial phase focuses on crafting the evaluation methodology, devising instruments, and formulating action plans. Following this, the subsequent phase involves the execution of tasks during school implementations, ensuring that the evaluation process is effectively integrated into project activities. Finally, the concluding phase centers on data analysis and the articulation of key findings derived from the evaluation process. Below, a comprehensive description of the tasks undertaken within each phase is provided to facilitate a detailed understanding of the project's evaluation framework progression and objectives.

Table 1.1: Evaluation Methodology Phases Overview

Phase 1		**Phase 2**		**Phase 3**	
Period	Main tasks	Period	Main tasks	Period	Main tasks
08/2022 – 10/2022	1. Identification of evaluation indicators. 2. Identification and design of evaluation instruments. 3. Protocol of Conduct construction.	11/2022 – 01/2024	1. Participating schools', teachers' & students' recruitment. 2. Educational seismology activities implementation. 3. Data & feedback collection.	02/2024 – 05/2024	1. Data analysis. 2. Synthesis of main findings. 3. Policy report.

1.1 Evaluation Indicators

The evaluation of progress, achievements, and the overall effectiveness and impact of the SEISMO-Lab project is conducted through a comprehensive assessment relying on both quantitative and qualitative indicators identified for each of the three levels: school, teacher, and student.

1.1.1 Quantitative Indicators

Quantitative indicators primarily focus on attaining the project's specified participant targets. Specifically, the project aimed to engage a total of 100 schools (20 schools in each country), 200 teachers (40 teachers in each country), and approximately 4000 students (see Table 1.2). The key measure of success was the degree to which implementations met these targets and surpassed expectations.

Table 1.2: SEISMO-Lab targeted Schools', Teachers', and Students' number.

	Schools	Teachers	Students
Target number	100	200	4000

Quantitative indicators also delve into specific details regarding participating schools, teachers, and students, encompassing:

- **Geographical Distribution of Schools:** This aspect examines the spread of schools across different regions, providing insights into the project's reach and coverage.
- **Seismograph Installation Status:** It involves identifying whether a seismometer was installed in each participating school, specifying the type (Raspberry Shake, TC-1, or self-made), and determining its availability on the SEISMO-Lab platform.
- **Gender Distribution:** This analysis focuses on examining the balance between male and female teachers and student participants, providing insights into the gender inclusivity of the project.
- **Distribution of Subject Disciplines:** It involves understanding the variety of subject disciplines engaged in the project, such as Physics, Geography, Technology, etc.
- **Distribution of Students' Ages:** This aspect examines the age range of participating students, providing insights into the diversity of the student population involved in the project.

1.1.2 Qualitative Indicators

In tandem with quantitative measures, qualitative indicators play a pivotal role in providing nuanced insights into the impact and effectiveness of the SEISMO-Lab project. While quantitative data quantifies reach and numerical success, qualitative indicators delve deeper into the qualitative aspects of the project's influence on the participating schools, teachers, and students.

The distinct areas that the project aimed to assess for each of the three participatory levels are presented below.

School Level

At this level, the project aims to assess and estimate the extent to which:

a. School authorities encouraged or facilitated the participation of staff teachers in training and teacher development programs.
b. School authorities encouraged or facilitated the development of interdisciplinary educational activities.
c. Schools collaborated or plan to collaborate in the future with other schools in their area/region/country or other countries.
d. Schools considered recognition or distinction of achievement and further facilitated participation in other projects and initiatives.

Teachers Level

At this level, the project aims to assess and estimate effectiveness and impact in the following areas:

a. Effectiveness of the offered training,
b. Development of interdisciplinary educational activities,
c. Collaboration with other teachers.

Student Level

The project's evaluation at the student level focuses on the development of content and concept knowledge, skills, and attitudes toward sciences, covering distinct areas such as:

a. Creation, change, or enhancement of a positive attitude towards STEM.
b. Increase in interest, fascination, motivation, and levels of achievement in STEM.
c. Enhancement of problem-solving competences and interdisciplinary thinking.
d. Creation, change, or enhancement of critical thinking, understanding of civic responsibility, and Responsible Research Innovation (RRI) principles.
e. Enhancement of understanding of how science is interlinked with cultural, environmental, economic, and other contexts, especially in earthquakes and seismic risk.
f. Ability to handle experimental techniques to conduct a scientific investigation/inquiry.
g. Ability or enhancement to code, record, and analyze data with the offered hardware sensors and software tools.

The qualitative indicators corresponding to the distinct evaluation areas and instruments for the school, teacher, and student levels are presented in Table 1.4, Table 1.5, and Table 1.6, respectively.

1.2 Identification and Design of Evaluation Instruments.

To assess the project's impact on all three levels, various evaluation instruments and methods were employed.

Quantitative indicators were tracked using an Excel sheet template designed to monitor school, teacher, and student involvement. This template captured essential demographic details such as school name, geographic area, seismograph type, number of participating teachers, their subject disciplines and gender, the total number of students involved, and their ages. An illustrative example of this tracking system is presented in Table 1.3, displaying how the data were organized and recorded for analysis and evaluation purposes.

Table 1.3: Quantitative indicators Excel sheet template.

No	School name	Area	Seismograph type	No of the involved teachers	Subject disciplines	Teacher's gender	Student's age	No of the involved students
1	Sample School	Urban	Raspberry Shake	2	Physics, Geography	1 Male & 1 Female	14 – 16	50

For the qualitative indicators assessment, an initial research phase was undertaken to identify appropriate instruments and methodologies from existing literature. The selected instruments were adjusted to align with the specific objectives of the project, while others were created anew as required. The selection process for methods and instruments considered several factors including validity, reliability, completion time, as well as the age and competency level of the students.

Below, the evaluation instrument(s) for each evaluation level and corresponding indicator(s) are presented.

1.2.1 School Level

To evaluate the project's impact on the school level, the School's Report (SR) was designed, serving as the primary data source for evaluating related indicators (SCH1- SCH4; Table 1.4).

School's Report (SR)

The SR comprises two sections:

- **Section A** provides information about the school, including the school's name, respondent's administrative position, number of teachers involved in the project, their subject disciplines, and previous participation in Educational Seismology projects.
- **Section B** focuses on assessing the contribution of the schools' administration staff. It includes 5-point Likert scale questions (ranging from 1 = "Not at all" to 5 = "To a very large extent"), each accompanied by necessary action descriptions.

The breakdown of questions is as follows:

  - Questions 1 to 3 gauge the extent to which the school's administration encouraged or facilitated the participation of staff teachers in training events and teacher development programs (SCHI 1).
  - Question 4 assesses the extent to which the school's administration encouraged or facilitated the development of interdisciplinary educational activities (SCHI 2).
  - Questions 5 and 6 inquire about the extent to which the school's administration collaborated or plans for future collaboration with other schools in the area/region/country or other countries (SCHI 3).
  - Question 7 explores the extent to which the school's administration recognized the project's educational value and plans to participate in future similar projects (SCHI 4).
  - The final question seeks input from the school's administrative staff, inviting their suggestions and recommendations for the project's future actions.

The SR was crafted in both traditional paper-and-pencil and online format, providing flexibility in data collection. Completed by a school's administrative staff member post-implementation, it ensures anonymity and takes approximately one hour to complete. Based on the individual SR responses, each school receives a score indicating its status concerning each evaluation indicator. Higher scores correspond to better performance in the respective indicator.

Table 1.4: School Level Evaluation: Areas, Indicators, and Instruments.

Evaluation areas	Indicators	Instrument
School authority encouragement or facilitation of participation of its staff teachers in trainings and teacher development programs.	SCHI1	School's Report (SR) Questions 1 - 3
School authority encouragement or facilitation of development of interdisciplinary educational activities.	SCHI2	School's Report (SR) Question 4
Schools' collaboration or plans for future collaboration with other schools in their area/region/country or other countries.	SCHI3	School's Report (SR) Questions 5 - 6
Schools' consideration of recognition or distinction of achievement and further facilitation of participation in other projects and initiatives.	SCHI4	School's Report (SR) Question 7

1.2.2 Teacher Level

To evaluate the project's impact on the teachers' level, two instruments were designed: (i) the Teacher's Questionnaire (TQ) and (ii) the Teacher's Report (TR), each addressing the respective evaluation indicators (T1 – T3; refer to Table 1.5).

Table 1.5: Teacher Level Evaluation: Areas, Indicators, and Instruments.

Evaluation areas	Indicators	Evaluation Instruments
Effectiveness of the offered training	TI1	Teacher's Questionnaire (TQ)
Development of interdisciplinary educational activities.	TI2	Teacher's Questionnaire (Q6) Teacher's Report (TR; Section B, C)
Collaboration with other teachers	TI3	Teacher's Report (TR; Section E)

i. Teacher's Questionnaire (TQ)

The TQ serves as the primary data source for evaluating the impact of SEISMO-Lab training events on participating teachers (TI1). Offered both as a traditional paper-and-pencil document and as an accessible online form, the TQ provides flexibility in the data collection process. Administered immediately post-training events, the questionnaire was intended for individual completion by each participating teacher, ensuring anonymity. Typically taking around 15 minutes to complete, the questionnaire's data is analyzed quantitatively to assess the effectiveness of the training events. Additionally, it investigates teachers' intentions to engage in the project, collaborate with peers, and develop interdisciplinary educational seismology activities.

The TQ consists of two sections:

- **Section A** concerns demographic information about the teacher (e.g., country, gender, subject discipline and students' grade, and participation in previous Educational Seismology projects).
- **Section B** comprises statements rated on a 5-point Likert scale (1 = "Strongly disagree", 5 = "Strongly agree") and Yes/No questions. These items assess the effectiveness of the distributed material and the activities conducted during the training event. Additionally, they include inquiries about teachers' intentions to participate in the project.
  The breakdown of statements is as follows:
  - Statements 1 to 5 concern the effectiveness of the training events (TI1).
  - Questions 6 and 7 refer to teachers' intentions in developing interdisciplinary educational seismology activities (TI2) and collaborating with other teachers (TI3) accordingly.
  - Question 8 inquires teachers' intention to participate in the SEISMO-Lab project.
  - The final question seeks input from teachers, inviting their suggestions and recommendations for future training events.

ii. Teacher's Report (TR)

The TR is an instrument that aids teachers in reporting on the implementation of project-related educational activities. This report acted as the main data source for evaluating the extent to which teachers developed interdisciplinary activities (TI2) and collaborated with other teachers (TI3). Additionally, this report gave insights about students' actions and developed products during the school implementations (SI2, SI4 & SI5; see Table 1.6).

The TR consists of six sections:

- **Section A** pertains to information regarding the participating teachers and the school, encompassing demographic details such as teachers' gender, country, subject discipline, grade, the number of participating students, and the seismograph type and installation status.
- **Section B** focuses on the utilization of the project's demonstrators, which have been developed by the partners and recommended for use during teachers' implementations. It includes a list of the developed demonstrators, from which teachers can select the ones they have implemented. Following the list is an open-ended question prompting teachers to describe any modifications they made to tailor the demonstrators to their classrooms, considering factors such as students' interest and prior knowledge. Additionally, teachers are asked to evaluate the success of the demonstrators' implementation and offer feedback and suggestions for their future use.
- **Section C** concerns educational activities that have been developed or found by teachers themselves and have been implemented during the project. Teachers are asked to describe these activities, assess their success during their implementations, and provide their ideas and suggestions for future use.
- **Section D** concerns specific tasks students performed during the implementations, while using the available equipment/resources/tools. Teachers are asked to identify these tasks and share any indicative learning products and/or materials developed during the project. For each school, a Google Drive link is given to the teachers to upload the necessary files.
- **Section E** concerns teachers' collaborations with other teachers or external stakeholders. Teachers are asked to identify from a given list or describe the kind of collaboration they developed with other teachers or external stakeholders, the challenges they faced during these collaborations, as well as future plans or suggestions for improvement.
- **Section F** concerns the overall evaluation of the implementations. Teachers are asked to identify and present the main challenges they faced during the implementations, make suggestions on achieving successful collaborations, and introducing innovations to students.

The TR was accessible in both traditional paper-and-pencil format and as an online form, providing flexibility in the data collection process. Teachers were given the option to choose their preferred method, accommodating diverse preferences. The TRs were completed by each participating teacher at the conclusion of the school implementations. The information gathered from these reports played a crucial role in evaluating indicators at both the students' and teachers' levels.

1.2.3 Student Level

To assess the impact of the project on the students' level, interconnected evaluation areas were grouped together to form a unifying indicator. For a comprehensive assessment of these indicators, two evaluation instruments were employed. The evaluation areas, indicators, and corresponding instruments are presented in Table 1.6.

To evaluate indicators SI1 – SI4, the Students' Questionnaire (SQ) was developed.

Students' Questionnaire

The Students' Questionnaire comprises three parts:

- **Demographic information** including school, gender, and age.
- **Guidelines for Generating a Personal Code** providing instructions on creating a Personal Code that is used to match students' pre and post-responses.
- Main Body of the Questionnaire consisting of 36 items built on a 5-point Likert scale (ranging from 1 = "Strongly disagree" to 5 = "Strongly agree"). The items are clustered into four domains:
  a. Items **1 - 15** refer to students' attitudes toward STEM (e.g., interest, motivation, levels of achievement) (SI1). Adapted from Kind et al. (2007) and Glynn et al. (2011) for the purposes of this study.
  b. Items **16 - 18** and **19 - 21** evaluate students' problem-solving confidence and interdisciplinary thinking, respectively (SI2). Adapted from Baldwin et al. (1999) and Jackson (2018), based on the STEAM4U project's toolkit (http://steam4u.eu/homepage/the-steam4u-toolkit/).
  c. Items **22 - 31** measure students' understanding of civic responsibility and Responsible Research and Innovation (RRI) principles (SI3). Adapted from The Civic Responsibility Survey (Furco et al., 1998).
  d. Items **32 – 36** evaluate students' ability to handle experimental techniques for conducting a scientific investigation (SI4). Adapted from Baldwin et al. (1999), based on the STEAM4U project's toolkit (http://steam4u.eu/homepage/the-steam4u-toolkit/).

The SQ stands as the primary data source for discerning the impact of the SEISMO-Lab project on students, effectively addressing the majority of the pertinent evaluation indicators (SI1-SI4). To ensure a comprehensive assessment, the questionnaire was administered to students both before (as a pre-test) and immediately after the implementations (as a post-test). During each administration, students generated a personal code based on their private information to ensure anonymity while facilitating the matching of their pre- and post-responses. Each student completed the questionnaire individually, and the process took approximately 20 minutes per student. Based on their responses, students were assigned pre- and post-scores for each of the four clusters associated with the relevant evaluation indicators (see Table 1.6). Finally, these scores were analyzed through paired samples t-test analysis using IBM SPSS Statistics software. This statistical analysis allows for a rigorous examination of the effectiveness of the educational seismology activities by comparing pre- and post-implementation scores and identifying any significant changes.

Additionally, the Teacher's Reports (TRs) served as a complementary data source for assessing the project's impact on students. Through the TRs, teachers documented the types of activities in which students participated and the collaborations they engaged in during the project, providing valuable insights into their problem-solving competences, experimental, and interdisciplinary thinking skills (SI2, SI4). Moreover, the TRs emerged as the primary data source for collecting evidence for indicator SI5. This was accomplished through teachers' reflections on the specific tasks students completed during the project's implementations. Based on these tasks, three proficiency levels were developed (see Table 1.7) to evaluate students' abilities or enhancements in coding, recording, and analyzing data using the provided hardware sensors and software tools (SI5).

This approach allowed for a thorough understanding of the changes and outcomes resulting from the project, offering valuable insights into students' perspectives and experiences.

Table 1.6: Student Level Evaluation: Areas, Indicators, and Instruments

<table>
<tr><th>Evaluation areas</th><th>Indicators</th><th colspan="2">Evaluation Instruments</th></tr>
<tr><td>Creation, change and enhancement of a positive attitude towards STEM.</td><td rowspan="2">SI1</td><td colspan="2" rowspan="2">Students' questionnaire (items 1-15)</td></tr>
<tr><td>Increase in interest, fascination, motivation, and levels of achievement in STEM.</td></tr>
<tr><td>Enhancement of problem-solving competence and interdisciplinary thinking.</td><td>SI2</td><td>Students' questionnaire (items 16-21)</td><td>Teacher's Report (Section B & E)</td></tr>
<tr><td>Creation, change and enhancement of critical thinking, understanding of civic responsibility and Responsible Research Innovation (RRI) principles.</td><td rowspan="2">SI3</td><td colspan="2" rowspan="2">Students' questionnaire (Items 22-31)</td></tr>
<tr><td>Enhancement of understanding of how science is interlinked with cultural, environmental, economic, and other contexts, especially in earthquakes and seismic risk.</td></tr>
<tr><td>Ability to handle experimental techniques to conduct a scientific investigation/inquiry.</td><td>SI4</td><td>Students' questionnaire (items 32-36)</td><td>Teacher's Report (Section B)</td></tr>
<tr><td>Ability or enhancement to code, record, and analyze data with the offered hardware sensors and software tools.</td><td>SI5</td><td colspan="2">Teacher's report (Section D)</td></tr>
</table>

Table 1.7: SI5 proficiency levels

Proficiency Level	Students' code, record, and data analysis abilities
Low	1. Identification of a seismic event in real-time seismic data. 2. Identification of the date and time of an earthquake. 3. Identification of The Primary, Secondary, and surface seismic waves
Moderate	1. Identification of a seismic event in real-time seismic data. 2. Identification of the date and time of an earthquake. 3. Identification of The Primary, Secondary, and surface seismic waves 4. Calculation of time distance between P, and S waves. 5. Calculation of the distance between an earthquake and a seismograph. 7. Measurement of wave's amplitude.
High	1. Identification of a seismic event in real-time seismic data. 2. Identification of the date and time of an earthquake. 3. Identification of The Primary, Secondary, and surface seismic waves 4. Calculation of time distance between P, and S waves. 5. Calculation of the distance between an earthquake and a seismograph. 6. Localization of earthquake's epicenter by using data from 3 seismograms. 7. Measurement of wave's amplitude. 8. Estimation of earthquake's magnitude. 9. Estimation of earthquake's depth

1.3 Protocol of Conduct

The protocol of conduct was developed to ensure the successful implementation of the project's evaluation methodology. This protocol outlines the steps that all partners should follow to apply the methodology and inform schools, teachers, and students about the evaluation process.

Step 1: Familiarization with the Evaluation Methodology and Translation of Instruments

Initially, each partner should review the evaluation methodology and indicators at each level (school, teacher, and student) and study the corresponding evaluation instruments. Partners are encouraged to seek clarifications or suggest improvements as needed. Upon finalization of all evaluation instruments, partners should translate each one into their country's native language before sharing them with any project participants.

Step 2: Presentation of Evaluation Instruments and Completion of Teachers' Questionnaire

During national training, multiplier events, or individual meetings with school administration staff and teachers interested in participating, partners must introduce the project's objectives and evaluation methodology. Teachers and school administration staff should be briefed on the evaluation processes and the instruments to be used with students. All participants must understand that involvement in the project is voluntary and anonymous, with data used solely for project evaluation and policy development. Following the multiplier and training events, teachers must complete the Teachers' Questionnaire, either online or as a paper-and-pencil survey, primarily to assess the effectiveness of the training provided.

Step 3. Acquiring Permission for Student Questionnaire Administration & Pre-Test Questionnaire Administration

Before administering the initial questionnaire (Student Questionnaire) to students, partners must secure permission from parents/guardians following their country's ethics policies. The decision regarding the questionnaire administration, including its format (digital or paper-and-pencil), will be collaboratively made with the school and teachers. Each student must individually complete the questionnaire, which typically takes approximately 20 minutes to finish.

Step 4. Data Collection and Monitoring of Teachers' Implementations During Implementations:

Throughout the implementation phase, partners are tasked with maintaining regular communication with school administration staff and teachers to offer support and monitor progress. Partners will gather information about school implementations by completing an online Excel sheet. It's crucial to note that if a teacher fails to complete the Teacher's Report, the coordinator from the participating country should take responsibility for completing it on behalf of the respective school. The information collected will encompass the activities carried out, students' involvement, and details regarding collaboration within the school and/or with local stakeholders.

Step 5. Administration of Students' Questionnaire (as Post-test) & Collection of Evaluation Data from Each School

Following the conclusion of the implementations, students will once again complete the Students' Questionnaire, teachers will compile the Teachers' Report, and school administration staff will submit the Schools' Report. Each partner will be tasked with collecting all data from schools in their country, translating them into English, and providing them in Excel files or reports (depending on the type of data gathered) for further analysis, at least three months before the SEISMO-Lab project completion.

After collecting data from all participating countries, UCY will begin analyzing and synthesizing the results of the three-level evaluation to determine the project's impact. Quantitative data, from tools such as the Students' and Teachers' Questionnaires, will be analyzed using SPSS and Excel, while qualitative data, from sources like schools' and teachers' reports, will be analyzed using the open coding method.

The conclusions of the project evaluation will inform a policy report containing specific recommendations for the future utilization of School Labs for Competence Development. This report will provide valuable insights to facilitate partners' communication with educational authorities and other stakeholders in their countries regarding the potential application of the project's outcomes in different or broader contexts and countries.

2. Analysis of Results

2.1 Quantitative indicators evaluation

Throughout the project's duration, the participating schools, teachers, and students not only met but exceeded the targeted numbers. The initial goal was to involve 100 schools, 200 teachers, and approximately 4000 students (Table 1.2). However, the project remarkably engaged a total of 167 schools/institutes, 1368 teachers, and about 6680 students. Schools or institutes were considered involved if they either implemented educational seismology activities or installed a seismograph on their premises. The count of involved teachers includes those who participated in training and multiplier events or developed and implemented related educational seismology activities in their classrooms. The number of involved students is calculated as the number of involved schools multiplied by 40. Table 2.1 illustrates the numbers of participating schools, teachers, and students per country.

Table 2.1: Numbers of schools, teachers and students involved in the project per country.

Country	Schools	Teachers	Students
Cyprus	44	58	1760
Greece	46	688	1840
Italy	13	50	520
Romania	37	164	1480
Turkey	20	403	800
Other	7	5	280
Total	**167**	**1368**	**6680**

As depicted in the preceding table, a considerable number of 1368 teachers actively participated in the project’s activities, exceeding the initially set goal. A crucial factor contributing to the project’s outreach success was the impact of the devastating earthquake that occurred in Turkey on 06/02/2023, leading to increased interest among teachers from neighboring countries in the topics of seismology, earthquakes, and civil protection. This heightened interest led to a substantial demand from teachers for training events related to educational seismology. Consequently, the project hosted more than 19 face-to-face and online training and multiplier events. The number of training/ multiplier events and trained teachers per country is detailed in Table 2.2.

*Table 2.2**:** List of training and multiplier events and number of involved teachers.*

Country	**Number of training/ multiplier events**	**Teachers trained**	**Nature**
Cyprus	1	57	Face to face
Greece	4	688	Face to face & virtual
Italy	4	50	Virtual
Romania	6	120	Face to face
Turkey	2	403	Face to face & virtual
Summer schools	2	50	Face to face & virtual

2.1.1 School-Level Quantitative Indicators Analysis

The following tables provide crucial information regarding the project's network in each country, including the name of the institution/school, educational level, location, and, if applicable, the installed seismograph code.

Table 2.3: List of involved institutions/ schools in Cyprus

N	Name	Level	Area	Seismograph
1	1st Primary School of Dromolaxia	Primary	Rural	n/a
2	1st Primary School of Ypsonas	Primary	Urban	n/a
3	1st Technical School of Nicosia	Secondary	Urban	n/a
4	23rd Primary School	Primary	Urban	n/a
5	4th Primary School of Paralimni	Primary	Urban	n/a
6	5th Primary School of Aglantzia	Primary	Urban	n/a
7	High School of Agia Fylaxeos	Secondary	Urban	n/a
8	High School of Archangel "Apostolos Marcos"	Secondary	Urban	n/a
9	High School of Archbishop Makarios III	Secondary	Urban	n/a
10	High School of Idalion	Secondary	Urban	n/a
11	High School of Kykkos A'	Secondary	Urban	n/a
12	Laniteio High School	Secondary	Urban	n/a
13	Middle School - High School of Eirini and Eleftheria	Secondary	Rural	n/a
14	Middle School of Agia Paraskevi	Secondary	Urban	n/a
15	Middle School of Agios Stylianos	Secondary	Urban	n/a
16	Middle School of Apostolos Pavlos	Secondary	Urban	n/a
17	Middle School of Archangelos in Lakatamia	Secondary	Urban	n/a
18	Middle School of Dianellou & Theodotou	Secondary	Urban	n/a
19	Middle School of Egkomi	Secondary	Urban	n/a
20	Middle School of Latsia	Secondary	Urban	n/a
21	Middle School of Makedonitissa	Secondary	Urban	n/a
22	Middle School of Paliouriotissa	Secondary	Urban	n/a
23	Middle School of Petraki Kyprianou	Secondary	Urban	n/a
24	Middle School of Polemidia	Secondary	Urban	n/a
25	Pancyprian Middle School of Nicosia	Secondary	Urban	n/a
26	Pascal Greek and English School Nicosia	Secondary	Urban	RF201
27	Primary School of Agia Varvara	Primary	Rural	n/a
28	Primary School of Agios Andreas (K. A.)	Primary	Urban	n/a
29	Primary School of Agios Ioannis	Primary	Urban	n/a
30	Primary School of Anglisides	Primary	Rural	n/a
31	Primary School of Kamaras	Primary	Rural	n/a
32	Primary School of Kambos Tsakistras	Primary	Rural	RCAE3
33	Primary School of Kampia - Ethnomartyra Kyprianou	Primary	Rural	n/a
34	Primary School of Livadia	Primary	Rural	n/a
35	Primary School of Lymbia	Primary	Rural	n/a
36	Primary School of Lythrodontas	Primary	Rural	n/a
37	Primary School of Mathiatis	Primary	Rural	n/a
38	Regional High School of Livadia	Secondary	Rural	n/a
39	Regional High School of M. Koutsofta - A. Panagidi Paleometochou	Secondary	Rural	n/a
40	Regional Middle School of Kiti	Secondary	Rural	n/a
41	Regional Middle School of Livadia	Secondary	Rural	n/a
42	The American Academy Larnaca	Secondary	Urban	RE0D3
43	The G C School of Careers	Secondary	Urban	RCBE2
44	University of Cyprus	Tertiary	Urban	R9D86

Table 2.4: List of involved institutions/ schools in Greece

N	Name	Level	Area	Seismograph
1	General High School of Avlonari	Secondary	Rural	-
2	Kotronis Schools	Primary & Secondary	Rural	-
3	3rd Primary School of Ioannina	Primary	Urban	R1388
4	Music School of Chania	Primary	Urban	R1822
5	Fioliths, Zakynthos	Primary	Rural	R1C6C
6	Neapoli High School - Laconia	Secondary	Rural	R4C5A
7	Institute of Geodynamics	Not Applicable	Urban	R4EB6
8	1st Middle School of Vrilissia	Secondary	Urban	R4F38
9	4th Middle School of Lamia	Secondary	Urban	R58B0
10	1st General High School of Kos "Hippocratic"	Secondary	Rural	R62B3
11	Kindergarten of Klimatia, Ioannina	Pre-school	Rural	R729D
12	Middle School of Folegandros	Secondary	Rural	R7C7B
13	Middle School of Moudros "Argyrios Moschidis," Lemnos	Secondary	Rural	R9AC0
14	1st Middle School of Corfu	Secondary	Urban	RA4CA
15	7th Middle School of Trikala	Secondary	Urban	RAC91
16	9th Primary School of Rethymno	Primary	Rural	RC057
17	4th Middle School of Lagkada	Secondary	Rural	RC574
18	Middle School of Diapolitismikhs Ekpaideushs Sapwn	Secondary	Rural	RE950
19	Panou Educational Center, Nafpaktos	Primary & Secondary	Rural	RF25A
20	General High School of Methoni	Secondary	Rural	RFA3D
21	Thirasia Middle/High School	Secondary	Rural	RG596
22	Thira Middle School	Secondary	Rural	RG730
23	Hellenic-French School Jeanne d'Arc, Piraeus	Primary & Secondary	Urban	RG7FF
24	Samothraki High School, Samothraki	Secondary	Rural	RGF1A
25	2nd Middle School Almyros, Magnhsia	Secondary	Urban	SALMR
26	High School of Argostoli	Secondary	Rural	SARG
27	Middle School of Agnanta, Arta	Secondary	Rural	SART
28	Middle School of Avlonari, Evia	Secondary	Rural	SAVL
29	Middle Scool Eretria, Evia, Greece	Secondary	Urban	SERTR
30	3rd Middle School of Glyfada	Secondary	Urban	SGLFD
31	3rd Middle School of Igoumenitsa	Secondary	Rural	SIGU
32	Ergasthriako Kentro Karditsas	Secondary	Rural	SKAR
33	Bouga Educational Center	Primary & Secondary	Urban	SKLMT
34	1st Middle School Agios Nikolaos, Lasithi	Secondary	Urban	SLSTH
35	Middle School of Logga Messinia	Secondary	Rural	SMES
36	National Observatory of Athens	Not Applicable	Urban	SNOA
37	1nd Middle School, Palamas, Karditsa	Secondary	Urban	SPLM
38	Evangelical School of Nea Smyrni	Secondary	Urban	SNSM
39	2nd Middle School of Sparti	Secondary	Urban	SPRT
40	Ellhnogermanikh Agwgh	Primary & Secondary	Urban	SSEA
41	Natural History Museum	Not Applicable	Rural	SSIGR

42	Primary School of Emporeio	Primary	Rural	SSNT
43	Thessaloniki Special High School	Secondary	Urban	STHS
44	Experimental Middle School, University of Patras	Secondary	Urban	SPGPP
45	2nd High School Serres	Secondary	Urban	SSRS
46	University of Thessaly	Tertiary	Urban	SVOL

Table 2.5: List of involved institutions/ schools in Romania

N	Name	Level	Area	Seismograph
1	Școală Gimnaziala Hartop	Secondary	Rural	R8EEB
2	Liceul "Simion Mehedinți", Vidra, Vrancea	Secondary	Rural	RAC63
3	Colegiul National "Stefan cel Mare", Suceava	Secondary	Urban	RB153
4	Colegiul Tehnic de Căi Ferate Unirea, Pașcani	Secondary	Urban	RACAF
5	Colegiul Național Pedagogic Regina Maria" Ploiesti	Secondary	Urban	RCC9B
6	Colegiul de Arte "Sabin Drăgoi", Arad	Secondary	Urban	R7AA4
7	Colegiul National "Calistrat Hogas", Tecuci	Secondary	Urban	RA11D
8	Colegiul National "Gheorghe Sincai", București	Secondary	Urban	RCBB8
9	Colegiul National de informatica "Grigore Moisil" Brasov	Secondary	Urban	R71B0
10	Liceul Teoretic Horia Hulubei	Secondary	Urban	n/a
11	Școala Gimnazială Comuna Colți	Primary	Rural	R6DC2
12	Gimnaziala Scortoasa	Secondary	Rural	n/a
13	Colegiul Național "Mihai Eminescu", Oradea	Secondary	Urban	R3CE7
14	Școala Gimnazială Liebling	Secondary	Urban	R93A1
15	Liceul Teoretic "Tudor Vianu", Giurgiu	Secondary	Urban	n/a
16	Colegiul Național "Unirea", Târgu Mureș	Secondary	Urban	RAD18
17	Colegiul Național de Informatică, Piatra-Neamț	Secondary	Urban	R02CF
18	Liceu teoretic "Carmen Sylva", Eforie Sud	Secondary	Urban	REC3A
19	Colegiul National "Gheorghe Lazăr", Sibiu	Secondary	Urban	R1A15
20	Colegiul Național "Johannes Honterus", Braşov	Secondary	Urban	n/a
21	Colegiul National "Emanuil Gojdu", Oradea	Secondary	Urban	S7258
22	Școala Gimnazială Sîntămăria-Orlea	Secondary	Rural	R7DE0
23	Liceul Teoretic "Nicolae Iorga", Nehoiu	Secondary	Rural	n/a
24	Liceul tehnologic Anghel Saligny, Bacău	Secondary	Urban	R71BF
25	Centrul Județean de excelență, Prahova	Secondary	Urban	n/a
26	Colegiul Național de Artă "Octav Băncilă", Iași	Secondary	Urban	n/a
27	Lycée Français Anna de Noailles, Bucharest	Secondary	Urban	R1784
28	Nicolae Balcescu Highschool, Oltenita	Secondary	Urban	R32F0
29	Seismo Labotory, NIEP	n/a	Urban	R3BC5
30	Petrila	n/a	Urban	R401A
31	Ilfov - Mark Twain	Secondary	Urban	R44CB
32	Moroeni	n/a	Urban	R717A
33	Deva	n/a	Urban	R71B3
34	Vrancioaia	n/a	Rural	R71D4
35	Valcea - Liceul de Arte, Victor Giuleanu	Secondary	Urban	RA12A
36	Curcani	Secondary	Rural	RB0E4
37	Hateg	Secondary	Rural	RDD69

Table 2.6: List of involved institutions/ schools in Italy

N	Name	Level	Area	Seismograph
1	Deledda International School di Genova	Secondary	Urban	RI043
2	Liceo Don Bosco di Brescia	Secondary	Urban	RIECA
3	Liceo Scientifico Statale Leon Battista Alberti	Secondary	Urban	RI22D
4	Istituto Comprensivo Comuni della Sculdascia di Merlara	Secondary	Urban	RIDA4
5	Liceo Scientifico Statale A. Labriola di Napoli	Secondary	Urban	RBBBF
6	Polo Liceale Salvatore Di Giacomo di San Sebastiano al Vesuvio	Secondary	Urban	R2F0C
7	Istituto superiore Quasimodo, Messina	Secondary	Urban	RFE90
8	Istituto Comprensivo Michelangelo-Augusto	Secondary	Urban	n/a
9	Istituto Comprensivo G. Pascoli	Secondary	Urban	n/a
10	Istituto Superiore A. Gentileschi	Secondary	Urban	n/a
11	Istituto Comprensivo Gigante-Neghelli	Secondary	Urban	n/a
12	Istituto Statale di Istruzione Secondaria Europa	Secondary	Urban	n/a
13	Istituto Comprensivo Pertini	Secondary	Urban	n/a

Table 2.7: List of involved institutions/ schools in Turkey

N	Name	Level	Area	Seismograph
1	Bahçeşehir College Bornova Middle School	Secondary	Urban	n/a
2	Bahçeşehir College Bursa Bademli Anatolian High School	Secondary	Urban	RT53F
3	Bahçeşehir College Bursa Bademli Middle School	Secondary	Urban	n/a
4	Bahçeşehir College Denizli Anatolian High School	Secondary	Urban	RT56F
5	Bahçeşehir College Denizli Middle School	Secondary	Urban	n/a
6	Bahçeşehir College Güzelbahçe Anatolian High School	Secondary	Urban	n/a
7	Bahçeşehir College Güzelbahçe Middle School	Secondary	Urban	n/a
8	Bahçeşehir College İzmir 50th Year Middle School	Secondary	Urban	n/a
9	Bahçeşehir College İzmir 50th Year Anatolian High School	Secondary	Urban	n/a
10	Bahçeşehir College İzmir 50th Year Science and Technology High School	Secondary	Urban	n/a
11	Bahçeşehir College Karşıyaka Middle School	Secondary	Urban	n/a
12	Bahçeşehir College North Campus Anatolian High School	Secondary	Urban	n/a
13	Bahçeşehir College North Campus Middle School	Secondary	Urban	n/a
14	Bahçeşehir College North Campus Science High School	Secondary	Urban	n/a
15	Bahçeşehir College Samsun Anatolian High School	Secondary	Urban	n/a
16	Bahçeşehir College Samsun Middle School	Secondary	Urban	n/a
17	Bahçeşehir College Samsun Science and Technology High School	Secondary	Urban	n/a
18	İzmir Özel Türk College Bornova Anatolian High School	Secondary	Urban	RTBBF
19	İzmir Özel Türk College Bornova Middle School	Secondary	Urban	RT4F7
20	İzmir Özel Türk College Bornova Science High School	Secondary	Urban	RT080

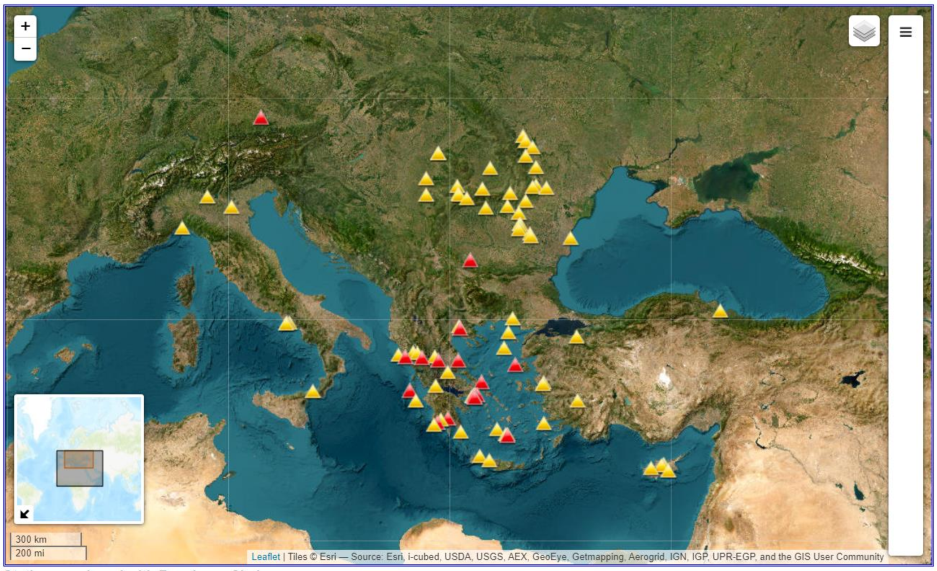
Table 2.8: List of involved institutions/ schools in other countries

N	Name	Level	Area	Seismograph
1	Emiliano De Antrante School, Azores	Secondary	Urban	SAZR
2	PPMG 'Akad Ivan Cenov', Vratsa, Bulgaria	Secondary	Urban	VRCA
3	Porto Santo	n/a	Urban	R0D9F
4	Funchal	n/a	Urban	R1A12
5	Escola Basica e Secundaria Goncalves Zarco	Secondary	Urban	R3DA0
6	Ehrenfried-Walther von Tschirnhaus Gymnasium Dresden, Germany	Secondary	Urban	SDRSD
7	Sigtunaskolan Humanistiska Laroverket, Sigtuna	Secondary	Urban	SSHL

The geographical distribution of participating institutions and schools in the project showcases a remarkable inclusivity, with 48 establishments located in remote or disadvantaged areas, surpassing the initial goal with approximately 1920 participants. These institutions/ schools often face exclusion from participation in projects and activities due to geographical, socioeconomic reasons, and various forms of disabilities. The inclusive nature of this project provided them with a unique opportunity. Not only did it enable their participation in educational seismology activities, fostering positive attitudes toward science, but it also granted access to valuable resources and data. This access can be utilized to inform and raise awareness among citizens about recent seismic events worldwide.

Among the 167 institutions/schools involved in the project, 98 have gone a step further by installing a seismograph on their premises. This collaborative effort has led to the establishment of the project's seismograph network, offering real-time data, and compiling a database from previous recordings across stations in Europe. This network, depicted in Figure 2.1, comprises 25 TC1 seismometers, represented by red triangles on the map, and 73 Raspberry Shake seismometers, denoted by yellow triangles. Remarkably, this network is open and accessible to everyone through the project's platform at https://seismolab.gein.noa.gr/project-network/, where users can download seismic data and analyze them with the use of the SWARM software. All the necessary information for the proposed hardware and software tools is available for all interested schools, accessible on the project's platform https://seismolab.gein.noa.gr/.

Figure 2.1: The SEISMO-Lab project seismograph network.

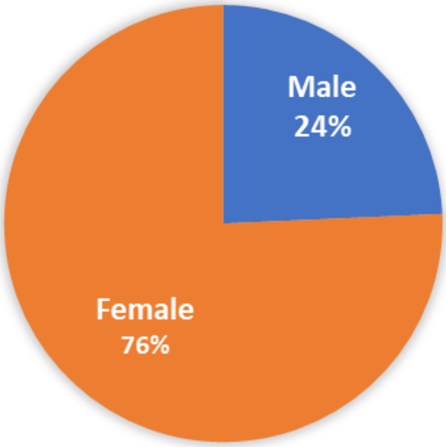


2.1.2 Teacher-Level Quantitative Indicators Analysis

Out of the total 1368 teachers involved in the project's activities, 466 actively participated in the evaluation process by providing feedback through the Teacher's Questionnaire (TQ) completed right after the training/multiplier events and/or the Teacher's Report (TR) completed immediately after the school implementations.

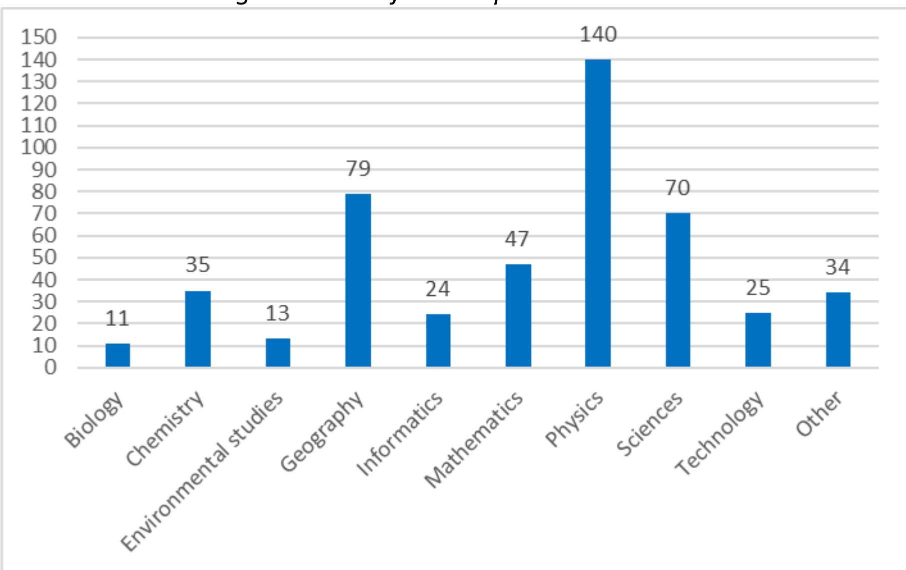
Based on the teachers' responses, approximately 1/4 of them were males (refer to Figure 2.2). This gender distribution pattern holds true for each country, with females constituting the majority of participating teachers in the project. This observation suggests that female teachers exhibit a higher level of interest and involvement in training events related to the topic of educational seismology and the implementation of associated educational activities.

Figure 2.2: Teachers' gender distribution.



When examining the subjects taught by these teachers, it becomes evident that the project involved a diverse range of subject disciplines (see Figure 2.3). The most common subjects were those connected with sciences (e.g., Physics, Geography, Sciences, Chemistry). However, the project seems to have also engaged teachers from different disciplines under the umbrella of STEAM (e.g., Mathematics, Informatics, Technology, Engineering, Music).

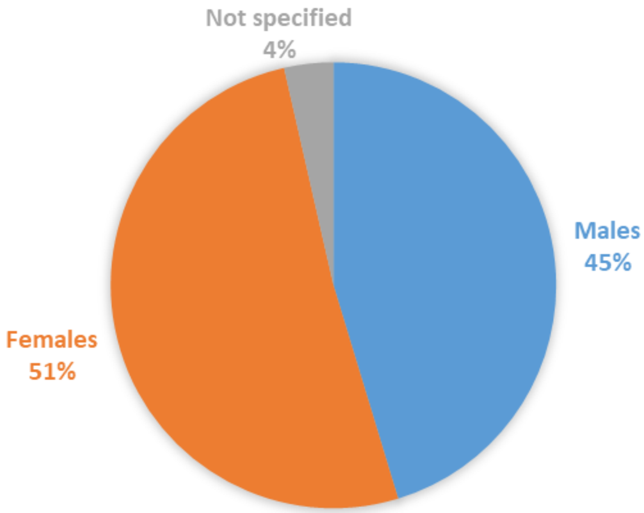
Figure 2.3: Subject discipline distribution



2.1.3 Students-Level Quantitative Indicators Analysis

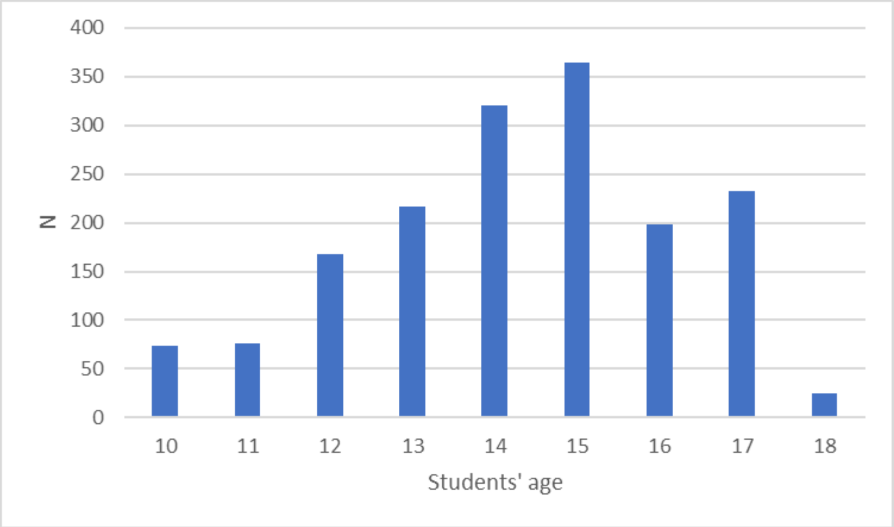
Out of the estimated 6680 students involved in the project's activities, 1678 actively engaged in the evaluation process by completing both the pre- and post-Student Questionnaires (SQ). Their responses reveal an equal gender distribution: 51% female, 45% male, and 5% unspecified (Figure 2.4).

Figure 2.4: Students' gender distribution.



When examining the students' age distribution (Figure 2.5), the data indicate a varied distribution across different age groups, with a substantial number of students from ages 13 to 15 participating in the project's activities.

Figure 2.5: Students' age distribution.



These findings suggest that the project has achieved significant outreach and inclusivity. The high level of participation in the evaluation process, coupled with the equal gender distribution among respondents and the wide age range of participants, reflects the project's success in engaging a diverse range of students. This inclusive approach ensures that both male and female students from various age groups have been effectively reached and involved in the project's activities. Overall, these findings highlight the project's success in fostering broad participation and diversity among its student participants.

2.2 Qualitative indicators evaluation

Qualitative indicators align with specific areas targeted for assessment at each of the three evaluation levels. Employing various instruments, as detailed in the preceding chapter, facilitated the evaluation of these indicators, providing a blend of qualitative and quantitative data. The ensuing analysis of this data offers valuable insights into the SEISMO-Lab project's impact across all levels of participation, encompassing schools, teachers, and students.

2.2.1 School-Level Qualitative Indicators Analysis

The primary instrument utilized for gathering data to evaluate indicators at the school level was the School’s Report (SR). Completed by a member of the school’s administrative staff immediately after concluding the activities’ implementation phase, the SRs yielded both quantitative data, featuring 5-point Likert scale questions addressing relevant indicators, and qualitative data obtained through open-ended questions accompanying each Likert scale inquiry. The correlation between the SR’s questions and the evaluation indicators is detailed in Table 1.4. Upon project completion, a member of the administrative staff from 47 participating schools finalized the SR.

Examining the extent to which the school administration encouraged or facilitated the participation of its teaching staff in training and teacher development programs (SCHI1), it is evident that most schools significantly encouraged and created opportunities for their teaching staff to participate in professional development courses (Figure 2.6, Figure 2.7, Figure 2.8) through various actions, including:

- **Financial Support and Information Sharing:**
  Many schools actively inform teachers about various training courses and opportunities. Some also allocated resources and provided financial support for their staff participation in these professional development activities, minimizing the financial burden on teachers. Additionally, the administrative staff played a supportive role by organizing similar seminars and providing mentoring and guidance to the teachers.
- **Schedule Flexibility:**
  Some schools adjusted their schedules to enable educators to participate in training sessions and activities.
- **Collaborations and Partnerships:**
  Some schools established collaborative partnerships with external entities, like universities and institutes, to enhance professional development opportunities.
- **Creating a Learning Community:**
  Schools focused on creating an environment encouraging teachers to share experiences and best practices, forming a learning community. In this context, schools encouraged and acknowledged teachers’ participation in professional development activities, fostering a culture of continuous improvement, accountability, and dedication among teachers.
- **Utilizing Online Education Platforms**:
  Some schools ensure that teachers receive periodic training from the institution's online education platforms. Furthermore, innovative approaches, such as the use of social networks to promote educational activities and achievements, were implemented.

Overall, the findings suggest that most schools were initiative-taking in creating and promoting opportunities for the professional development of their teaching staff, employing various strategies and support mechanisms.

Figure 2.6: Administrative staff responses to the SR's 1st question.

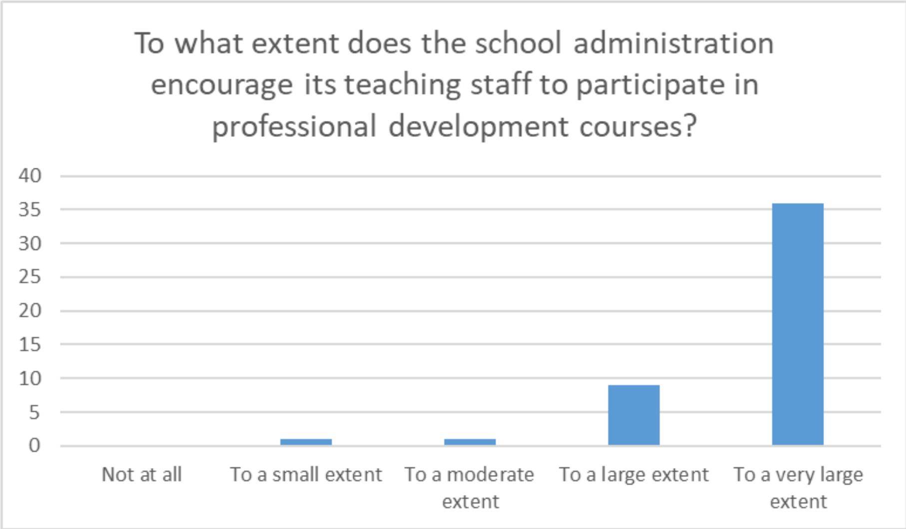


Figure 2.7: Administrative staff responses to the SR's 2nd question.

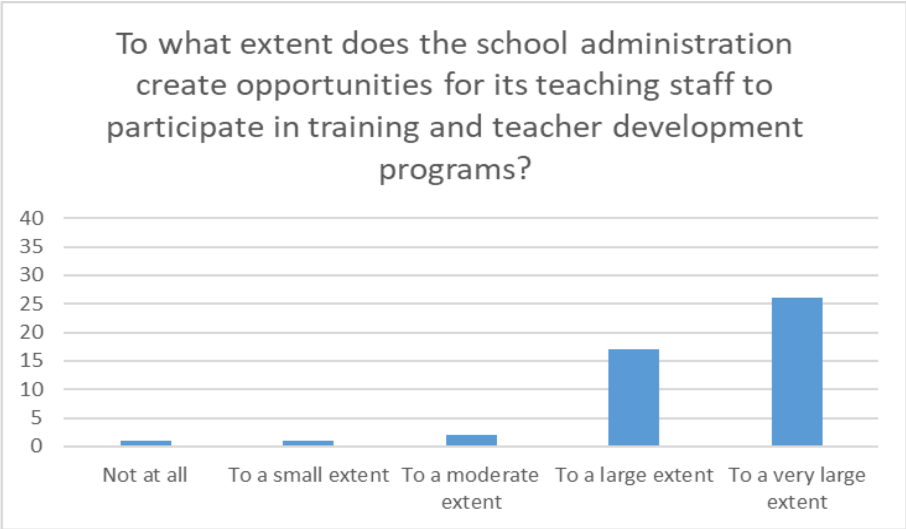
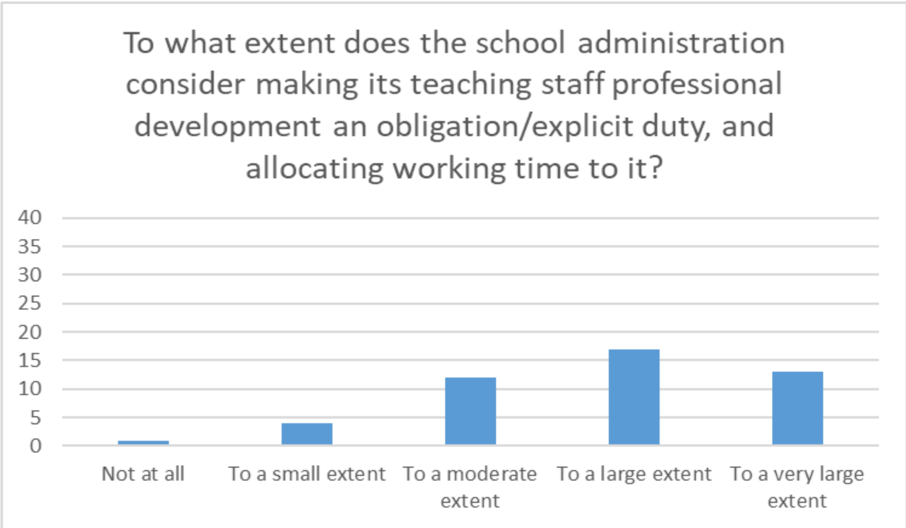


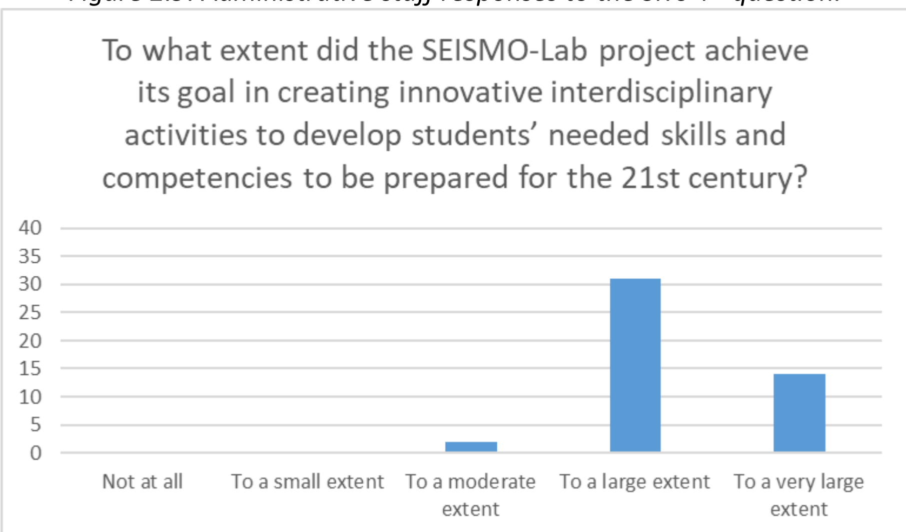
Figure 2.8: Administrative staff responses to the SR's 3rd question.



The examination of the extent to which the school authority encouraged or facilitated the development of interdisciplinary educational activities (SCHI2) reveals that the SEISMO-Lab project has significantly contributed to the creation of innovative interdisciplinary activities aimed at developing students' skills and competencies for the 21st-century (see Figure 2.9). The main ways in which this impact was achieved, as indicated by school administrative staff responses, are outlined below:

- **Engagement in Innovative Activities:**
  Participants, including students and educators, were allowed to engage in innovative activities, leverage novel technologies, and foster collaboration. The project facilitated students' familiarity with computers, technology, and the concept of seismic activity through the utilization of the seismograph network.
- **Real-World Application:**
  SEISMO-Lab demonstrated practical applicability and provided scientific information relevant to school subjects. Students directly studied natural phenomena, such as earthquakes, gaining insights into their impact on the environment.
- **Multidisciplinary Approach:**
  The project promoted a multidisciplinary approach, considered essential for comprehending complex and real-world problems. By integrating computers, programming, and applications, SEISMO-Lab laid the foundation for potential future scientific careers.
- **Collaboration and Resource Development:**
  SEISMO-Lab successfully merged subjects such as Geography, Sciences, Math, and Computer Science, offering students a hands-on experience with a relevant subject. This approach empowered teachers to develop their skills, becoming valuable resource persons who shared knowledge with students and colleagues, fostering a beneficial exchange of expertise.
- **Awareness and Civic Education:**
  The project significantly contributed to civic education by raising awareness of earthquakes and educating participants on protective measures against their effects. This aspect was recognized as pivotal in civic education, addressing behavior in emergency situations.

Figure 2.9: Administrative staff responses to the SR's 4th question.



These findings underscore a positive impact on both students and educators, cultivating a holistic educational experience characterized by real-world applications and the development of essential 21st-century skills.

In examining the extent to which schools encouraged collaboration among their teaching staff and with other schools in their area/region/country or other countries (SCHI3), the responses reveal that school administrations played a significant role in promoting collaboration, as depicted in Figure 2.10 and Figure 2.11. The open-ended questions unveiled various strategies employed by school authorities, including:

- **Promotion of Interdisciplinary Educational Activities:**
  Many schools actively promoted the creation and implementation of interdisciplinary activities to foster collaboration, with a particular emphasis on STEM approaches. This involved allocating dedicated time for interdisciplinary activities within the class schedule, engaging in STEM-related projects, and facilitating collaboration by modifying timetables, encouraging co-teaching, and initiating projects involving teachers from different disciplines.
- **Avoidance of Unproductive Competition:**
  Several schools explicitly mentioned their efforts to avoid situations that could breed unproductive competition among teachers. Instead, they focused on cultivating an environment that encourages collaboration and teamwork.
- **Creation of School Networks:**
  Schools established networks to facilitate the exchange of information, resources, and best practices. These networks were designed to encourage collaboration, sharing experiences, and addressing common problems. Common practices included educational visits between schools, participation in school exchanges, and the organization of inter-school competitions, scientific symposia, and activities bringing together students and teachers from different schools.
- **Participation in Programs and Initiatives:**
  Schools actively participated in various programs, conferences, and initiatives aimed at promoting collaboration. This encompassed engagement in learning communities, European programs, conferences, and cultural/environmental projects.
- **Extracurricular Projects and Clubs:**
  Many schools supported collaboration through extracurricular projects and clubs, such as the Robotics Club, Debating Club, and Science Club. These platforms provided teachers with opportunities to collaborate on innovative projects.
- **Educational Platforms:**
  The use of educational platforms is emphasized to facilitate collaboration, providing a digital space for sharing information and resources.

The findings regarding the last indicator (SCHI4) underscore the significant contribution of the project towards recognizing achievement and fostering increased participation of schools in additional projects and initiatives. This conclusion is supported by the data presented in *Figure 2.12*, which indicates a notable level of involvement from schools, teachers, and students in the project. Particularly noteworthy is the fact that most of these participating schools had not been involved in previous projects, highlighting the effectiveness of the SEISMO-Lab project in not only acknowledging achievements but also stimulating ongoing engagement in educational initiatives.

Figure 2.10: Administrative staff responses to the SR's 5th question.

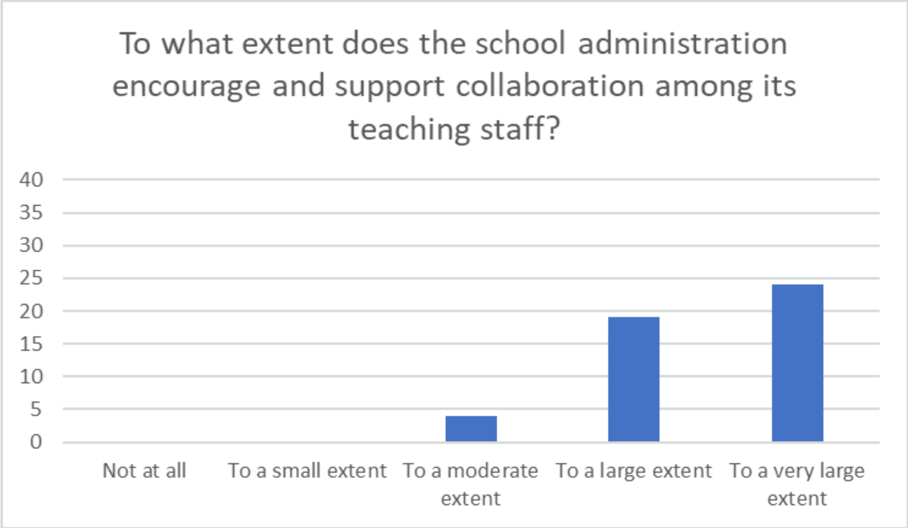


Figure 2.11: Administrative staff responses to the SR's 6th question.

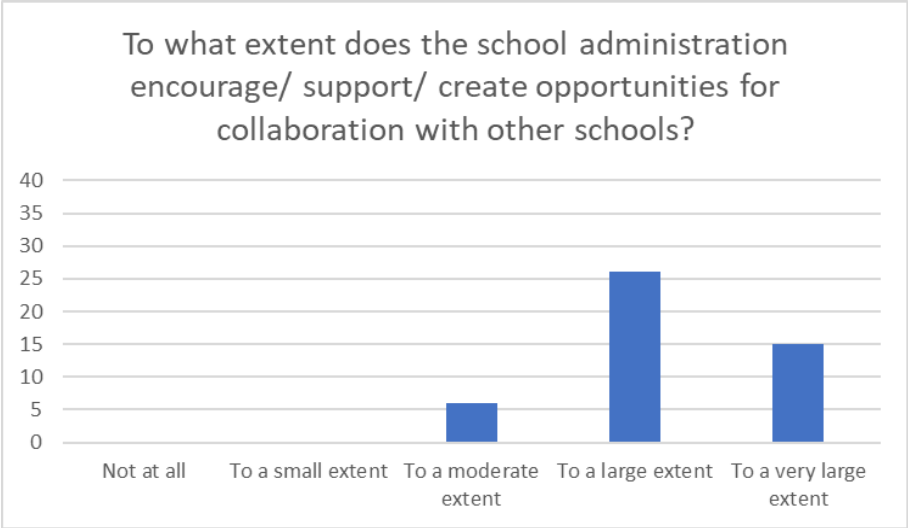
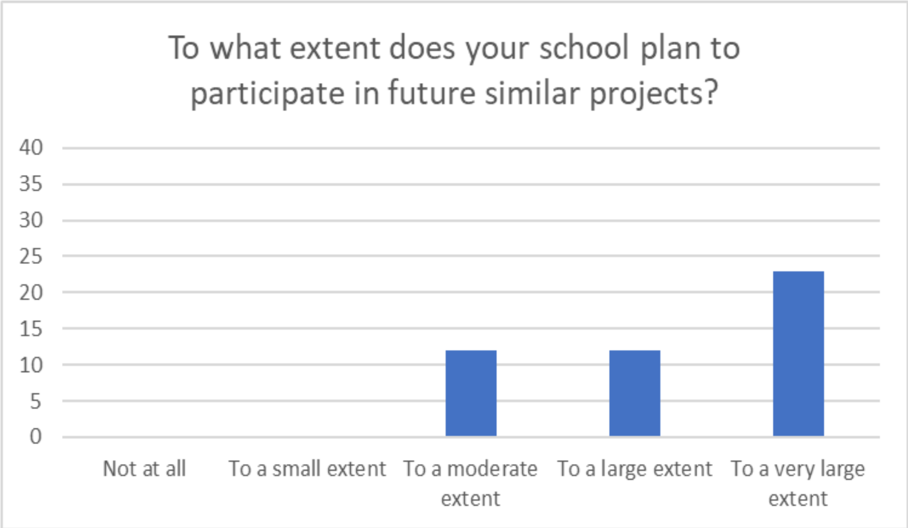


Figure 2.12: Administrative staff responses to the SR's 7th question.



2.2.2 Teacher-Level Qualitative Indicators Analysis

The evaluation at the teachers' level utilized two instruments, as outlined in the previous chapter. SEISMO-Lab training events' effectiveness (SCHI1) was assessed via the Teachers' Questionnaire (TQ). Out of the 1368 teachers who participated in various training events, 311 responded to a series of statements, each rated on a 5-point Likert scale. Insights derived from their responses shed light on the perceived effectiveness of these training events.

The TQ addressed crucial aspects, encompassing the utility of provided material and activities, the efficacy of the training event, and its potential impact on teachers' future activities, as well as their willingness to participate in the project and its related activities.

Based on their responses, the majority of participating teachers acknowledged the usefulness of the training presentations and activities for their teaching practice (*Figure 2.13*), reporting that they met or exceeded their expectations (*Figure 2.14*). This positive feedback suggests that the training content aligned well with the participants' anticipations. Additionally, a significant number of participants expressed confidence in the materials presented during the training (*Figure 2.15*), affirming that these materials would facilitate their school implementations. This suggests a positive correlation between the training content and its applicability in the school settings.

Figure 2.13: Teachers' responses to the TQ's 1st question.

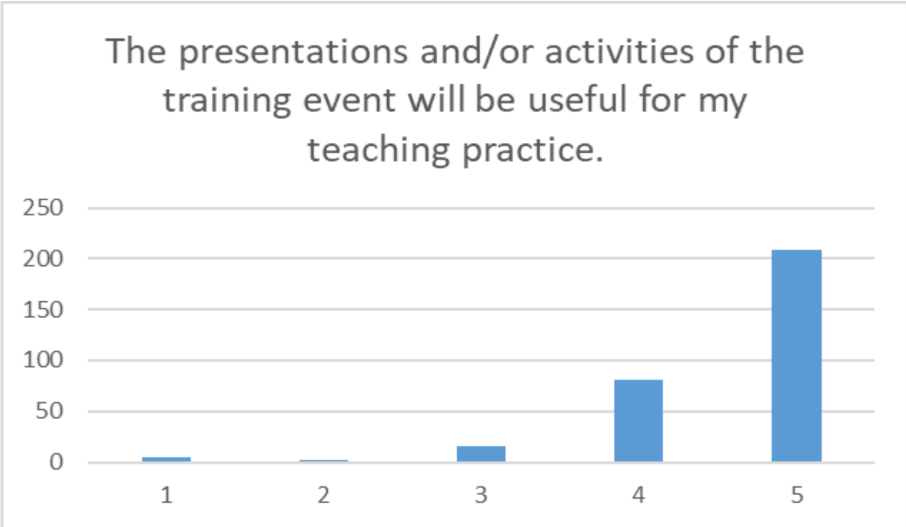
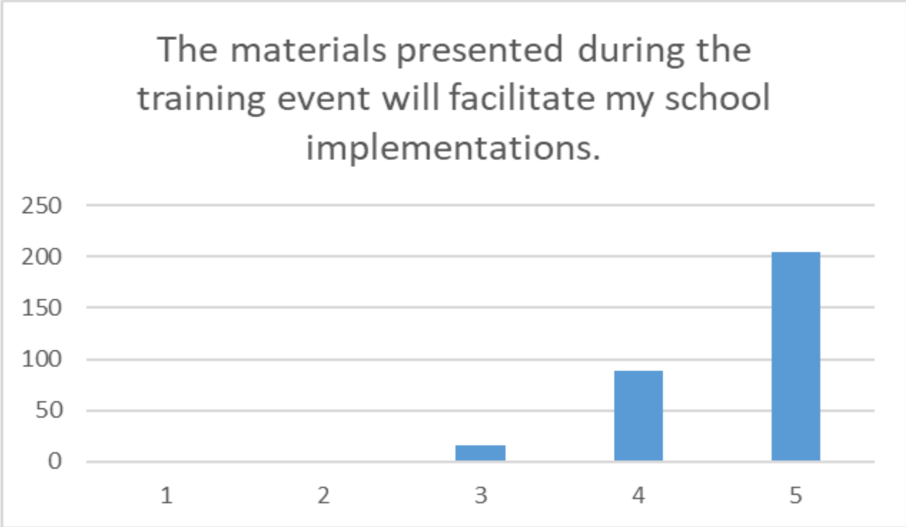


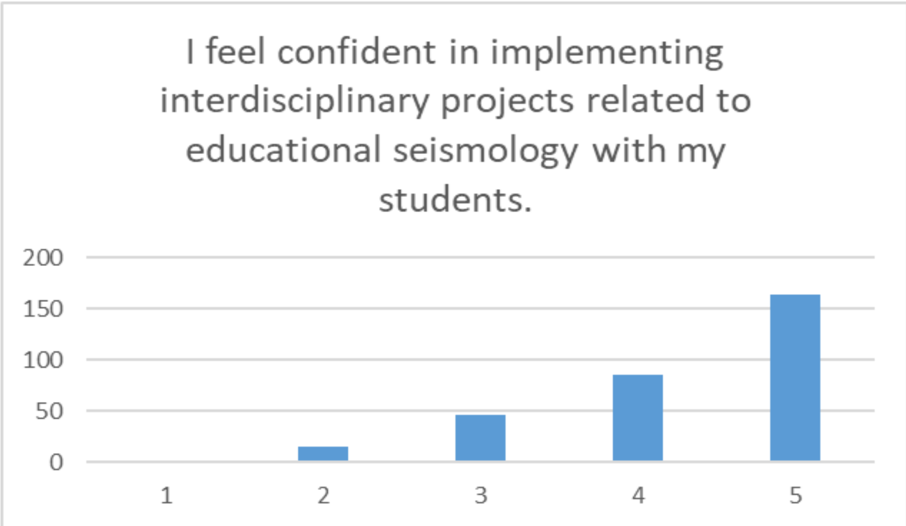
Figure 2.14: Teachers' responses to the TQ's 2nd question.

Figure 2.15: Teachers' responses to the TQ's 3rd question.



Furthermore, most teachers reported feeling confident in implementing interdisciplinary projects related to educational seismology with their students (Figure 2.16). This indicates a positive outcome, as it reflects teachers' perceived ability to integrate acquired knowledge into practical applications. Consequently, a high percentage of teachers expressed their intention to participate in the SEISMO-Lab project (Figure 2.17), showcasing enthusiasm for sustained involvement and commitment to project activities. This level of confidence and eagerness among teachers suggests a promising outlook for the project's ongoing success and impact on educational practices.

Figure 2.16: Teachers' responses to the TQ's 5th question.

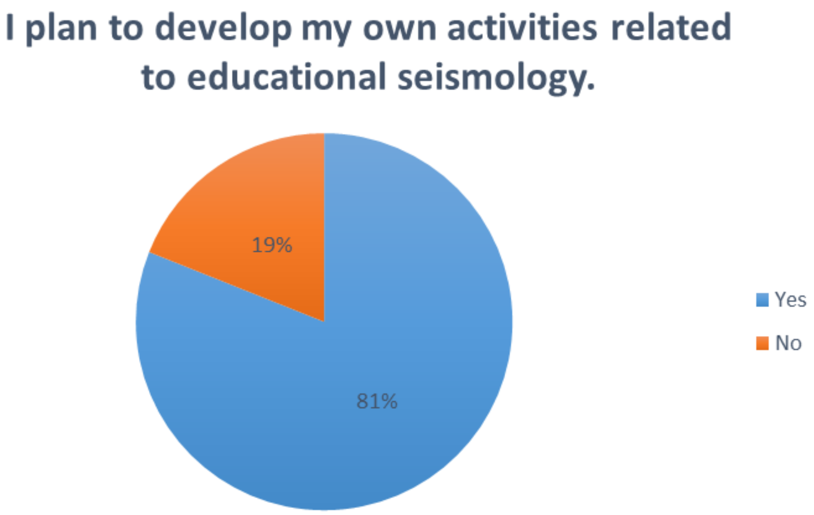


In conclusion, the responses gathered from the Teachers' Questionnaire indicate an overall positive perception of the training events' effectiveness. A significant majority of participants found the content valuable, meeting or even exceeding their expectations. Moreover, teachers expressed confidence in applying the knowledge gained from the training in their teaching practices and future collaborative endeavors. The high intention to participate further in the SEISMO-Lab project underscores a strong commitment to ongoing engagement with the initiative, highlighting its potential for long-term impact and success.

Figure 2.17: Teachers' responses to the TQ's 8th question.

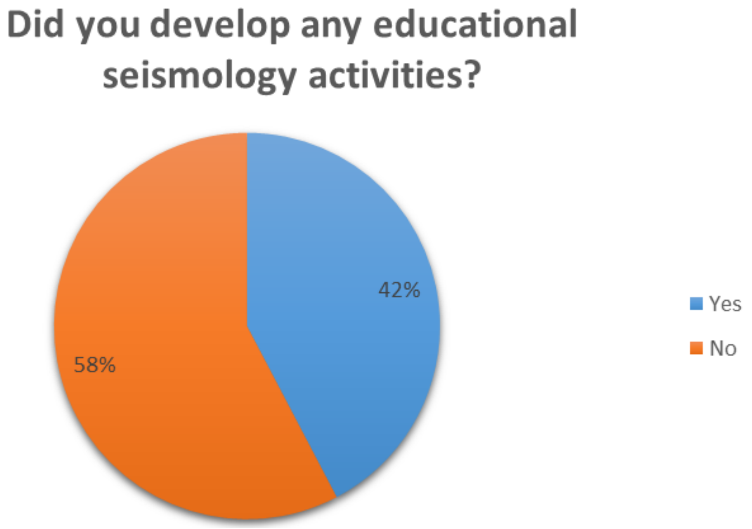
In assessing the development of interdisciplinary educational seismology activities (TI2) and the collaboration between teachers (TI3), data from both the TQ and the TR were utilized. According to teachers' responses in the TQ, approximately 80% expressed intentions to develop their own activities (Figure 2.18). However, analysis of the 52 TRs completed at the end of school implementations revealed that only 42% of teachers developed their own activities (Figure 2.19), with the remainder opting to utilize the project's proposed demonstrators. This discrepancy between intentions and actions suggests a need for future training events to place greater emphasis on facilitating and encouraging teachers to create their own activities, fostering a more proactive approach to curriculum development and implementation.

Figure 2.18: Teachers' responses to the TQ's 6th question.



Further investigation into why teachers chose not to develop their own activities revealed that many found the project's demonstrators highly effective and beneficial. Consequently, they plan to continue incorporating these resources into their future classroom activities, indicating a positive reception of the provided materials and the need for continued support in developing custom activities.

Figure 2.19: Teachers' report Section B responses.



It's encouraging to note that teachers express positive intentions regarding collaboration within the school to implement activities related to the project, as indicated by their responses to the Teachers' Questionnaire (TQ) related question (Figure 2.20). The positive correlation between the reported intentions in the questionnaire and the actual collaborations among teachers within the school, as reported in the TRs (Figure 2.21), suggests a strong alignment between teachers' expressed willingness to collaborate and their subsequent actions.

This positive indication not only reflects a shared engagement in the project but also highlights the commitment of teachers to actively collaborate and implement activities related to the project. The consistency between reported intentions and actual collaborations is a positive outcome, demonstrating that the collaborative spirit envisioned in the project is translating into tangible actions among the teaching community. This alignment underscores the importance of fostering a collaborative environment within schools to enhance the effectiveness and sustainability of project activities, ultimately enriching the educational experience for both teachers and students alike.

Figure 2.20: Teachers' responses to the TQ's 7th question.

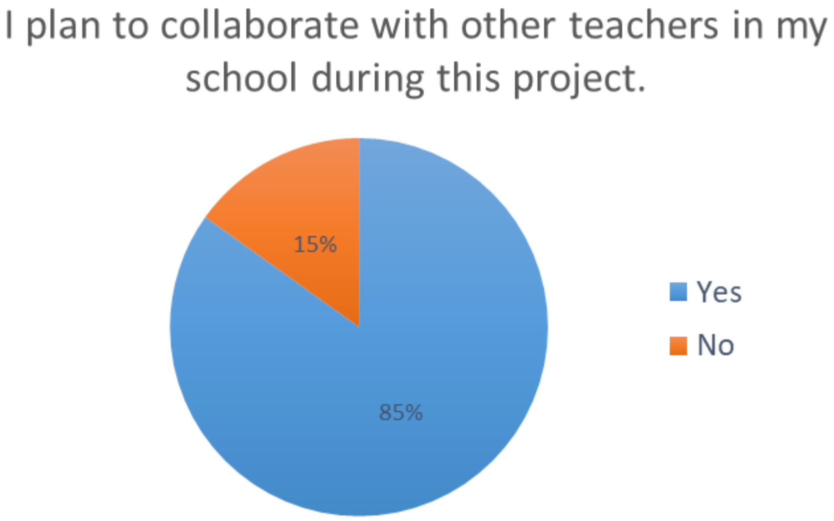
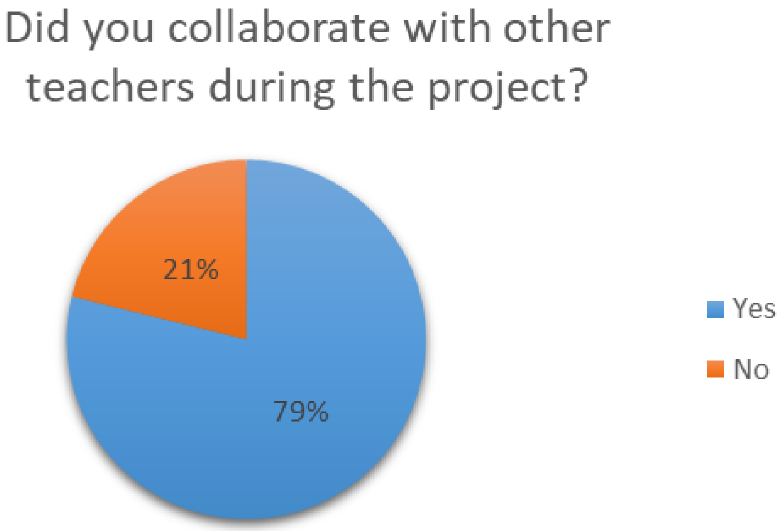


Figure 2.21: Teachers' report Section E responses.



Additionally, teachers' responses reveal a diverse array of collaborative activities, reflecting a high level of engagement and interaction both among teachers and with external entities. The variety of collaborative endeavors underscores the dynamic nature of the interactions within the educational community. Here is a summary of the types of collaborations reported by teachers:

Exchange of Ideas: Many teachers engaged in the exchange of ideas, showcasing a willingness to share insights and perspectives with their peers.

Co-development of Activities: A significant number of teachers collaborated in developing activities collectively. This indicates a collaborative effort in designing educational content.

Co-teaching: Some teachers reported engaging in co-teaching activities, demonstrating a shared approach to delivering educational content or activities.

Exchange of Educational Materials: Teachers exchanged educational materials, emphasizing the sharing of resources and materials to enhance teaching practices.

Providing Feedback: Teachers participated in providing feedback for activities developed, highlighting a collaborative approach in evaluating and refining educational initiatives.

Collaboration with External Stakeholders: Some teachers collaborated with external entities. These collaborations involved dissemination activities and visits, indicating efforts to share knowledge and experiences beyond the immediate educational context.

Project Initiatives: Collaborations extended to initiating projects, such as building seismometers within the school, demonstrating a proactive engagement in educational initiatives.

The diverse nature of these collaborations suggests a rich and multifaceted network of interactions among teachers. This collaborative spirit contributes not only to the success of the project but also to the professional development and mutual support within the teaching community. It reflects a dynamic and proactive educational environment that goes beyond traditional boundaries.

2.2.3 Student-Level Qualitative Indicators Analysis

To comprehensively evaluate the indicators at the student level, both the Student's Questionnaire (SQ) and the Teacher's Report (TR) were utilized, as outlined in the preceding chapter. Out of the estimated 6680 students who participated in the project's activities, 2368 pre-SQ and 1908 post-SQ were completed. Following the matching process, 1678 paired pre- and post-SQ responses were obtained. This matching process ensured the reliability of the data by facilitating the analysis of changes in individual students' responses before and after their engagement with the educational seismology activities.

Students' attitudes, including interest, motivation, and level of achievement, toward STEM disciplines (SI1) were assessed by comparing their pre- and post-scores derived from their responses to statements 1-15 in the SQ (Table 2.9). The paired samples analysis (Table 2.10, Table 2.11) reveals a statistically significant ($p < 0{,}001$) increase in students' attitudes toward STEM disciplines. This finding suggests that the educational seismology activities had a tangible impact on students' perceptions of STEM subjects. The observed increase is indicative of the effectiveness of the project's activities in fostering a more positive outlook among students regarding these disciplines.

Table 2.9: Students' SI1 Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean
SI1_pre	3,59	1678	0,78	0,19
SI1_post	3,73	1678	0,81	0,20

Table 2.10: Students' SI1 Paired Samples Correlations

	Correlation	Significance
SI1_pre SI1_post	0,443	<0,001

Table 2.11: Students' SI1 Paired Samples Test

	Mean	Std. Deviation	Std. Error Mean	t	df	Significance
SI1_pre SI1_post	-0,14	0,84	0,02	-6,90	1677	<0,001

Students' problem-solving competences and interdisciplinary thinking (SI2) were assessed by comparing their pre- and post-scores derived from their responses to statements 16-19 (

Table 2.12) and 19-21 (Table 2.15) in the SQ, respectively. Furthermore, insights into the evaluation of these aspects were gained from the related sections of the Teacher's Reports (TRs), providing valuable additional perspectives.

The paired samples analysis (Table 2.13, Table 2.14) reveals a statistically significant increase in students' problem-solving competences. Similarly, the paired samples t-test analysis of students' interdisciplinary thinking pre- and post-scores (Table 2.15, Table 2.16) indicates a statistically significant increase in their competences subsequent to participating in the educational seismology activities. This significant increase underscores the profound impact of the project on enhancing students' interdisciplinary thinking skills.

Table 2.12: Students' problem-solving competences Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean
SI2a_pre	3,73	1668	0,82	0,02
SI2a_post	3,90	1668	0,80	0,02

Table 2.13: Students' problem-solving competences Paired Samples Correlations

	Correlation	Significance
SI2a_pre SI2a_post	0,358	<0,001

Table 2.14: Students' problem-solving competences Paired Samples Test

	Mean	Std. Deviation	Std. Error Mean	t	df	Significance
SI2a_pre SI2a_post	-0,17	0,92	0,02	-7,73	1667	<0,001

Furthermore, according to the teachers' reports, most participating students actively engaged with the SEISMO-Lab demonstrator activities. These activities demanded a considerable level of problem-solving competence and the integration of concepts from multiple disciplines, thereby fostering interdisciplinary thinking among students. These findings indicate that the activities effectively enhanced students' problem-solving abilities, contributing to the development of their critical thinking skills. Moreover, the activities facilitated the cultivation of students' interdisciplinary thinking skills, empowering them to approach challenges from various angles and make connections across different subject areas.

Table 2.15: Students' interdisciplinary thinking competences Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean
SI2b_pre	3,62	1674	0,83	0,02
SI2b_post	3,82	1674	0,84	0,02

Table 2.16: Students' interdisciplinary thinking competences Paired Samples Correlations

	Correlation	Significance
SI2b_pre SI2b_post	0,358	<0,001

Table 2.17: Students' interdisciplinary thinking competences Paired Samples Test

	Mean	Std. Deviation	Std. Error Mean	t	df	Significance
SI2_pre SI2_post	-0,20	0,98	0,02	-8,44	1673	<0,001

Students' understanding of civic responsibility and Responsible Research Innovation (RRI) principles (SI3) was evaluated by comparing their pre- and post-scores derived from responses to statements 22-31 (refer to Table 2.18). The data reveals a modest increase in students' comprehension of civic responsibility and RRI principles (SI3) from pre- to post-assessment. Furthermore, the paired-samples t-test results (refer to Table 2.19, Table 2.20) indicate that the observed changes are statistically significant. This statistically significant increase provides robust evidence that the educational seismology activities had a tangible impact on students' understanding of civic responsibility and RRI principles. It underscores a positive trajectory in students' grasp of these concepts following their involvement in educational seismology activities. This signifies that the project has effectively contributed to fostering awareness and understanding of ethical and responsible research practices among students, thereby nurturing a culture of responsibility within the scientific community—an outcome of considerable value.

Table 2.18: Students' SI3 Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean
SI3_pre	3,79	1666	0,70	0,17
SI3_post	3,86	1666	0,73	0,18

Table 2.19: Students' SI3 Paired Samples Correlations

	Correlation	Significance
SI3_pre SI3_post	0,384	<0,001

Table 2.20: Students' SI3 Paired Samples Test

	Mean	Std. Deviation	Std. Error Mean	t	df	Significance
SI3_pre SI3_post	-0,08	0,79	0,19	-4,15	1665	<0,001

Students' ability to handle experimental techniques for conducting scientific investigations/inquiries (SI4) was evaluated by comparing their pre- and post-scores, as indicated in Table 2.21. The data shows that there was a notable increase in students' ability to handle experimental techniques following their engagement with educational seismology activities. This increase, although subtle, is statistically significant, as evidenced by the paired-samples t-test results (refer to Table 2.23). The statistically significant improvement underscores the effectiveness of the project in enhancing students' practical skills in conducting scientific investigations. This improvement indicates that the educational seismology activities provided students with valuable hands-on experience in applying scientific methods and experimental techniques, thereby strengthening their ability to conduct scientific inquiries. Moreover, it reflects the project's success in fostering a culture of inquiry and experimentation among students, which are essential aspects of scientific literacy and critical thinking. Thus, the project has made a meaningful contribution to equipping students with the necessary skills for engaging in scientific exploration and inquiry.

Table 2.21: Students' SI4 Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean
SI4_pre	3,70	1676	0,79	0,19
SI4_post	3,86	1676	0,79	0,19

Table 2.22: Students' SI4 Paired Samples Correlations

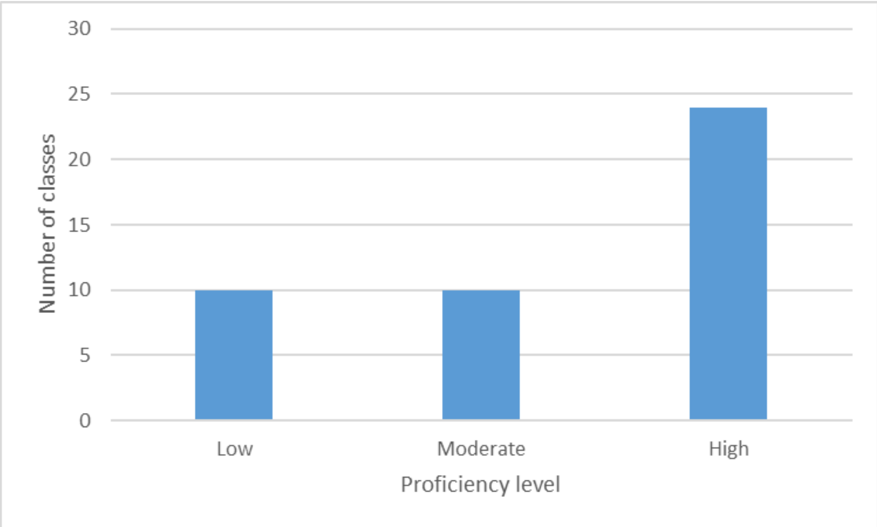
	Correlation	Significance
SI4_pre SI4_post	0,42	<0,001

Table 2.23: Students' SI4 Paired Samples Test

	Mean	Std. Deviation	Std. Error Mean	t	df	Significance
SI4_pre SI4_post	-0,15	0,86	0,02	-7,29	1675	<0,001

To evaluate students' ability in coding, recording, and analyzing data with the provided hardware sensors and software tools (SI5), the Teachers' Reports (TR) were used. In Teachers' Report Section D, the tasks completed by students were detailed, enabling the classification of each class into corresponding proficiency levels based on student actions. For instance, classes where students identified specific seismograph characteristics were categorized as "Low" proficiency. Those who used this information to calculate measurements like the time distance between P and S waves were classified as "Moderate" proficiency. Finally, students who took further steps, such as locating earthquake epicenters and estimating magnitudes, were assigned the "High" proficiency level. This classification system facilitated a nuanced understanding of students' capabilities, providing insight into their practical skills and the effectiveness of the educational activities in developing their scientific competencies.

Figure 2.22: Classes proficiency level in coding, recording, and analyzing data with the provided hardware sensors and software tools



Based on the data presented in Figure 2.22, the proficiency levels among classes seem to vary. Among the observed classes, 10 were categorized under the "Low" proficiency level, indicating that students primarily focused on identifying specific characteristics on a seismograph. Additionally, 10 classes demonstrated moderate proficiency, where students progressed beyond identification to calculate useful measurements such as the time distance between the P and S waves. Remarkably, the highest number of classes, totaling 24, exhibited high proficiency. In these classes, students not only identified characteristics of a seismograph but also applied this information to locate the earthquake's epicenter and estimate its magnitude.

These findings indicate varying levels of proficiency among students in utilizing hardware sensors and software tools provided for coding, recording, and analyzing data. Classes demonstrating high proficiency represent a substantial portion, suggesting effective engagement with the tools and tasks provided during the implementation phase.

The evaluation of students' performance across multiple indicators reveals the substantial impact of the educational seismology activities on their development and skills acquisition. Firstly, the analysis of students' attitudes toward STEM disciplines (SI1) demonstrates a statistically significant increase in their interest, motivation, and achievement levels following their engagement with the project. This positive shift underscores the effectiveness of the activities in fostering a more favorable perception of STEM subjects among students. Moreover, the assessment of students' problem-solving competencies and interdisciplinary thinking (SI2) reveals a notable improvement in their abilities, indicating the project's success in enhancing critical thinking skills and interdisciplinary approach among students.

Furthermore, the evaluation of students' understanding of civic responsibility and Responsible Research Innovation (RRI) principles (SI3) shows a modest yet statistically significant increase, signifying the project's impact on nurturing awareness of ethical research practices among students. Additionally, the analysis of students' practical skills in conducting scientific investigations (SI4) demonstrates a considerable enhancement, highlighting the project's effectiveness in providing hands-on experience and fostering a culture of scientific inquiry among students.

Finally, the assessment of students' ability to code, record, and analyze data with provided hardware sensors and software tools (SI5) indicates varying levels of proficiency among classes, with a significant portion exhibiting high proficiency. This finding reflects effective engagement with the project's tools and tasks, highlighting the project's success in equipping students with the necessary skills for scientific exploration and data analysis. Overall, these findings underscore the substantial positive impact of the educational seismology activities on students' learning outcomes and skill development, highlighting the project's success in promoting STEM education and fostering a culture of scientific inquiry among students.

3. Policy Report

The SEISMO-Lab project stands as a pioneering initiative aimed at revolutionizing education by integrating seismology into school curricula. This innovative endeavor, spanning across schools, teachers, and students, seeks to not only enhance scientific literacy but also foster critical thinking, collaboration, and interdisciplinary learning among participants.

SEISMO-Lab was conceived with a vision to leverage advancements in technology and scientific research to create engaging educational experiences centered around the fascinating field of seismology. By deploying a network of seismographs across participating schools, the project facilitated real-time data collection and analysis, allowing students to explore seismic events firsthand and engage in meaningful scientific inquiry.

At its core, SEISMO-Lab was designed to address key challenges in education, including a lack of hands-on learning opportunities, limited interdisciplinary integration, and insufficient teacher training. Through a multifaceted approach that included teacher development programs, interdisciplinary activities development, and student-centered approaches, the project aimed to inspire a new generation of scientifically literate individuals equipped with the skills and knowledge needed to thrive in the 21st century.

This chapter offers a concise and comprehensive overview of the project's framework and outcomes, serving as a guide for individuals interested in adopting the SEISMO-Lab approach, including educators, policymakers, and stakeholders.

More specifically the report aims to:

- **Highlight Successes and Best Practices** by showcasing the achievements and effective strategies employed by the SEISMO-Lab project in enhancing education. This includes identifying successful approaches in teacher development of interdisciplinary activities and fostering student engagement.
- **Identify Areas for Improvement** by identifying areas where the project can be further refined or expanded to maximize its impact. This involves addressing challenges encountered during implementation or identifying opportunities for growth and innovation.
- **Provide Recommendations for Future Initiatives** by offering actionable recommendations for educators, policymakers, and stakeholders interested in implementing similar projects or improving existing science education initiatives, based on the project's successes, challenges, and lessons learned.
- **Inform Decision-Making and Resource Allocation**, serving as a valuable resource for decision-makers involved in education policy and resource allocation. The insights provided in this report can inform strategic decisions regarding funding, program development, and curriculum design aimed at improving education outcomes.
- **Support Continuous Improvement**, by facilitating a culture of continuous improvement within the education community by sharing insights, best practices, and lessons learned from the SEISMO-Lab project. This will contribute to ongoing efforts to enhance the quality and effectiveness of education at all levels.

Overall, the recommendation report aims to not only celebrate the achievements of the SEISMO-Lab project but also to provide actionable recommendations and insights that can inform future initiatives and contribute to the advancement of education on a broader scale.

3.1 Consolidation of Main Achieved Results and Findings

The SEISMO-Lab project aimed to revolutionize science education by employing innovative approaches to address critical challenges. Its objectives encompassed supporting educational reforms to cultivate cross-curricular STEAM curricula with student-centered pedagogies, fostering inclusive scenarios to augment problem-solving skills and creativity, strengthening competencies in seismic risk mitigation, delivering effective pedagogical training programs for teachers, facilitating hands-on STEAM activities for students, and expanding the network of school seismometers across several European countries. Through these aims, SEISMO-Lab endeavored to inspire a new generation of scientifically literate individuals equipped with the skills and knowledge necessary to excel in the 21st century.

3.1.1 Evaluation Methodology Overview

To evaluate the project's impact and success, a comprehensive methodology was developed, integrating both qualitative and quantitative data collection techniques. The evaluation was structured across three levels: school-level, teacher-level, and student-level, each focusing on specific indicators aligned with the project's objectives.

At the school level, qualitative indicators were assessed using instruments such as the School's Report (SR), which gathers data from administrative staff regarding school participation and support for teacher development programs, interdisciplinary activities development, and collaboration encouragement. The SR includes both Likert scale questions and open-ended inquiries to capture both quantitative and qualitative aspects of school-level evaluation indicators.

For teacher-level evaluation, two instruments were utilized: the Teachers' Questionnaire (TQ) and the Teacher's Report (TR). The TQ collected data from participating teachers regarding the effectiveness of training events, confidence in implementing interdisciplinary projects, and intention to further engage with similar projects. The TR provided additional insights into teacher collaboration and the development of interdisciplinary activities.

At the student level, data were collected through the Student's Questionnaire (SQ) and the Teacher's Report (TR). The SQ assessed students' attitudes towards STEM disciplines, problem-solving competencies, interdisciplinary thinking, understanding of civic responsibility, and practical skills in scientific investigations. The TR complemented this effort by providing information on students' proficiency levels in coding, recording, and analyzing data with provided hardware sensors and software tools.

Overall, the evaluation methodology combined quantitative data from Likert scale responses with qualitative insights from open-ended inquiries and teacher reports to provide a comprehensive understanding of the project's impact across all levels of participation. By triangulating data from multiple sources, the evaluation methodology ensured robust and nuanced insights into the effectiveness of the SEISMO-Lab project in achieving its objectives and fostering positive outcomes for schools, teachers, and students.

3.1.2 Key Findings Overview

Following the evaluation methodology and utilizing the data gathered during the project's implementation phase, the evaluation process unveiled several pivotal findings regarding the impact of the SEISMO-Lab project at all three levels of participation.

School-Level Impact: Most schools actively embraced and facilitated the professional growth of their teaching staff, nurturing a culture of ongoing enhancement. Notably, the project played a significant role in fostering the creation of innovative interdisciplinary activities geared towards equipping students with 21st-century skills and competencies, emphasizing practical applications and collaborative endeavors. Additionally, school administrations emerged as key drivers in fostering collaboration among faculty members and fostering partnerships with other schools, both locally and internationally.

Teacher-Level Impact: A significant portion of participating teachers recognized the effectiveness of the training events, expressing confidence in their ability to implement interdisciplinary projects within the realm of educational seismology. Notably, there existed a positive correlation between teachers' expressed intentions to collaborate and their actual engagement in collaborative efforts within their respective schools. Moreover, teachers showcased diverse collaborative initiatives, indicative of a high level of engagement and interaction within the educational community.

Student-Level Impact: The evaluation uncovered a notable increase in students' attitudes toward STEM disciplines, problem-solving aptitude, interdisciplinary thinking, comprehension of civic responsibility, and grasp of Responsible Research Innovation (RRI) principles. Additionally, students demonstrated varying degrees of proficiency in coding, data recording, and analysis utilizing the provided hardware sensors and software tools, with a noteworthy proportion exhibiting advanced proficiency levels.

Overall, these findings underscore the project's triumph in advancing the professional development of educators, fostering interdisciplinary collaboration within educational institutions, and markedly enhancing students' 21^{st}-century skills.

3.2. Looking Backward: Reflecting on Project Strategy, Approach, and Experience

The evaluation of the SEISMO-Lab project provided an opportunity to reflect on the effectiveness of its strategy, approach, and overall experience. This section delves into an assessment of the strategies employed, lessons learned from implementation, challenges encountered, and strategies devised to overcome them.

3.2.1 Evaluation of Project Strategy and Approach

The SEISMO-Lab project was underpinned by a strategy that aimed to address critical challenges in science education through innovative approaches. The strategy involved a multifaceted approach that included teacher development programs, interdisciplinary activities development, and student-centered initiatives. One of the key strengths of the project strategy was its emphasis on collaboration and partnership, both within schools and across participating countries. By fostering collaboration among educators and leveraging resources across institutions, the project was able to create a more impactful learning environment.

Additionally, the approach taken by SEISMO-Lab in implementing its objectives was characterized by a combination of top-down guidance and bottom-up innovation. While the project provided a framework and resources for implementation, it also encouraged creativity and flexibility at the local level. This approach allowed for adaptation to the specific needs and contexts of participating schools, resulting in more effective outcomes.

3.2.2 Lessons Learned from Implementation

Throughout the implementation of the project, several valuable lessons were learned that can inform future initiatives in education. One key lesson was the importance of ongoing professional development for teachers. Providing teachers with training and support not only enhances their confidence and competence but also ensures the sustainability of educational innovations.

Another lesson learned was the significance of interdisciplinary collaboration in enriching the learning experience. By integrating various disciplines such as science, technology, engineering, arts, and mathematics (STEAM), the project was able to create more engaging and relevant educational activities. Additionally, the project highlighted the importance of leveraging technology to enhance learning outcomes. By utilizing tools such as seismometers and data analysis software, students were able to engage in authentic scientific inquiry and develop practical skills.

3.2.3 Challenges Encountered and Strategies for Overcoming Them

Despite its successes, the SEISMO-Lab project encountered several challenges during implementation, with resistance to change among educators and administrators being one of the main obstacles. Some stakeholders were hesitant to adopt new teaching methods or integrate seismology into existing curricula.

To identify challenges and issues arising during implementation, both the school administrative staff from the participating schools and the involved teachers were invited to report any encountered issues and provide relevant suggestions through the School's and Teacher's Reports. By soliciting input from both administrative staff and teachers through these reports, the SEISMO-Lab project managed to effectively capture any implementation issues and received valuable suggestions for improvement. This feedback mechanism enabled a comprehensive understanding of the challenges faced at various project levels, from administrative barriers to practical obstacles encountered by teachers in the classroom. It also offers stakeholders an opportunity to contribute to the refinement and enhancement of the project, ensuring its responsiveness to the needs and realities of the educational context. Some of the main identified challenges include:

- **Time constraints:** One of the major challenges reported was the limited time availability, particularly concerning the scheduling of activities outside regular school hours. Students' busy and rigid curricula posed difficulties in implementing alternative and innovative activities, hindering their participation.
- **Staff Availability:** There were challenges in securing staff availability for activities conducted outside regular working hours. Encouraging staff involvement in extracurricular activities proved to be a hurdle due to conflicting schedules and other commitments.
- **Teacher Training and Support:** Teachers require additional training and support to effectively implement innovative activities and integrate seismology topics into their curricula.
- **Sustainability:** Ensuring the sustainability of the project and its continued development emerged as a concern. Maintaining momentum and engagement beyond the initial phase of the project was identified as crucial for long-term success.
- **Technical Issues:** Technical issues, such as internet connection problems affecting data recording, disrupt the smooth implementation of project activities.

- **Resource Accessibility:** Some respondents highlighted the need for readily available and age-appropriate educational materials for conducting activities related to seismology. Access to materials and resources, especially in kit form, was deemed essential for facilitating smooth implementation.
- **Collaboration Challenges:** While collaboration among schools and stakeholders was encouraged, logistical challenges in organizing collaborative activities and meetings were reported. Coordination efforts were hindered by factors such as scheduling conflicts and the need for clear communication channels.

Based on the encountered challenges, several strategies were proposed for overcoming them, either by the participants or by the project partners. These strategies include:

- **Scheduling Optimization:** Reducing the curriculum content in certain subjects. Adjusting curriculum schedules or reallocating time for project-related activities to accommodate implementation needs. Organizing programs during after-school hours or weekends to accommodate student participation. Tighten relations between schools and streamline meeting schedules to enhance collaboration.
- **Foster Professional Development:** Provide continuous training and support for teachers to enhance their confidence and effectiveness in implementing interdisciplinary projects. Explore opportunities for international collaboration and exchange of best practices.
- **Facilitate Knowledge Sharing:** Organize meetings and workshops to facilitate knowledge sharing and collaboration among teachers. Provide guidance on integrating seismology topics into existing curricula and conducting interdisciplinary activities.
- **Ensure Sustainability:** Develop strategies for sustaining the project's impact beyond the initial phase, including partnerships with higher education institutions and research institutes. Create teaching materials that align with curriculum requirements and promote active student engagement.
- **Enhance Resource Accessibility:** Simplify applications and allocate more time for program implementation to alleviate resource constraints. Encourage the construction and placement of seismographs in other schools to expand access to resources.
- **Promote Collaboration:** Encourage the involvement of other colleagues and stakeholders to reach more students. Facilitate collaborations between different actors by presenting the program to relevant associations and organizing collaborative events.

In conclusion, the SEISMO-Lab project offers valuable insights into the strategies, approaches, and experiences involved in implementing innovative science education initiatives. By reflecting on the lessons learned and challenges encountered, future projects can build upon the successes of SEISMO-Lab and further enhance science education for students worldwide.

3.3 Identification and Presentation of Main Success Stories and Cases

In this section, the focus is on highlighting and showcasing the most notable achievements and successful implementations of the SEISMO-Lab project across different countries involved. By delving into specific success stories and cases, valuable insights into the diverse approaches, strategies, and outcomes achieved within each country's educational context can be gained.

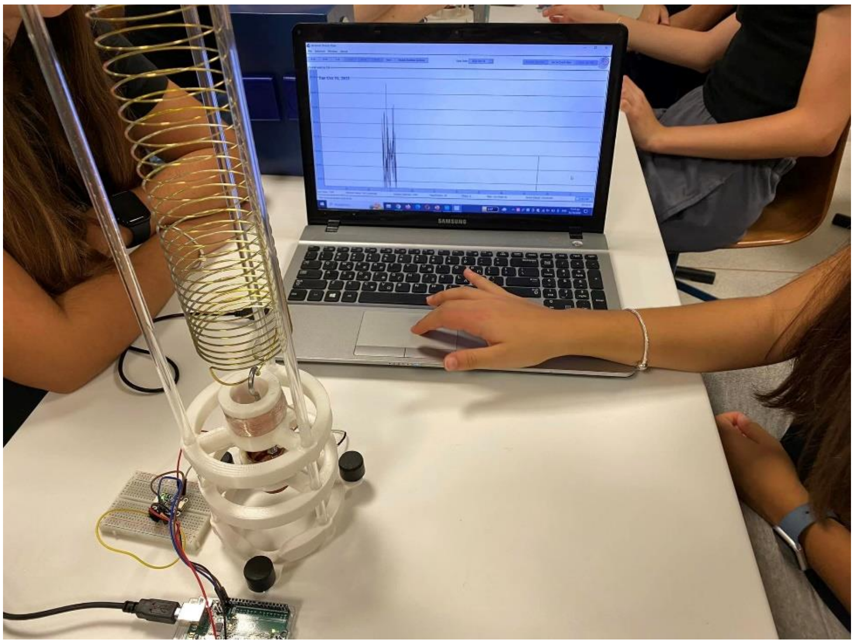
3.3.1 Cross-Border Seismology Adventures: SEISMO-Lab Unites Students from Greece, Germany, and Bulgaria

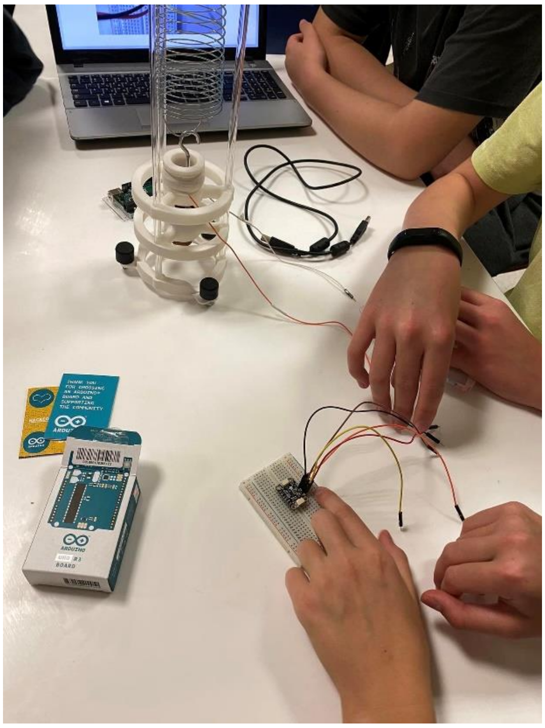
Ellinogermaniki Agogi, a Greek school renowned for its innovative educational practices, in collaboration with Ehrenfried - Walther - von - Tschirnhaus Gymnasium Dresden from Germany and PPMG Akad. Ivan Tsenov Gymnasium from Bulgaria embarked on an enriching journey as part of the SEISMO-Lab project. This partnership aimed to enhance students' educational experiences through immersive activities in educational seismology.

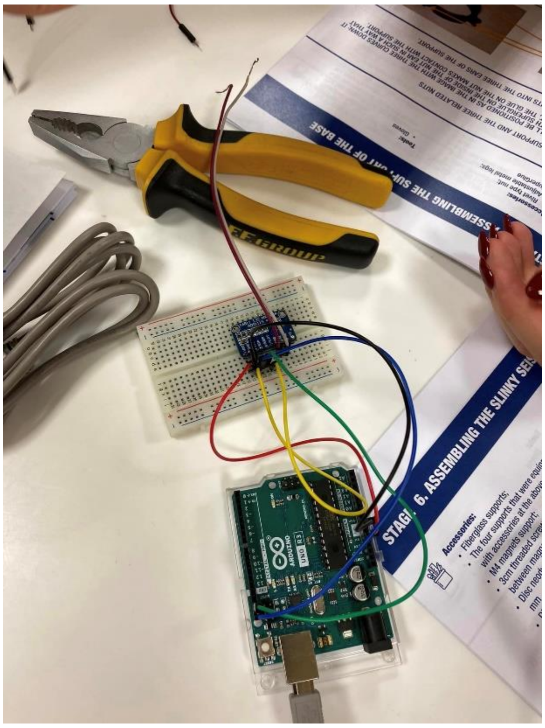
The collaboration saw students from Gymnasium Dresden visiting Ellinogermaniki Agogi in Athens, Greece. During their stay, students engaged in various educational seismology activities. This hands-on activity epitomized the project's interdisciplinary approach and fostered collaborative learning among students. One of the highlights of the collaboration was the joint seismology class attended by students from both schools. Guided by educators, they collectively constructed a school seismograph using Arduino and JamaSeis technology. The culmination of the collaboration was marked by the successful completion of the seismograph and the presentation of waveform data on computers. This interactive exercise not only enhanced their understanding of seismology but also strengthened their technical proficiency in instrument construction and data analysis.

Similarly, students from PPMG Akad. Ivan Tsenov Gymnasium in Bulgaria participated in a SEISMO-Lab training session hosted by Ellinogermaniki Agogi. The session focused on methods for determining the epicenter and magnitude of earthquakes, as well as seismograph construction. This initiative provided Bulgarian students with valuable insights into seismology and equipped them with practical skills to engage with seismic data.

The success of the collaboration was evident as students from both schools departed Ellinogermaniki Agogi with enriched knowledge and lasting friendships. Plans for further collaboration were made, showcasing the enduring nature of the partnership and the transformative impact of the SEISMO-Lab project. This cross-border seismology adventure not only enhanced students' understanding of seismology but also strengthened their technical proficiency in instrument construction and data analysis, leaving a lasting impact on their educational journey.



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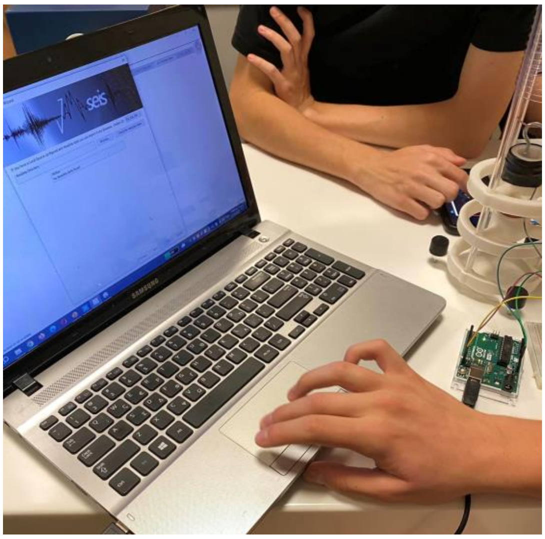


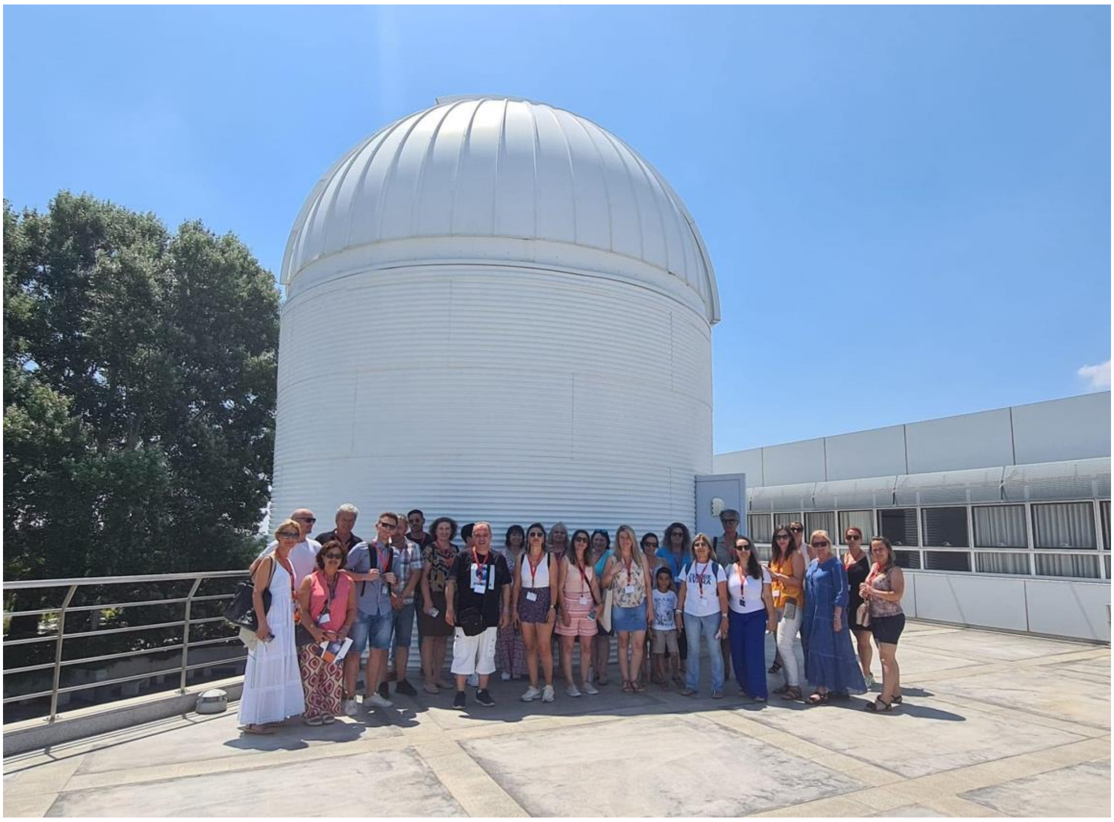
3.3.2 Empowering Educators Through Interactive Training Events

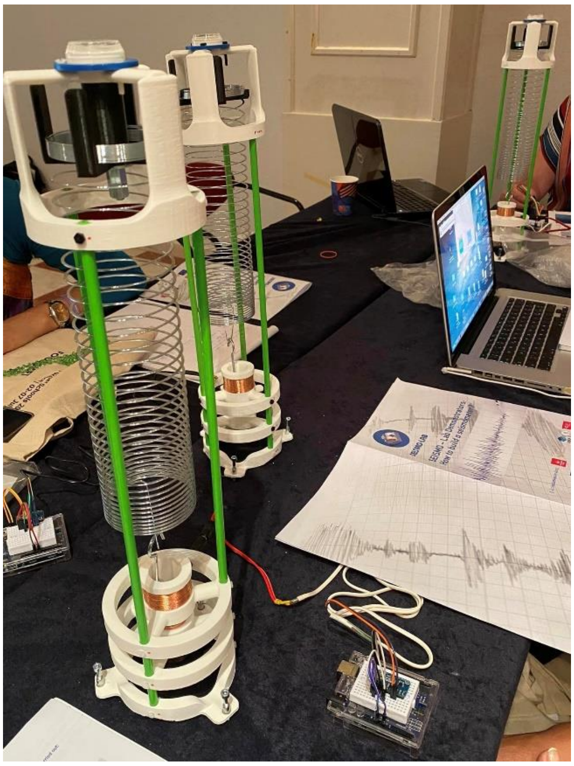
The SEISMO-Lab project has significantly empowered educators across Europe through a series of comprehensive training events in educational seismology. Over 20 training events were conducted throughout the project's duration, attracting approximately 1500 teachers from Cyprus, Turkey, Italy, Romania, and Greece. Among the standout events were the two international 6-day summer schools held in Marathon, Greece, during the summers of 2022 and 2023.

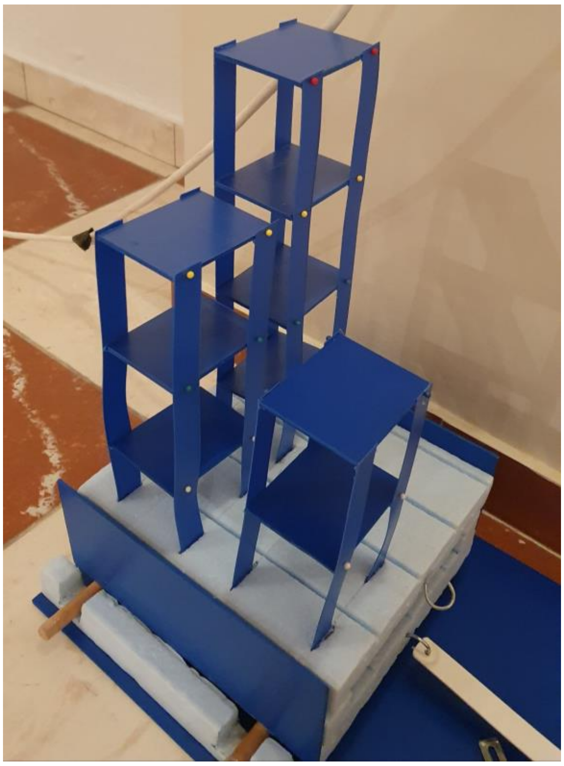
These summer schools provided intensive training to over 50 educators, focusing on various educational scenarios within seismology. Participants actively engaged in interactive sessions covering earthquake epicenter calculation and seismograph construction, gaining practical skills and knowledge essential for implementing engaging activities in their classrooms. Additionally, the program featured insightful lectures delivered by esteemed professionals, enriching participants' understanding of seismology concepts and methodologies.

One of the key highlights of the summer schools was the collaborative atmosphere, fostering idea exchange and partnership among educators from diverse backgrounds. Participants had the opportunity to share their educational seismology scenarios, laying the groundwork for future collaborative projects and initiatives. This collaborative spirit not only enhanced the learning experience but also strengthened the network of educators dedicated to advancing science education.

Overall, the SEISMO-Lab summer schools have emerged as dynamic platforms for professional development, empowering educators to become catalysts for change in science education. By offering hands-on training, engaging lectures, and opportunities for collaboration, these summer schools have equipped educators with the tools and inspiration needed to nurture the curiosity and passion for science in the next generation of learners.







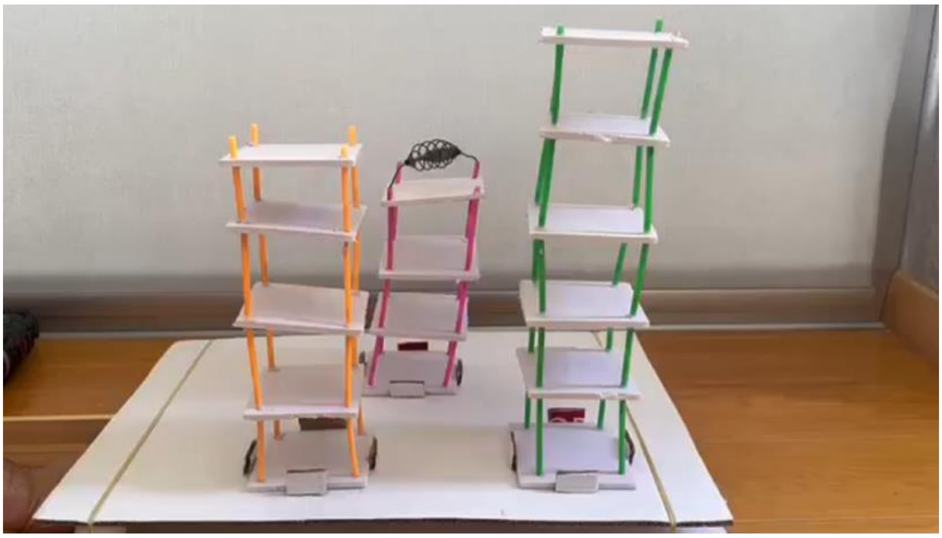
3.3.3 Participation in National and International Competitions: Celebrating Academic Excellence and Innovation

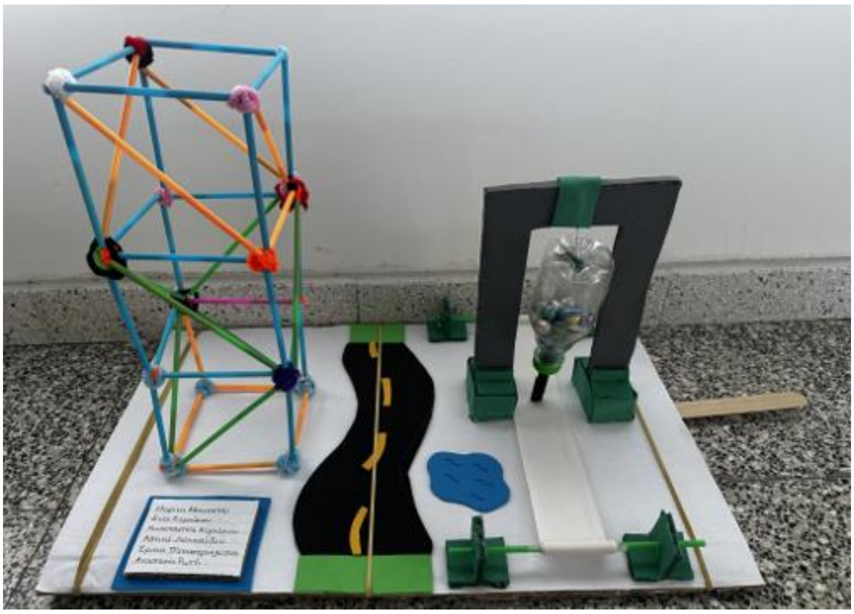
Participation in national and international competitions represents a significant milestone for schools involved in the SEISMO-Lab project, showcasing their dedication to academic excellence and innovation in the field of seismology. These competitions serve as platforms for students and educators to demonstrate their knowledge, skills, and creativity while contributing to the broader scientific community. The success of SEISMO-Lab schools in these competitions underscores the project's impact in nurturing a culture of scientific inquiry and discovery among students, fostering interdisciplinary learning, and inspiring the next generation of scientists and engineers.

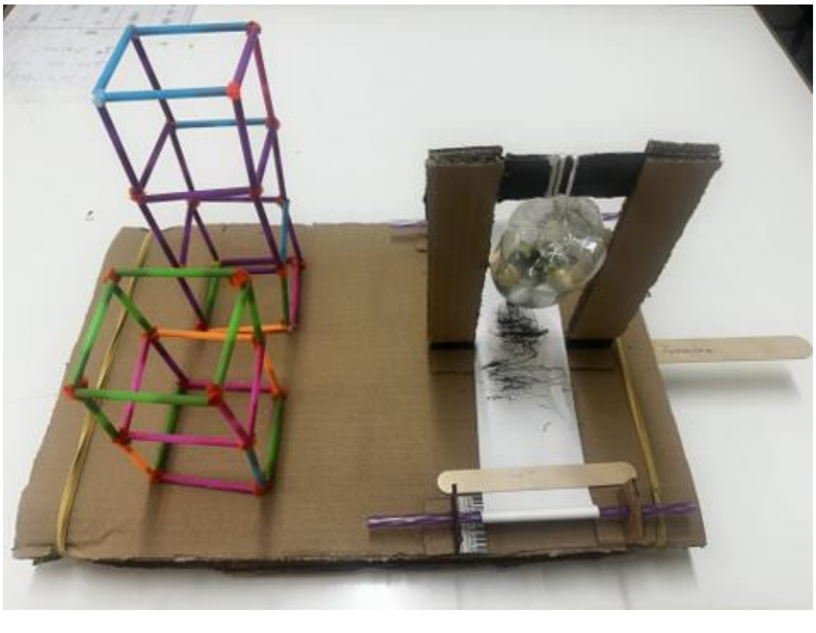
Some indicative examples of SEISMO-lab school's participation include:

- "Carmen Sylva" Theoretical High School, Romania
  Students and their coordinating teacher, from "Carmen Sylva" Theoretical High School in Eforie Sud, Romania, achieved notable success at the RoSEF (Romanian Science and Engineering Fair). Their project, titled "Analysis of Earthquakes Recorded in 2023: Seismic Warning System," earned them the second prize. Through meticulous analysis of seismic data collected by the school's specialized equipment, including Raspberry Shake and SEP seismometers, students demonstrated their analytical skills and scientific rigor.
- Laniteio Lyceum, Cyprus
  Laniteio Lyceum in Cyprus secured victory in the national Science on Stage competition with their project investigating how the height of buildings affects their tolerance to seismic waves of different frequencies. Led by dedicated educators, students explored the intersection of physics, engineering, and seismology, offering valuable insights into structural dynamics and earthquake resilience. Their success highlights the transformative impact of hands-on learning experiences facilitated by initiatives like SEISMO-Lab.

In conclusion, the participation of SEISMO-Lab schools in national and international competitions exemplifies the project's commitment to fostering excellence and innovation in seismology education. These success stories underscore the dedication of students and educators to scientific inquiry, interdisciplinary learning, and the pursuit of knowledge. By engaging in rigorous scientific investigations and highlighting their findings on prestigious platforms, SEISMO-Lab schools not only demonstrate their academic prowess but also contribute to advancing our understanding of seismic phenomena and promoting earthquake resilience. These achievements stand as a testament to the transformative impact of the SEISMO-Lab project in empowering students and educators to become active contributors to the scientific community and agents of positive change in their societies. As SEISMO-Lab continues to inspire and empower learners across Europe, these success stories serve as beacons of excellence and motivation for future generations of scientists and engineers.







3.3.4 Expanding Horizons: SEISMO-Lab's Network of Seismographs

The SEISMO-Lab project has made significant strides in expanding its seismograph network across Mediterranean and European countries, a milestone that significantly enhances seismic monitoring capabilities and fosters scientific engagement among students. With approximately 100 stations now deployed, this expansion reflects the project's commitment to promoting scientific research and collaboration on a regional scale. By strategically placing seismographs in diverse geographical locations, SEISMO-Lab aims to facilitate the collection of comprehensive seismic data, providing researchers and educators with deeper insights into seismic activity and its implications for earthquake preparedness and mitigation.

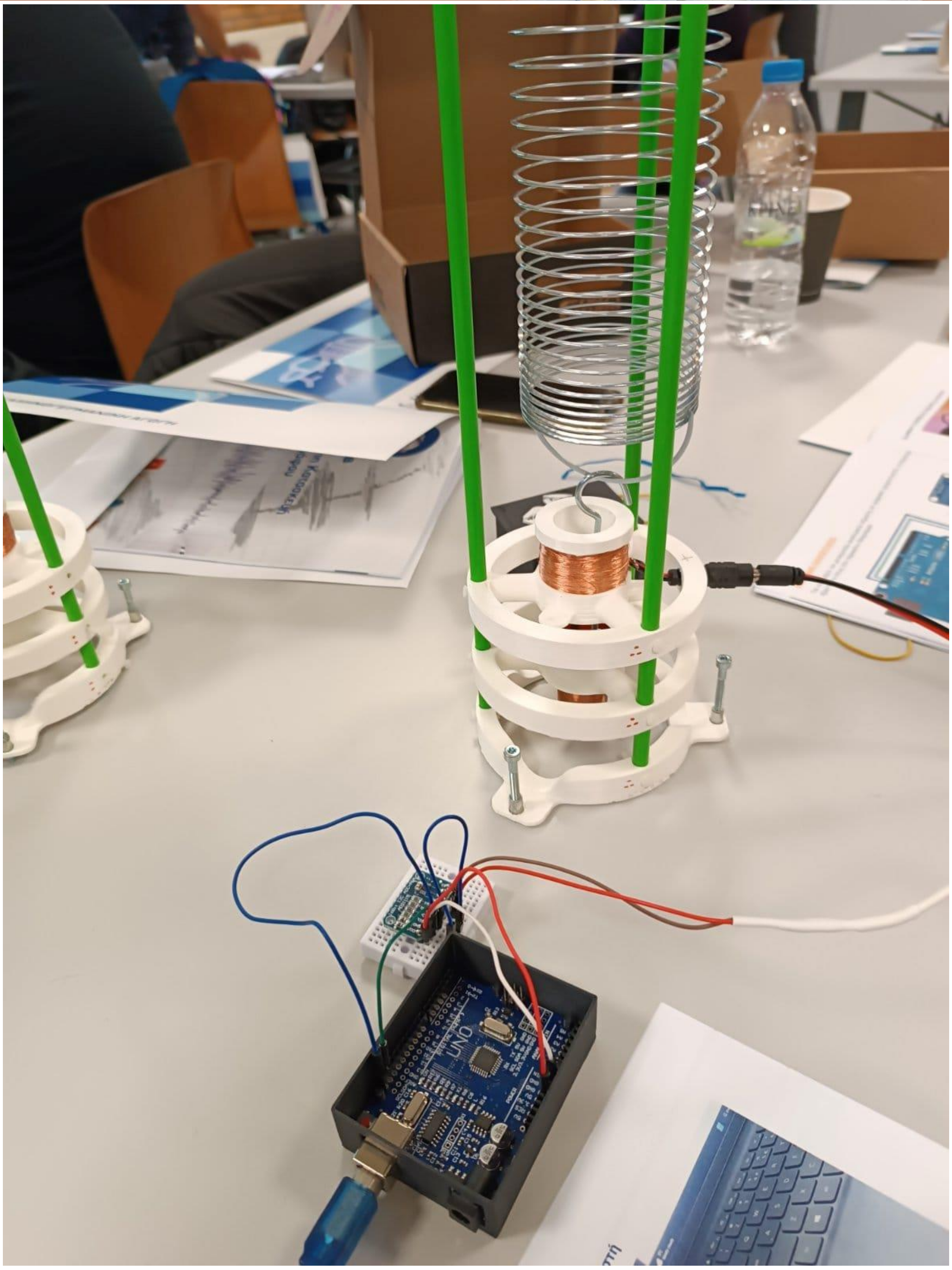
Through collaborative efforts with educational institutions, research organizations, and government agencies, SEISMO-Lab has successfully extended its network of seismographs to key locations throughout the Mediterranean and Europe. These seismographs play a vital role in monitoring seismic events, capturing ground motions, and analyzing seismic wave propagation patterns. By harnessing modern technology and innovative approaches, SEISMO-Lab empowers students and researchers to engage in practical learning experiences and contribute to ongoing scientific inquiries in seismology.

Furthermore, the establishment of this robust seismograph network fosters interdisciplinary collaboration and knowledge exchange among participating countries. By sharing data and resources, SEISMO-Lab enables scientists and educators to address common challenges, explore new research avenues, and develop effective strategies for earthquake risk assessment and mitigation. The network's geographical diversity and comprehensive coverage enhance the reliability and accuracy of seismic data analysis, facilitating informed decision-making and proactive measures to enhance community resilience to earthquakes and related hazards.

An outstanding aspect of this network expansion is the innovative integration of 3D printing technology, which has revolutionized the design and manufacturing process of seismographs. This utilization of 3D printing for producing seismograph components has not only reduced costs but also increased flexibility in customization, allowing for tailored solutions to specific educational and research needs. Moreover, the inclusion of 3D printed parts underscores the project's commitment to embracing innovative technologies and promoting hands-on learning experiences for students.

A notable feature of the expanded seismograph network is the active involvement of students from SEISMO-Lab schools in the assembly and deployment of these instruments. Through practical workshops and collaborative projects, students have gained invaluable experience in instrument construction, data collection, and seismic analysis. This direct participation in the expansion of the seismograph network not only nurtures students' scientific curiosity but also instills a sense of responsibility and ownership toward seismic research and monitoring efforts.

This innovative approach exemplifies SEISMO-Lab's broader mission to democratize access to scientific instrumentation and foster interdisciplinary collaboration in seismology education. By integrating 3D printing technology and student participation into the expansion of the seismograph network, the project not only enhances scientific literacy but also cultivates a new generation of researchers and innovators dedicated to advancing our understanding of seismic phenomena.



3.4 Looking Forward: Recommendations for Uptake and Scale-Up

Building upon the successes, challenges, and lessons learned from the SEISMO-Lab project, this section focuses on providing forward-looking recommendations aimed at furthering the uptake and scale-up of educational seismology initiatives. Drawing from comprehensive evaluations at the school, teacher, and student levels, these recommendations aim to guide educators, policymakers, and stakeholders in optimizing the impact and sustainability of future projects. By leveraging insights garnered from the project's framework, outcomes, and experiences, the following recommendations seek to foster continued innovation, collaboration, and excellence in science education.

3.4.1 School-Level Recommendations

The comprehensive evaluation of school-level quantitative indicators has provided valuable insights into the effectiveness and impact of the SEISMO-Lab project at the institutional level. Building upon these findings, the following recommendations are proposed to further enhance the project's outcomes and maximize its impact:

Prioritize Geographical Inclusivity: Given the remarkable inclusivity demonstrated by the project in engaging institutions from remote or disadvantaged areas, it is recommended to continue prioritizing geographical inclusivity in future initiatives. Efforts should be made to identify and reach out to schools in underserved regions, ensuring equitable access to educational opportunities in seismology and related sciences.

Expand Seismograph Network: The successful installation of seismographs in 90 institutions underscores the collaborative effort in establishing a robust seismograph network. To build upon this achievement, it is recommended to expand the network by encouraging more schools to install seismographs on their premises. This expansion will not only contribute to real-time data collection but also facilitate broader participation in STEM education.

Promote Resource Utilization: The availability of the project's seismograph network and educational resources presents an opportunity for schools to enrich their curriculum and engage students in hands-on learning experiences. It is recommended to actively promote the utilization of project resources, such as the SWARM software and online platform, to facilitate data analysis, research, and collaborative learning activities among students.

Ensure Sustainability: Develop strategies to ensure the long-term sustainability of educational initiatives by establishing partnerships with higher education institutions, research organizations, and agencies, and creating a framework for continuous funding and support.

3.4.2 Teacher-Level Recommendations

The analysis of teacher-level quantitative indicators has shed light on the demographics and subject diversity of participating educators. Considering these findings, the following recommendations are proposed to support and empower teachers in their role as facilitators of seismology education:

Promote Continuous Professional Development: The significant interest and engagement observed among teachers, particularly in response to training events, underscore the importance of ongoing professional development opportunities. It is recommended to continue offering a diverse range of training and multiplier events, both face-to-face and virtual, to cater to the varying needs and preferences of educators across different countries.

Encourage Interdisciplinary Collaboration: The project's success in engaging teachers from diverse subject disciplines presents an opportunity to foster interdisciplinary collaboration in education. It is recommended to encourage and facilitate collaboration among teachers from different disciplines, enabling them to integrate seismology concepts into various curricular areas and promote interdisciplinary learning experiences for students.

Support Gender Diversity: The predominance of female teachers in project participation highlights the need to support and empower educators of all genders in seismology education. It is recommended to implement strategies aimed at promoting gender diversity in training events and project activities, ensuring equitable representation and participation across all demographics.

Design Engaging Educational Activities: Design engaging and relevant educational activities that empower students to actively participate in scientific inquiry and exploration, utilizing tools such as seismographs and data analysis software to develop practical skills and deepen understanding.

3.4.3 Student-Level Recommendations

The analysis of student-level quantitative indicators has demonstrated the project's success in achieving broad participation and inclusivity among students. Leveraging these findings, the following recommendations are proposed to further enhance student engagement and learning outcomes:

Sustain Student Participation: The equal gender distribution and diverse age representation among student participants indicate the project's success in engaging a wide range of learners. It is recommended to sustain and expand student participation by continuing to offer engaging and accessible educational activities that cater to the diverse interests and learning needs of students across different age groups and demographics.

Promote STEM Interest and Skills: The positive impact of the project on students' attitudes toward STEM and their problem-solving competencies underscores the importance of promoting interest and proficiency in STEM fields. It is recommended to incorporate interdisciplinary and hands-on learning experiences, such as those offered through educational seismology activities, into school curricula to foster students' curiosity, creativity, and critical thinking skills.

Empower through Data Analysis: The availability of real-time seismic data and software tools provides students with valuable opportunities to engage in scientific inquiry and data analysis. It is recommended to empower students with the knowledge and skills to analyze seismic data, conduct research, and draw meaningful conclusions, thereby fostering a deeper understanding of earth sciences and promoting scientific literacy among future generations.

3.4.4 Policy makers recommendations

As key stakeholders in shaping the landscape of education, policymakers play a crucial role in driving meaningful change and fostering innovation in science education. In alignment with the overarching goals of promoting excellence and equity in STEM learning, the following recommendations are tailored specifically for policymakers.

Advocate for Investment in Science Education: Advocate for increased funding and support for science education initiatives that promote hands-on learning experiences, interdisciplinary collaboration, and STEM literacy, highlighting their importance for preparing students for success in the modern workforce.

Align Curriculum with 21st Century Skills: Advocate for curriculum reform that aligns with the development of 21st-century skills, prioritizing the integration of STEM disciplines and real-world applications into educational curricula to meet the evolving needs of society.

Facilitate Knowledge Sharing and Research: Support initiatives that facilitate knowledge sharing and collaboration among educators, policymakers, and stakeholders, and promote research and evaluation efforts to assess the effectiveness of educational initiatives and inform evidence-based decision-making.

By prioritizing these initiatives, policymakers can contribute significantly to the advancement of STEM literacy and the preparation of students for success in the modern workforce and society at large.

3.5 Conclusion

The SEISMO-Lab project has emerged as a beacon of innovation in science education, fostering interdisciplinary learning, collaboration, and excellence among students and educators. Through a multifaceted approach that integrates seismology into school curricula, the project has not only enhanced scientific literacy but also empowered participating students with essential skills and knowledge for the 21st century.

The comprehensive evaluation of the project's framework, outcomes, and experiences has yielded valuable insights and lessons learned that can inform future initiatives in educational seismology. From the successful implementation of training events and collaborative projects to the expansion of the seismograph network and participation in national and international competitions, SEISMO-Lab schools have demonstrated a commitment to academic excellence, innovation, and scientific inquiry.

Looking ahead, recommendations have been outlined to further the uptake and scale-up of educational seismology initiatives, encompassing school-level strategies to prioritize geographical inclusivity, expand the seismograph network, and promote resource utilization. Additionally, teacher-level recommendations emphasize the importance of continuous professional development, interdisciplinary collaboration, and gender diversity. Student-level recommendations highlight the significance of sustaining participation, promoting STEM interest and skills, and empowering students through data analysis. Furthermore, specific recommendations tailored for policymakers underscore the importance of advocating for investment in science education, aligning curriculum with 21st-century skills, and facilitating knowledge sharing and research.

As SEISMO-Lab continues to inspire and empower learners across Europe, these recommendations serve as a roadmap for advancing science education and preparing students for success in the modern world. By building upon the successes, addressing the challenges, and embracing the lessons learned, stakeholders can collectively contribute to the continued evolution and impact of educational seismology, ensuring that future generations are equipped with the knowledge, skills, and mindset to navigate an ever-changing world with confidence and resilience.

4. References

Baldwin, J. A., Ebert-May, D., & Burns, D. J. (1999). The development of a college biology self-efficacy instrument for nonmajors. *Science Education*, *83*(4). https://doi.org/10.1002/(sici)1098-237x(199907)83:4<397::aid-sce1>3.0.co;2-%23

Furco, A., Muller, P. & Ammon M.S. (1998) *The Civic Responsibility Survey*. Service-Learning Research Center, University of California, Berkley.

Glynn, S. M., Brickman, P., Armstrong, N., & Taasoobshirazi, G. (2011). Science motivation questionnaire II: Validation with science majors and nonscience majors. *Journal of Research in Science Teaching*, *48*(10), 1159–1176. https://doi.org/10.1002/tea.20442

Jackson, C. R. (2018). Validating and Adapting the Motivated Strategies for Learning Questionnaire (MSLQ) for STEM Courses at an HBCU. *AERA Open*, *4*(4), 233285841880934. https://doi.org/10.1177/23328584188093466

Kind, P., Jones, K., & Barmby, P. (2007). Developing attitudes towards science measures. *International Journal of Science Education*, *29*(7), 871–893. https://doi.org/10.1080/095006906009090911

5. Appendices

5.1 School’s Report (SR)

School’s Report

The goal of this tool is to gain insight into the school's actions, gather feedback from the school administration staff, and investigate the impact of the SEISMO-Lab project on the participating students, teachers, and schools. Your comments and recommendations will be used for improving the project's materials and practices for future use. Any personal information provided (e.g., names) will be hidden.

Thank you for your contribution!

Section A

School name: …………………………………………………………………………

Administrative position: ……………………………………………………………

Number of teachers involved in training events: ……………………………

Number of teachers involved in the project: ……………………………

Teachers’ discipline:
1. ……………………………………
2. ……………………………………
3. ……………………………………
4. ……………………………………
5. ……………………………………

Did your school participate in any previous research projects?

☐ Yes ☐ No

Did your school participate in any of the previous Educational Seismology projects?

☐ Schools Study Earthquakes (SSE)

☐ School Networks Alert Citizens Protection (SNAC)

☐ SSE & SNAC

☐ No

Section B

1. To what extent does the school administration encourage its teaching staff to participate in professional development courses?

Not at all ☐ ☐ ☐ ☐ ☐ To a very large extent

Please, briefly describe the actions that the school follows in this direction.

………
………
………
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………
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2. To what extent does the school administration create opportunities for its teaching staff to participate in training and teacher development programs?

Not at all ☐ ☐ ☐ ☐ ☐ To a very large extent

Please, briefly describe the actions that the school follows in this direction.

………
………
………
………
………
………

3. To what extent does the school administration consider making its teaching staff professional development an obligation/explicit duty, and allocating working time to it?

Not at all ☐ ☐ ☐ ☐ ☐ To a very large extent

Please, briefly describe the actions that the school follows in this direction.

………
………
………
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………

4. To what extent did the SEISMO-Lab project achieve its goal in creating innovative interdisciplinary activities to develop students' needed skills and competencies to be prepared for the 21st century?

Not at all ☐ ☐ ☐ ☐ ☐ To a very large extent

Please, explain your response below:

………
………
………
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………

5. To what extent does the school administration encourage and support collaboration among its teaching staff?

Not at all ☐ ☐ ☐ ☐ ☐ To a very large extent

In what of the following ways does the school administration support collaboration among its teaching staff?

- ☐ By avoiding situations that could encourage counterproductive competition between individuals
- ☐ By altering the school's timetable so that teachers from different disciplines can work together
- ☐ By promoting co-teaching
- ☐ By promoting the implementation of interdisciplinary educational activities
- ☐ Other

Please describe any other ways that the school administration supports collaboration among its teaching staff.

………
………
………
………
………
………

6. To what extent does the school administration encourage/ support/ create opportunities for collaboration with other schools?

Not at all ☐ ☐ ☐ ☐ ☐ To a very large extent

In what of the following ways does the school administration encourage/ support collaboration with other schools?

- ☐ By organizing educational competitions between schools
- ☐ By creating school networks to share information, resources, and practices
- ☐ By organizing educational visits to other schools
- ☐ By participating in projects with other schools
- ☐ Other

Please describe any other ways that the school encourages/ supports collaboration with other schools.

……
……
……
……
……
……

7. To what extent does your school plan to participate in future similar projects?

Not at all ☐ ☐ ☐ ☐ ☐ To a very large extent

8. One of the main objectives of the SEISMO-Lab project is to develop recommendations for future use for guiding and supporting schools, educators, and stakeholders in developing and offering innovative, interdisciplinary educational activities. As a member of the administrative staff of a school implementing the project this school year, do you have any relevant suggestions (e.g., how to avoid challenges that you faced, how to achieve collaborations between different actors, how to introduce innovation to students)?

Please provide your recommendations and suggestions below:

……
……
……
……
……
……
……
……

5.2 Teacher's Questionnaire (TQ)

Teacher's Questionnaire

The goal of this questionnaire is to gather information regarding the teachers' training events of the SEISMO-Lab project, regarding the activities, the tools and materials developed and their impact on the participating teachers. Your comments and recommendations will be used for improving the project's materials and practices for future use.

Completing this questionnaire is anonymous and any personal information provided will be hidden. Please provide us your opinion about the training. Your feedback is very valuable to us, as it will be used for improving our future actions and practices.

Thank you in advance for your participation!

Section A

Country:

- ☐ Cyprus/ Greece/ Italy/ Romania/ Turkey
- ☐ Other: …………………………………………..

Gender:

☐ Female ☐ Male ☐ Rather not say

Subject Discipline:

- ☐ Geography
- ☐ Mathematics
- ☐ Environmental education
- ☐ Technology
- ☐ Sciences
- ☐ Physics
- ☐ Chemistry
- ☐ Informatics
- ☐ Other: …………………………………………..

Grade:

☐ K5	☐ K6	☐ K7	☐ K8
☐ K9	☐ K10	☐ K11	☐ K12

Did you participate in any of the previous Educational Seismology projects?

☐ Schools Study Earthquakes (SSE)

☐ School Networks Alert Citizens Protection (SNAC)

☐ SSE & SNAC

☐ None

How did you find out about this training program?

☐ From the website of the group that organizes the training

☐ From a colleague

☐ From a poster

☐ From the letter sent to schools

☐ Other: …………………………………………..

How supportive was the administration of your school (e.g., school principal) in facilitating your participation in the training event?

Not at all ☐ ☐ ☐ ☐ ☐ Very much

Section B

In the following sentences, choose the statement that best represents your point of view.

1. The presentations and/or activities of the training event are useful for my teaching practice.

Strongly disagree ☐ ☐ ☐ ☐ ☐ Strongly agree

2. The presentations and/or activities of the training event met my expectations.

Strongly disagree ☐ ☐ ☐ ☐ ☐ Strongly agree

3. The materials presented during the training event will facilitate my school implementations.

Strongly disagree ☐ ☐ ☐ ☐ ☐ Strongly agree

4. The training event enhanced my understanding on how to implement interdisciplinary activities related to educational seismology.

Strongly disagree ☐ ☐ ☐ ☐ ☐ Strongly agree

5. I feel confident in implementing interdisciplinary projects related to educational seismology with my students.

Strongly disagree ☐ ☐ ☐ ☐ ☐ Strongly agree

6. I plan to develop my own activities related to educational seismology.

☐ Yes ☐ No

7. I plan to collaborate with other teachers in my school during this project.

☐ Yes ☐ No

8. I am going to participate in the SEISMO-Lab project.

☐ Yes ☐ No

9. Please mention any comments regarding the training event.

……
……
……
……

5.3 Teacher's Report (TR)

Teacher's report

The goal of this report is to gather information about the activities implemented during the SEISMO-Lab project for presenting the schools' work, to collect feedback from the teachers regarding the tools and materials developed, and to investigate the impact of the project on participating students, teachers, and schools. Your comments and recommendations will be used to improve the project's material and practices for future use. Any personal information provided (e.g., names) will be hidden.

Thank you for your contribution!

Section A

Gender:

☐ Female ☐ Male ☐ Rather not say

Country:

☐ Cyprus/ Greece/ Italy/ Romania/ Turkey

☐ Other: ……………………………………………….

School name: ………………………………………………………………………..

Subject discipline: ……………………………………………………….

Grade: ………………………………………………………………………………

Number of students involved in the project: …………………………………….

Do you have an educational seismograph installed in your school, and if so, what kind of seismograph do you have installed?

☐ Raspberry Shake ☐ TC1 seismometer

☐ Self-made ☐ No seismograph

Section B

Have you implemented any of the suggested educational seismology activities (demonstrators) in your classroom?

☐ Yes ☐ No, I created my own.

If the response is Yes, select which suggested activity/ies you used:

☐ How to build a seismometer?
☐ Print your shake table and build a better wall.
☐ The Seismo-Theater.
☐ How to estimate the magnitude of seismic shocks by comparison.
☐ Finding the velocity of P waves using real data collected from SEISMO-Lab seismometers.
☐ Sound of the Earth.

Did you make any modifications to the activity/ies that you used in order to adapt it/them to your classroom? If so, briefly describe these modifications below:

……
……
……
……
……

How successful do you think the implementation was in succeeding the activities' goals?

☐ Not successful at all ☐ Fairly successful ☐ Quite successful ☐ Very successful

Do you plan to use these activities again in the future?

☐ Yes ☐ No

If the response is No, please explain:

……
……
……

Do you have any suggestions or feedback on improving the suggested activities for future use? If so, please write your ideas below:

……
……
……
……

Section C

Have you implemented any educational seismology activity/ies that are not mentioned in the previous section?

☐ Yes ☐ No

If the response is Yes, please indicate from where you got this/these activities from.

☐ They were presented at a training event.

☐ I found them online.

☐ I developed them.

☐ Me and peers developed them.

☐ Other: ……………………………………………

Please, briefly describe the educational activity/ies below:

……
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……
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…….
……
……

How successful do you think the implementation was in succeeding the activities' goals?

☐ Not successful at all ☐ Fairly successful ☐ Quite successful ☐ Very successful

Do you plan to use these activities again in the future?

☐ Yes ☐ No

If the response is No, please explain:

……
……
…….

Do you have any plans or suggestions for improving the activities for future use? If yes, please write your ideas below:

……
……
……

Section D

What kind of actions did your students perform while using one or more of the available equipment/resources/tools* during the implementations?

[*Available equipment/resources/tools: (i) educational seismograph (ii) real-time seismic data of the SEISMO-Lab platform, (iii) available software for analyzing seismic data (e.g., SWARM)]

- ☐ Identification of a seismic event in real-time seismic data
- ☐ Identification of the date and time of an earthquake
- ☐ Identification of The Primary (P), Secondary (S), and surface seismic waves
- ☐ Calculation of time distance between P, and S waves
- ☐ Calculation of the distance between an earthquake and a seismograph
- ☐ Localization of an earthquake's epicenter by using data from 3 or more seismograms
- ☐ Measurement of wave's amplitude
- ☐ Estimation of earthquake's magnitude
- ☐ Estimation of earthquake's depth
- ☐ Other: ________________________________

Describe any other actions your students performed while using the available equipment and/or software tools during the implementations:

………
………
………
………

Share some indicative learning products and/or materials developed during the project (e.g., students' posters, photographs of the seismometer they created), or actions performed that resulted from the implementation of the educational activities:

(Add Google drive link for uploading the material)

[We note that some of these pictures might be used for dissemination purposes and/or for the purposes of the "PR5: SEISMO-Lab Evaluation Methodology, Analysis of Results and Policy Report". Any faces or personal information presented in the pictures/materials will be blurred and only the name of the school will be mentioned in the credits and captions of the pictures].

Section E

Did you collaborate with other teachers during the project?

☐ Yes ☐ No

If your response is Yes, please mention their subject discipline below:

1. ……………………………………………………………

2. …………………………………………………………….

3. …………………………………………………………….

4. …………………………………………………………….

What kind of collaboration(s) did you develop with other teachers?

☐ Exchange of ideas

☐ Exchange of educational material

☐ Provision of feedback for the activities developed

☐ Co-development of activities

☐ Co-teaching

☐ Other: ____________________________

Briefly describe any other kind of collaborations that you developed.

………
………
………

Did you face any challenges while collaborating with other teachers? If so, briefly mention some of these challenges below, as well as ways you used to overcome them:

………
………
………

Do you have any suggestions on how any future collaboration between you and other teachers could be improved? If yes, please write your ideas below:

………
………
………

Did you collaborate with any external stakeholders, experts, and/or institutes such as seismologists, museums, science or research centers?

☐ Yes ☐ No

What kind of collaborations did you develop with external stakeholders?

☐ They presented and explained their work.

☐ They gave us a presentation of concepts related to earthquakes.

☐ They trained us on how to use relevant equipment, tools and/or software.

☐ They provided us with resources and/or materials (e.g., materials for developing our seismometers, educational material, equipment)

☐ They participated in co-developing activities for the students.

☐ They provided feedback during the project (e.g., about tools, apps, software developed by students)

☐ They co-created with students (i.e., on-going participation during the development of relevant resources and tools)

☐ Other: ______________________

Briefly describe any other kind of collaborations that you developed.

……
……
……

Did you face any challenges while collaborating with external stakeholders? If so, briefly mention some of these challenges, as well as ways that you implemented to overcome them:

……
……
……

Do you have any suggestions on how any future collaboration between your school and external stakeholders could be improved? If yes, please write your ideas below:

……
……
……

Section F

One of the main objectives of the SEISMO-Lab project is to develop recommendations for future use for guiding and supporting schools, educators, and stakeholders in developing and offering innovative, interdisciplinary educational activities. As a teacher implementing the project this school year, do you have any relevant suggestions (e.g., how to avoid challenges that you faced, how to achieve collaborations between different actors, how to introduce innovation to students)?

……
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5.4 Students' Questionnaire (SQ)

Students' questionnaire

Completing the questionnaire is voluntary and anonymous. The data collected will only be used for evaluation purposes of the Seismo-Lab project.

School: ………

Age: ………………………………………

This questionnaire will be completed twice, once at the beginning of the lessons and once at the end of the lessons. For anonymity purposes and to match your answers in both completions, you are asked to create a personal code following these steps:

1. your gender: female (F), male (M), rather not say (N) ☐
2. your month of birth (01, 02, 03, …, 10, 11, 12) ☐☐
3. the two first letters of your mother's first name (e.g., MA for Maria) ☐☐
4. your day of birth (01, 02, 03, …, 29, 30, 31) ☐☐

Personal Code: _ _ _ _ _ _ _

Indicate how strongly you agree or disagree with each statement.

(Give your answer with an X on each statement. If you do not understand the statement, leave the line blank)

	Statements	**Strongly disagree**	**Disagree**	**Neither agree nor disagree**	**Agree**	**Strongly agree**
1	I like to do STEAM* activities outside the school.					
2	I like to visit websites about science, technology, engineer, or mathematics.					
3	I like to watch TV programs about science, technology, engineer, or mathematics.					
4	Science, technology and/or mathematics are one of my best subjects.					

5	Science, technology and/or mathematics lessons are exciting.					
6	Learning about STEAM at school is relevant to my life.					
7	Learning about STEAM is interesting.					
8	Learning about STEAM makes my life more meaningful.					
9	I am curious about discoveries in STEAM.					
10	I enjoy learning about STEAM.					
11	I am confident I will do well on STEAM tests.					
12	I believe I can master STEAM knowledge and skills.					
13	I believe I can earn a good grade in STEAM courses.					
14	I am sure I can understand STEAM.					
15	I am confident I will do well on STEAM labs and projects.					
16	I am confident that I can define a problem that needs to be solved.					
17	I am confident that I can design solutions for a problem.					
18	I am confident that I can find evidence that help me reason and argument when solving a problem.					

19	I try to relate ideas in this course to those in other courses whenever possible.					
20	When I study for this course, I pull together information from other courses.					
21	I think I will be able to use what I learn in this course in other courses.					
22	Doing something that helps others is important to me.					
23	I like to help other people, even if it is hard work.					
24	Helping other people is something everyone should do, including me.					
25	I know what I can do to help make the community a better place.					
26	I try to think of ways to help other people.					
27	I feel like I can make a difference in the community.					
28	I feel like I am a part of the community.					
29	I pay attention to news events that affect the community.					
30	I know a lot of people in the community, and they know me.					
31	Everyone should pay attention to the news, including myself.					
32	I am confident that I can carry out investigations.					

33	I am confident that I can analyse data.					
34	I am confident that I can use mathematics and computational knowledge.					
35	I am confident that I can obtain, evaluate and communicate information.					
36	I am confident that I can be successful carrying out an experiment.					

*STEAM: Science, Technology, Engineering, Arts and Mathematics