O4 Evaluation

Contributors: Jan Pawlowski, Annika Nowak, Michael Schäfer, Katerina Riviou, Federica Fiorio, Monika Mačiulienė, Gintarė Gulevičiūtė, Francesco Fieni, Nicola Parisi
Date: 31.08.2023
Version: 1.0

This research has been co-funded by the European Commission within Erasmus+ programme, project FabCitizen, grant no. 2020-1-DE01-KA203-005692.

Table of Contents

About this document

This document is the main outcome of IO4. It contains the validations in each country in the piloting phase as well as the large scale trials. Finally, good practices are identified and recommendations given based on our experiences. The following activities are covered:

O4.1 Design of the pilot project: In this activity, we created the validation plan and templates for the pilot workshops. These were run in O4.2 Germany, O4.3 Italy, O4.4 Greece, O4.5 Lithuania. This activity also contains community building.

O4.6 Initial Report: The report present the results of the validations. It also provides recommendations to update 1) the competence framework and 2) open learning scenarios based on the initial experiences.

The second empirical phase consists of Large Scale Trials in Germany (O4.7), Italy (O4.8), Greece (O4.9) and Lithuania (O4.10).

O4.11 Validation Report presents the results of the large scale trials and again provides recommendations for updating learning scenarios and the competence framework

O4.12 Good Practice Guide presenting practices which have been created within the project. Also, we gathered good practices from other experts in Europe in this area.

About The Fab Citizen Project

The main goal is to enable schools, in particular teachers, parents and pupils, to participate in high quality citizen science projects in both curricular and extracurricular contexts.
Citizen Science (CS) has raised a lot of attention in recent years. Its main goal is to involve citizens in different types of science projects, in particular to 1) improve engagement and 2) to increase research capacities, e.g. by shared data collection. Many projects have incorporated citizen science approaches. Whereas citizen science works well for educational purposes (e.g. in inquiry-based science education), the acceptance of CS on a scientific level ranges from low to questionable. Even though the European Association for Citizen Science has clear guidelines and support mechanisms, many CS projects are not taken seriously. This was the main starting point for the FabCitizen project: We provide tools to increase the quality of CS projects, in particular in schools. For this purpose, we integrate FabLabs as the main educational environment as they can provide both technological as well as methodological expertise.
We base our project on clearly defined requirements, amongst them:

- In schools, CS projects need to be embedded into the curriculum in various subjects
- To ease the implementation, teachers need high quality (open) scenarios and learning materials
- CS projects need support in terms of methodological and technological expertise.

In the project, we achieved the following main results:

- A Citizen Science competency framework describing knowledge, skills and attitudes to successfully engage in high quality CS projects
- A pedagogical concept incorporating aspects of service learning
- A guide for FabLabs as the key infrastructure to educate and train citizens.
- More than 150 Open learning scenarios to train teachers, pupils and parents in early secondary school
- A collection of Open Educational Resources supporting the approach
- A good practice guide for schools and FabLabs across Europe

The project provides guidance and concrete support to universities, FabLabs, schools and the surrounding communities to participate in successful, high quality CS projects.

1 Pilot Evaluation

The project aims at 1) bringing CS into practice and 2) continuously improving its outcomes. We therefore have carefully planned a two stage validation process. Due to the strong support and validation efforts, we have designed these activities as an intellectual output and not as a learning / teaching activity. Our evaluation methodology combines different methods / instruments. For each validation, we have run a similar methodology consisting of the following aspects:

- Introduction to CS
- Assessment of participants competences
- Discussion of the competence framework (O2)
- Discussion of OLS (O3)
- Learner activities in schools
- Feedback collection

Depending on the workshop type, different focus issues can be chosen.

1.1 Methodology

The method combines a focus group approach (teacher trainers as experts) which discusses the key aspects of the project. Additionally, we create a survey for the final feedback collection (including survey items on the curriculum, OLS, and experiences). The method applied here is also based on practice from the large European project Open Discovery Space which has trained teachers in more than 20 European countries. In terms of reporting, the initial experiences will be summarized in an initial validation report, the large-scale results will be summarized in the final validation report (this document).

The following piloting events tool place for teachers:

Name of the pilot	**Responsible**	**Participants**	**Evaluation**
Cultural heritage Accessibility	POLIBA	4	3
VR / AR	POLIBA	7	7
earthquake project	EA	50	43

The following piloting events tool place for students:

Name of the pilot	**Responsible**	**Participants**	**Evaluation**
Outdoor Computing 1	HRW	12	8
Outdoor Computing 2	HRW	8	5
Seismographs (2022)	EA	53	43
Fake news	VGTU	10	10
Basics of 3D printing	POLIBA	11	9
Basics of 3D printing	POLIBA	11	10

1.2 Evaluation based on the pilots (Germany)

1.2.1 First evaluation pilot (Germany)

Beginning with the demographic data, 13 children participated in the first evaluation trials which were divided into two weeks (8 from week 1 and 5 from week 2). Most children were from grade 5 (31%), followed by grade 6 (42%) and grades 7 to 9 (7.7% each). Children from comprehensive schools (38.5%), secondary schools (23.1%) and grammar schools (38.5%) participated in the first evaluation case. The gender ratio was about 70% (male) and 30% (female). The main sources of information about the courses were parents (53.8%) and friends (38.5%), while others were information sessions at school (15.4%) followed by siblings, teaching staff and the internet with 7.7% each. Most of the children participated due to their own motivation (84.6%), while other reasons were that "their parents wanted them to" (14.8% each) or that they "liked nature and technology".

For the **assessment of the competencies,** a questionnaire was used. In the children's (competency-)self-assessment, a ‘0’ means that they are not able to do a task, while a ‘4’ means that they rate themselves as being highly proficient at doing the task. Since the competencies are ordinal and not metric or interval scaled, no arithmetic means, such as the mean value, can be used here, which requires the interval scale level as a minimum (Müller-Benedict, 2006). A classic example of the ordinal scale level are school grades (Müller-Benedict, 2006), where it is not possible to say that a 2 is twice as favorable as a 4 or that two 2s make a 4. The same applies to the assessment and indication of competencies, but one can form a ranking at this point. For the median, the prerequisite is that at least ordinally scaled data are available and are given at this point regarding the competency assessment (Müller-Benedict, 2006). The following table provides a first overview of the median of the pupils self-assessed app development competencies.

Table 1: Rating of the app development competencies from the students (first evaluation case)

App development competencies	Median before	Median afterwards
I can display buttons and text fields on the App Inventor screen	0	4
I can include the camera and videos in an app	0	3.5
I can make fields visible/invisible	0	3
I know how to change and read variables	0	3
I know how to test an app	0	4

I know how to create an app from App Inventor (.apk).	0	4
I can find errors in blocks	0	3

In the area of app competencies (see Table 1), it is noticeable that the median for the above competencies "before" was 0, while “after” the course the children rated their competencies higher between 3 and 4.

Table 2: Rating of the data competencies from the students (first evaluation case)

Data competencies	**Median before**	**Median afterwards**
I know what a database is used for	0	3
I can write and read values in a database	0	2.5
I can delete values in a database	0	3
I can save a list in the database and display the list	0	3
I know the difference between a local and a web database	0	2
I can add, change, and delete values in a list	0	2.5

Regarding the evaluation of the self-evaluations on data competencies (see Table 2), a clear increase in the assessed competencies can be noted. In three competency areas, the median of the assessed data skills is 3, 2.5 in two areas and 2 in one.

1.2.2 Conclusion of the first evaluation case

In summary, the self-assessed competency increase is stronger in the field of the app development competencies than in the field of data competencies, because the self-acquired app development competencies were assessed in three cases at 4, representing the highest level, while the highest competency scores for data competencies were only 2.5 and 3.

The self-assessment of competencies is subjective, however, since it is possible that some students over- or underestimate themselves. It is also questionable regarding how far children at this age can assess their competencies. This evaluation nevertheless provided an initial

impression of whether the learning scenarios promote and increase competencies; however, other evaluation possibilities must be considered in the future to make the acquisition of competencies objectively measurable.

1.3 Evaluation based on the pilots (Italy)

(see evaluation document in folder “Italy” - move to this document for the final report)

1.3.1 Evaluation pilot (Italy)

Beginning with the demographic data, 22 children participated in the evaluation trials which were divided into two all-days. All of the children were from grades 7 to 9. The gender ratio was about 63,2% (male) and 36,8% (female). The main source of information about the courses was the school (94,7%), followed by parents (5,3%). Most of the children participated because it was part of the school course (63,2%), in addition to other reasons including “I think it will be useful for my training” (31,6%) and “it was advised by my teachers” (5,2%).

For the **assessment of the competencies**, a questionnaire was used. In the children’s (competency-) self-assessment, a ‘0’ means that they are not able to do a task, while a ‘4’ means that they rate themselves as being highly proficient at doing the task. The following table provides a first overview of the median of the pupils self-assessed digital literacy competencies.

Table 1.3.a: Self-assessment of the basic competencies from the pupils

Basic competencies	**Median before**	**Median afterwards**
I know what is a sensor	2.5	4
I know what is a 3D model	1	3.5
I know what is a 3D printer	1.5	4
I know what is scanning process	0.5	3

Regarding the development of self-assessed data literacy competencies (see Table 1.3.b), a positive trend can also be observed.

Table 1.3.b: Self-assessment of data and data literacy competencies from the pupils

Data competencies	**Median before**	**Median afterwards**

I can collect data.	1	3
I can analyze data.	1	4
I can display measurement data (e.g., on the display).	0.5	3.5
I can interpret the results of data (e.g. the result of a 3D scan).	1	3
I can open data in a programme and look at it.	0	3
I know what a data library is.	1	4
I know the difference between data and metadata.	0	2
I can handle data into software.	0.5	2.5

Digital fabrication competencies	**Median before**	**Median afterwards**
I understand the main definitions of 3D printing.	1	4
I can set up a 3D model ready to print.	0	3.5
I can use slicing software.	0	3
I can analyse a printed model.	0	4
I know what a machine path is to instruct a 3D printer.	0	3
I can handle a 3D model.	1	3.5

Self-assessed scientific inquiry competencies also developed positively (see Table 1.3.c).

Table 1.3.c: Self-assessment of scientific inquiry competencies and interests from the pupils.

Scientific inquiry competencies	**Median before**	**Median afterwards**
I can formulate a research question.	1.5	3.5
I can choose data for my research	0	3
I can present the results of an investigation (e.g., mapping a cultural asset/good).	0.5	4
I understand the scientific process (problem definition, formulation of research questions, planning, collection of data, analysis ...., summary of results).	1.5	3.5
Scientific/computer science/digital fabrication interests		
I am interested in science.	3	4
I can imagine studying something in the direction of computer science/digital fabrication.	2	3.5

1.3.2 Summing up the evaluation case

An overall increase in assessed competencies can be noted. The values in the scientific inquiry competencies and digital fabrication competencies were particularly high.

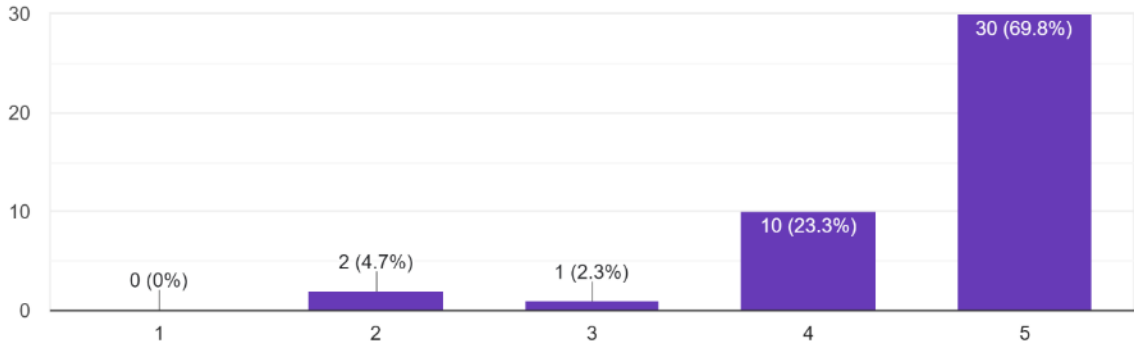
The overall assessment of the experience was positive. The most interesting activities were the collection of material data through 3D scanning of an object and its reproduction through 3D modelling and 3D printing. Interpretation and visualisation of the data was the most complex activity. The worksheets were considered simple and effective, especially the use of open source software, which provided students and teachers with tools and methods to easily replicate the activities at school. The time required to complete the activities was considered too short to develop the skills effectively, so a suggestion might be to revise longer scenarios for the future.

1.4 Evaluation based on the pilots (Greece)

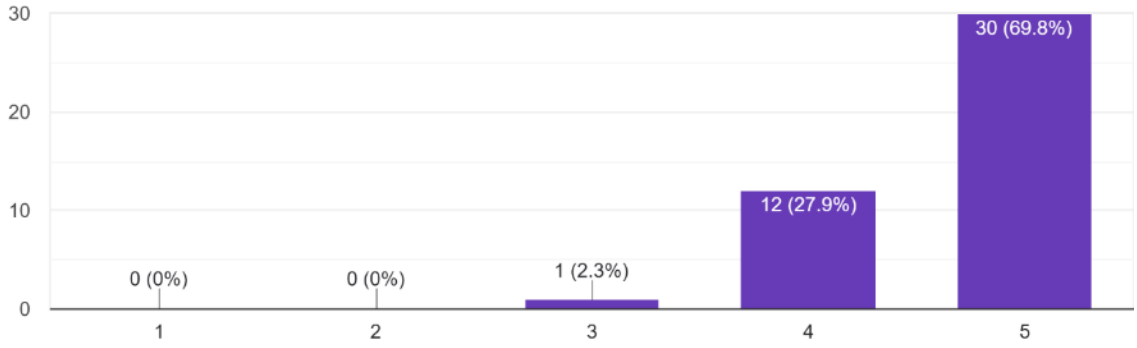
Beginning with the demographic data, 50 pupils participated in the evaluation trials. In the Skills Workshop we discussed how the data recorded by our school's seismograph can be used to inform the relevant authorities of an upcoming earthquake. The collection of scientific data by students and schools is part of a large movement called citizen science and can be of great help in several situations such as early warning of a major earthquake. Pupils were from Grade 8 second class of secondary school (100%). The gender ratio was about 47% (male) and 53% (female). The activities regarding earthquakes were delivered during the Soft skills session of the curriculum.

For the **assessment of the competencies,** questions addressing the relevant with the activity competences were used. In the pupil's (competency-)self-assessment, a '1' means that they are not able to do a task, while a '5' means that they rate themselves as being highly proficient at doing the task. The following Table provides a first overview of the pupils self-assessed data handling competencies.

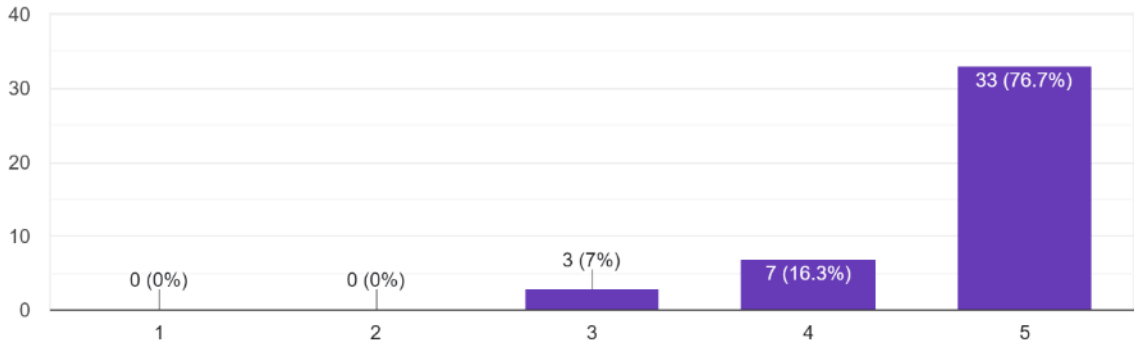
Table 1: Rating of the data handling competencies from the students



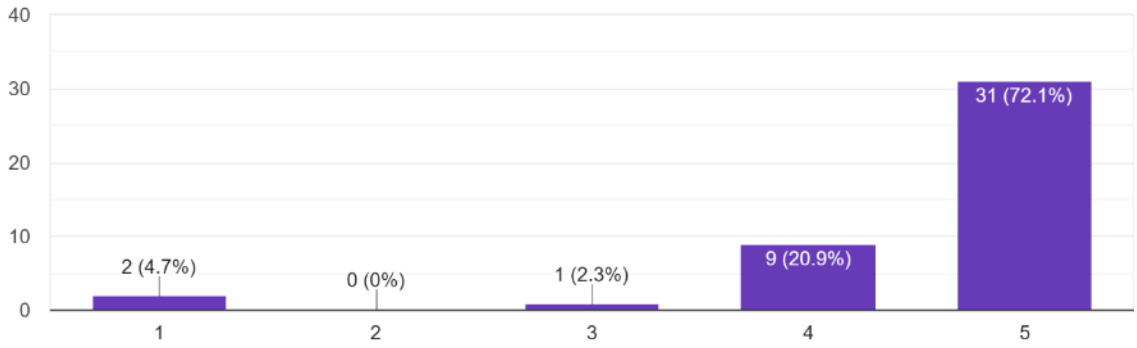
I can explain data that appear on the seismograph screen



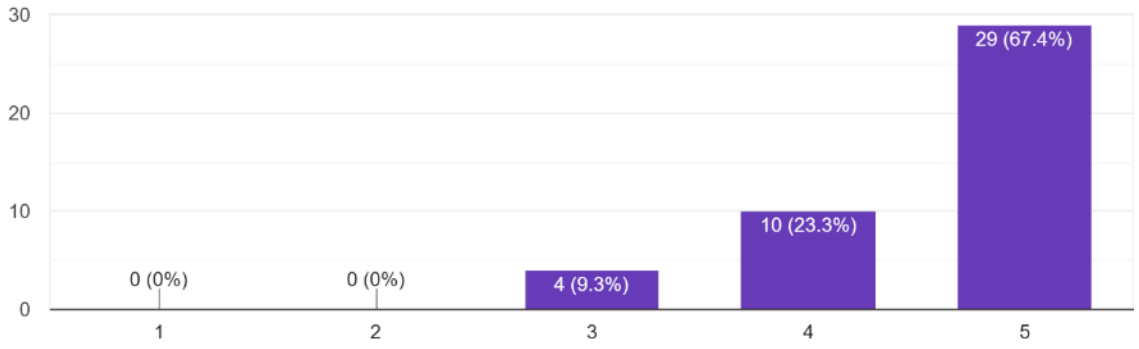
I can tell from the earthquake image if the earthquake happened near or far



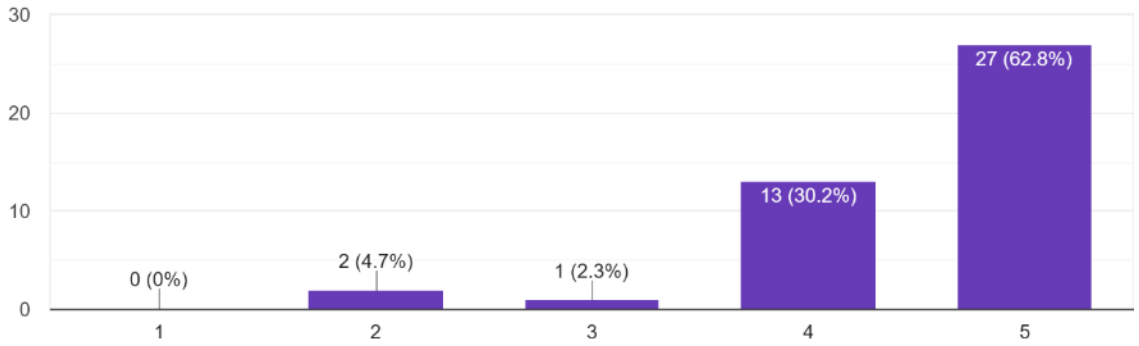
I can locate the epicentre of the earthquake from the seismograph data



I can explain the results of the earthquake epicentre exercise

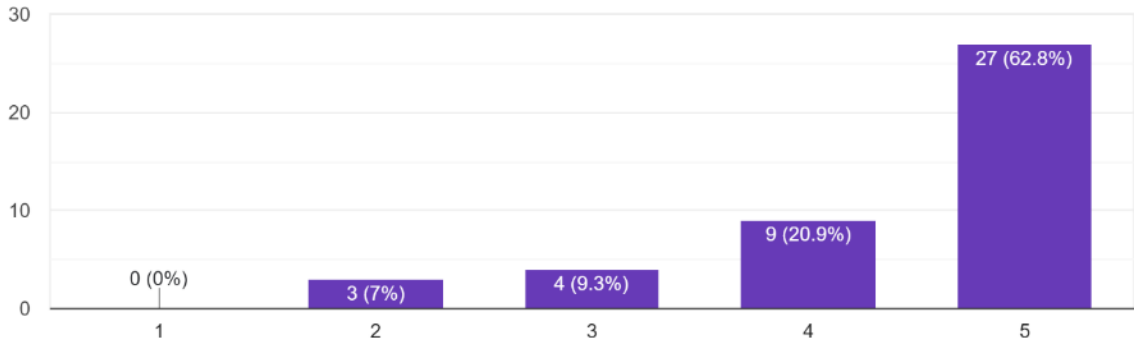


I can use the app to find the epicentre of the earthquake

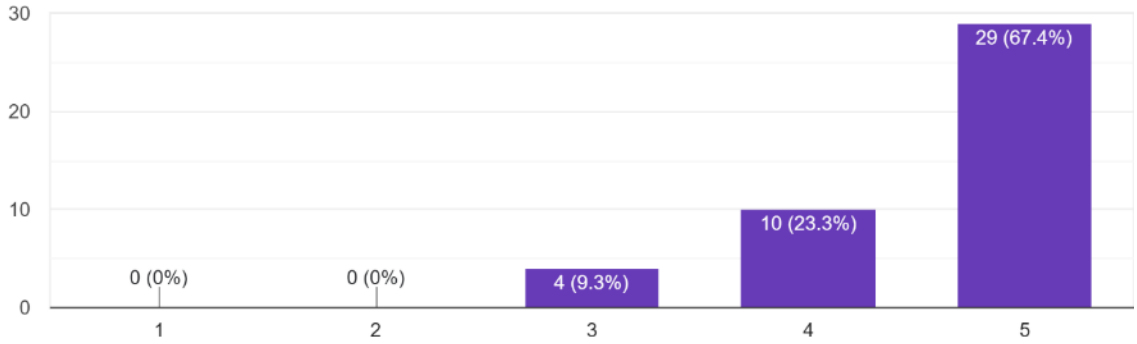


I can do the exercise for different earthquakes

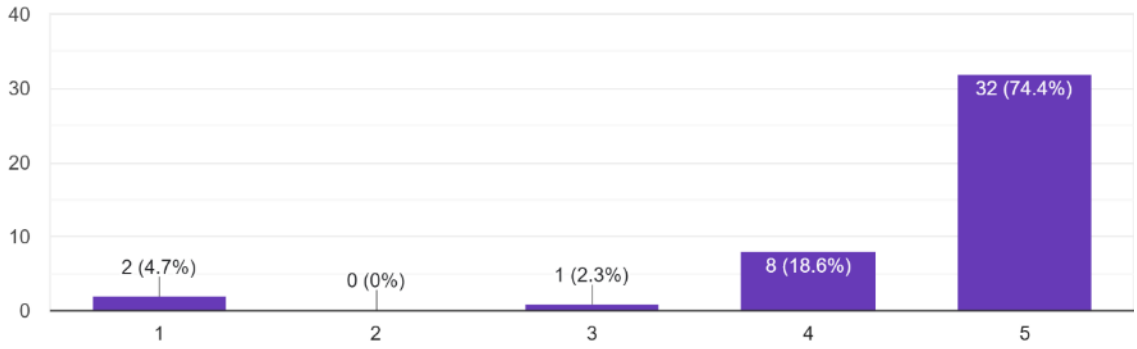
In the area of ***scientific inquiry*** competencies here follow the outcomes.



I can formulate a research question

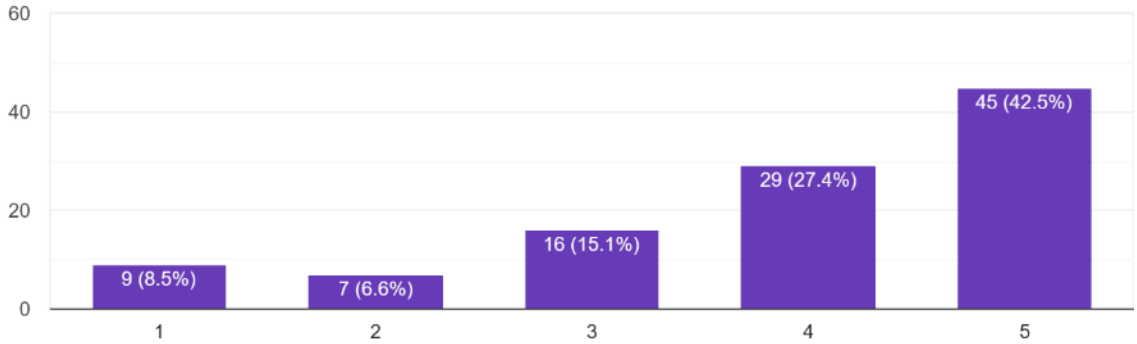


I can present the results of a survey.

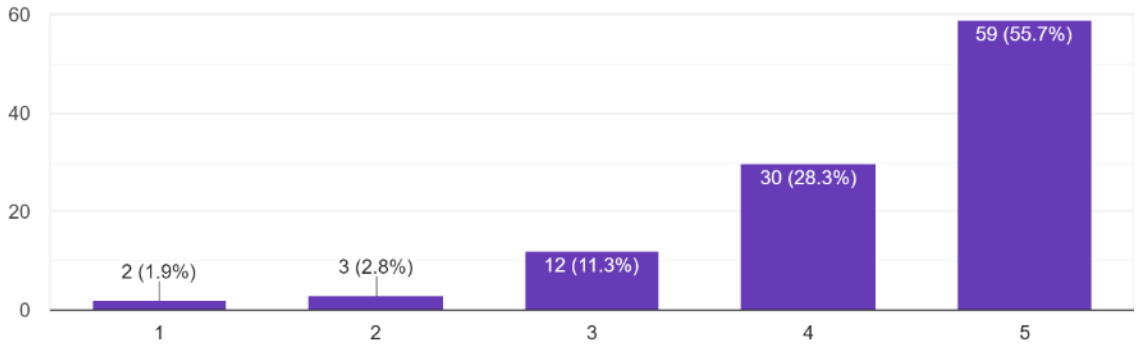


I have understood the scientific process

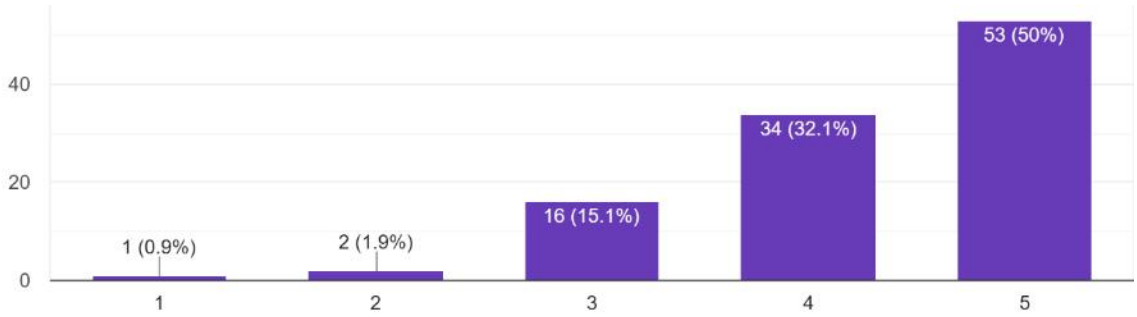
Regarding the didactic quality the following replies were collected.



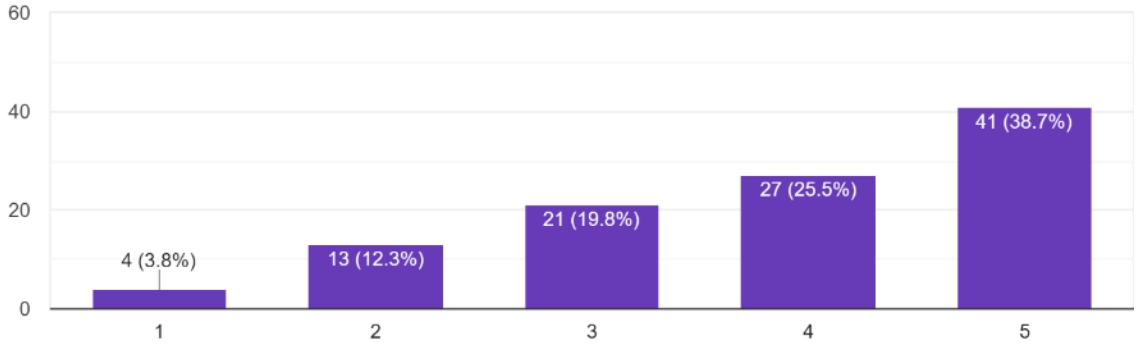
The atmosphere was pleasant



The description of the activity was clear



The instructions for the activities were clear and helpful



The number of hours spent was sufficient

1.5 Evaluation based on the pilots (Lithuania)

Beginning with the demographic data, 10 pupils participated in the evaluation trials. Pupils were from Grade 9 (100%). The gender ratio was about 40% (male) and 60% (female). The main sources of information about the courses were information at school (100%). Most of the pupils participated due to their own motivation (70%), while other reasons were that "the topic is included in the lesson plan" (30%).

For the **assessment of the competencies,** a questionnaire was used. In the pupil's (competency-)self-assessment, a '0' means that they are not able to do a task, while a '4' means that they rate themselves as being highly proficient at doing the task. The following Table provides a first overview of the median of the pupils self-assessed digital literacy competencies.

Table 1: Rating of the digital literacy competencies from the students

Digital literacy competencies	**Median before**	**Median afterwards**
I understand the main definitions of fake news.	0	3.5
I can analyze the media messages.	0	4
I can use lateral reading.	0	3
I know how to use the checklist in the evaluation of information sources.	0	3.5
I can evaluate the trustworthiness of my newsfeeds.	0	4

In the area of Digital literacy competencies (see Table 1), it is noticeable that the median for the above competencies "before" was 0, while "after" the course the children rated their competencies higher between 3 and 4.

Table 2: Rating of the Data/critical thinking competencies from the students

Data/critical thinking competencies	**Median before**	**Median afterwards**

I know where to check if the message is fake.	0	4
I can check the credibility of the source.	0	3.5
I understand the importance of validating information.	0	4
I understand the consequences if I do not fact check the information I receive	0	3

Regarding the assessment of the self-evaluations on Data/critical thinking competencies (see Table 2), a clear increase in the assessed competencies can be noted.

In summary, the self-assessed competency increase is more notable in the field of digital literacy competencies than in the field of data/critical thinking competencies.

However, it is important to note that the self-assessment of competencies is subjective since it is possible that some students over- or underestimate themselves. It is also questionable how competent are pupils at this age in assessing their competencies. This evaluation nevertheless provided an initial impression of whether the learning scenarios promote and increase competencies. Other evaluation possibilities must be considered in the future in order to make the measurement of competency acquisition more objective.

1.6 Summary and Recommendations

The first evaluation has shown promising results for the approach. The participants of the pilots have used the learning scenarios as well as provided input for the conceptual work. Each IO has been updated. Summarizing our results from the pilots, we can state the following:

- Citizen Science is a promising approach for teaching data-related as well as scientific competencies
- Citizen Science projects can be used in almost all subjects
- Citizen Science projects are not easy to organize, so guidance and supporting materials are urgently needed
- Open Learning Scenarios are helpful but most important are learning materials as OER
- OER should be easily retrievable and adaptable
- Worksheets are still most common and should be provided as an alternative to textbooks
- All pilots have shown positive competency developments

Based on the initial pilots, the project has made improvements to the conceptual IOs. The overall project approach (developing OEPs and OERs) will be continued as planned.

2 Large Scale Trials

The main idea of this phase is to try out the learning scenarios with schools in practice. We intended to involve both teachers as well as students. The results have also been used to create new versions of the learning scenarios (O3) and the competency framework (O2).

2.1 Participants

The evaluation in the large scale trials was separated into two main evaluation parts, for students and teachers. We focus on the evaluation of the main outcome, the learning scenarios which are most important for schools and teachers. We aimed to include both the students and teachers' perspective.

For students, the following events took place

Large scale trial	**Responsible**	**Participants**	**Evaluation**
senseBox - Co2 traffic light	HRW	9	8
senseBox- open evening	HRW	2	2
stratosphere balloon course	HRW	3	3
Girls Day	HRW	7	0
FabLab Course Goetheschule	HRW	27	27
Fake news	VGTU	40	40
Seismographs (2023)	EA	115	105
Preserving, restoring and reproducing cultural heritage	POLIBA	45	12

For teachers, the following events were organized

LARGE SCALE TRIAL			
Large scale trial	**Responsible**	**Participants**	**Evaluation**
FabLab 17.6.22	HRW	3	3
Summer school 2022	EA	25	13
Fake news	VGTU	10	10
Cultural Heritage Accessibility	POLIBA	56	3
Summer School Foodshift 2023	HRW/EA	30	23
earthquake project	EA	120	106

Overall, 248 students and 219 teachers joined our workshops. In the following, we will describe the results of the large scale trials and the corresponding results and implications.

2.2 Evaluation based on the trials (Germany)

Overall, 48 students and 33 teachers participated in the German events. One event was not local but organized in collaboration with EA (Summer School 2023, Marathon, Greece) where teachers from all over Europe participated.
Regarding the focus topics / competencies, HRW has specialized on the combination of Citizen Science with data science and computational thinking / programming as the FabLab is part of the Institute Computer Science.

2.2.1 Competency-based evaluation: Sense Box Autumn Course

This trial used an adapted evaluation framework focusing on the competencies addressed. The course has focused on the use of sensor to measure air quality. Around fifteen learning scenarios and related worksheets were prepared (https://fabcitizen.eu/technologies/sensebox/). Those included competencies on data handling (data collection, data cleaning, data analysis, data interpretation), app programming (App Inventor) as well as scientific thinking. The course duration was 5 days with about 7 hours per day.

		
App Development	Data Collection	Final day

Nine children (five boys and four girls) from 5th to 9th grade participated in the first evaluation case, where eight of nine children participated in the course evaluation. Most of the students learned about the course via flyers/posters or newspapers (four mentions) and by their parents (four mentions), while other information sources were the internet (one mention) and the personal contact with the course trainer (one mention).

The next evaluation section is the competency self-assessment of the basic competencies of the students (see Table 13), where a positive trend can be observed in relation to basic competencies. In three of the four competency areas, the median of the self-assessed basic

competencies after the course is in three cases at 4 and in one case at 3 (on a scale from 0 to 4).

Table 3: Self-assessment of the basic competencies from the pupils (first evaluation case)

Basic competencies	**Median before**	**Median afterwards**
I know what a condition is (if/else)	2.5	4
I know what a breadboard is and what a microcontroller is	1	3
I know what a loop is	2.5	4
I know what a sensor is	3	4

Regarding the development of self-assessed microcontroller programming competencies (see Table 4), a positive trend can also be observed. In three of the four areas of competency, the median of the self-assessed competencies is later at 4/4 and in one each at 2.5, 2 and 3. In two competencies (connect the senseBox to the internet and find errors in blocks), no previous knowledge is required.

Table 4: Self-assessment of the microcontroller programming competencies from the pupils (first evaluation case course)

Microcontroller programming competencies	**Median before**	**Median afterwards**
I can find, save, and reuse programmes	2.5	4
I can connect various components to the senseBox (e.g., LED, sensor...)	1	4
I know how to load a programme onto the microcontroller	2	4
I can connect the senseBox to the Internet.	0	2.5
I can find errors in blocks	0	2
I can write a programme using Blockly	1	3.5

The before and after comparison of the median of the self-assessed data competencies (see Table 5) shows that before, none of the medians of the data competency areas showed a value greater than 1, while after the course, six of eight competency areas were assessed with a median between 3 and 4 and only two competency areas with a 2 out of 4.

Table 5: Self-assessment of the data competencies from the pupils (first evaluation case course)

Data competencies	**Median before**	**Median afterwards**
I can retrieve sensor data.	1	3
I can analyze sensor data.	1	4
I can display measurement data (e.g., on the display).	1	4
I can interpret the results of (sensor) data (e.g., using limit values).	1	3.5
I can open data in a programme and look at it.	1	4
I can visualize data (e.g., with Excel).	1	4
I know different data formats (e.g., .csv file, .xlsx file).	0	2
I can convert data into another format.	0.5	2

Self-assessed scientific inquiry competencies also developed positively (see Table 16). While before the course the three competency assessments were between 1 and 2, the assessments were between 3.5 and 4 after the course, showing a significant increase.

Table 6: Self-assessment of the scientific inquiry competencies and interests from the pupils (first evaluation case course)

Scientific inquiry competencies	**Median before**	**Median afterwards**
I can formulate a research question.	2	3.5

I can present the results of an investigation (e.g., of the CO2 content).	1	4
I understand the scientific process (problem definition, formulation of research questions, planning, collection of data, analysis ...., summary of results).	1	3.5
Scientific/computer science interests		
I am interested in science.	4	4
I can imagine studying something in the direction of computer science.	3	3

Although comparing the medians shows no difference in the development of interest in science and computer science (see Table 6), a closer analysis of the data, including the view of the diagram, shows that the data have shifted to the right, meaning towards higher interest in science and computer science (see Appendix E: Final survey – second evaluation case).

Summarizing the results, an overall increase in assessed competencies can be noted. The values in the scientific inquiry competencies and basic competencies were particularly high. In the area of microcontroller programming and data competencies, both strong increases (to 4/4) and lower increases (2/4) were recorded, which can be explained in some instances, for example, due to a problem connecting the senseBoxes to the internet since too many were connected to the same network, resulting in a traffic overload (see competency "I can connect the senseBox to the internet). In addition, it is not yet known why the competency "I can find errors in blocks" is rather low, which represents a topic that could be examined in a follow-up course.

Regarding the data competencies, two competencies are rated lower due to different data formats and the transformation of data formats, where the method of converting the csv file into Excel did not work because the data were not analyzed from openSenseMap but from the SD card and '.txt-Files' were converted into Excel. The data formats were nonetheless briefly explained so that the students could develop basic knowledge. The worksheets were not yet designed for this method since another was originally planned. In addition, a different version of Excel on the laptops made the conversion difficult, which is why the worksheets were of limited help in this learning scenario.

The above-mentioned weaknesses of the learning scenarios were improved in the final work, but the course was overall rated positively by seven of eight students.

2.2.2 Stratosphere Balloon

In this course, several competences were combined. The overall project was to develop a stratosphere balloon mission to gather atmospheric data. This includes the development of a control unit (Arduino), programming and data management. A subset of three scenarios were addressed:

- Asking (research) questions: The goal is to give learners an understanding of scientific processes, in particular formulating questions. In order to provide learners with an age-appropriate introduction, this learning scenario therefore poses questions that can be answered by observation and without the necessary hardware.
- For the central project of the stratospheric balloon, the learning scenario forms the basis for building own sensors using Arduino
- Sensor technology and data memory: This learning scenario combines competencies in data collection with the basic knowledge of programming gained. Learners are asked a research question. Methodology and measuring stations are developed independently in order to answer it.

Those scenarios were evaluated to cover the broadest range of competencies as possible. The participating learners are listed below. It should be noted that learning scenarios 4 and 5 build on each other and were evaluated with the same learners.

Learning scenario	1	4	5
Learners (total)	11	3	3
- male	7	3	3
- female	4	0	0

In the following, we describe the competence development in detail.

As a start, the course format and learning materials were briefly evaluated. The following table shows the overall results, distinguished by grades. The scale was between 1 (strongly disagree) and 7 (strongly agree).

	The content of the course is comprehensible	The content of the course is well organized	The content of the course encourages reflection on the topic	The content of the course motivates me to continue to study the subject.	I have learned a lot
Total	6,7	6,4	6	5,7	6,3
Class 5	6,6	5,8	6,2	5,6	6,4
Class 6	6,7	7	6	6,3	6,7
Class 7	7	6,7	5,7	5,3	5,7
male	6,7	6	5,9	5,6	6
female	6,8	7	6,3	6	6,8

Overall, the course was well organized and suitable for the age group. As a second step, we focused on the three learning scenarios and corresponding competence development.

Learning Scenario 1 provides an important foundation of scientific literacy, a first insight into correctly answering and identifying scientific questions. The responses from "1 - strongly disagree" to "6 - strongly agree" were given for the following elements and their change between before and after in relation to the learning scenario was compared.

Competence	Before	After	Change
I know what science is all about	4,4	4,6	0,2
Basics	4,3	4,7	0,4
I know what an open question is	4	4,9	0,9
I can understand larger contexts of questions stand	4,6	4,5	-0,1
Data handling	4,2	4,5	0,3
I know how to get usable data (answers)	4,4	4,7	0,3
I know how correct of faulty and fal-data (responses) can be distinguished	3,9	4,3	0,4
Science	3,6	4,4	0,8
I know how to answer scientific questions	3,7	4,6	0,9
I can distinguish scientific from non-scientific questions distinguish	3,4	4,2	0,8

Overall, the competences have increased - given the rather short duration of the course, the development can be seen as very positive, in particular with the focus on research questions.

Learning scenario 4 covers the basics of programming with the Arduino. The 3 learners who were found for the evaluation of the learning scenario are all male and students of grade 7. Similar to the first learning scenario, we asked for the competence development - it should be noted that only three learners participated, therefore, we also included qualitative results.

Competence	Before	After	Change
I can program	2	2,3	0,3
Basics	3,7	4,3	0,6
I can break down a large task into smaller tasks	4	4,3	0,3
I understand the code that is explained to me	3,3	4,3	1,0
Programming	5,5	5,9	0,4
I know what a loop is	5,7	6	0,3

I know what a condition is	5,3	5,7	0,4
Microcontroller	3,5	5,1	1,6
I know what a microcontroller is and how to use it	4	5,5	1,5
I know how to build a microcontroller with additional Hardware extended	3	4,7	1,7

For the participants, the basic programming competence development including Arduino worked very well. Finally, it emerged in the conversation that one of the learners already had prior experience with the Arduino, which is why he found the course too easy / slow. We therefore recommend to allow different paces of mastering the scenarios.

Learning scenario 5 extends on the programming by adding data competences. The competence development was evaluated as following.

Competence	Before	After	Change
I can program	2,3	3,3	1,0
Basics	4,5	4,7	0,2
I understand the code that is explained to me	4,7	4,7	-
I can break a large task into smaller tasks split	4,3	4,7	0,4
Microcontroller	5	5,2	0,2
I know what a microcontroller is and how to use it	5,7	5,7	-
I know how to build a microcontroller with to-extended by additional hardware	4,3	4,7	0,4
Save measurement data	4,2	4,5	0,3
I know how measurement data is collected	4,3	4,3	-
I understand how measurement data is stored can	4	4,7	0,7

After this evaluation part, we improved the scenarios based on the suggestion of the students. In particular, we recommended to have different groups with different base knowledge. However, the scenarios and the related lessons can be seen as very successful and transferable to other schools and contexts.

2.2.3 FabLab - Artificial Intelligence

As a last exemplary evaluation, we choose a one day workshop on data handling and artificial intelligence (https://fabcitizen.eu/competencies/ai-knowledge/). 27 learners (17 male, 10 female) and 3 teachers participated in this course.

The focus areas were data competencies combined with App programming in App Inventor for data collection and analysis with mobile devices. Furthermore, basic machine learning principles were introduced with a focus on training data. The following competence developments were achieved.

The format of the course was a full day workshop in the FabLab Bottrop. After an introduction, the learning scenario on machine learning and related learning scenarios on AppInventor were utilized.

Competence	Before	After	Change
Basics			
I know what a variable is	2,0	2,5	0,5
I know and can choose variable types	3	4	1
I know what a condition is	2,6	2,8	0,2
I know what an object is	1,5	2,0	0,5
App Inventor			
I know how to create UI elements like buttons, text fields	0,8	2,5	1,7
I can integrate pictures and videos	0,9	1,5	0,6
I know how to deploy an app	0,7	1,8	1,1
Data and AI			
I know how to modify and display variables	1,4	2,4	1,0
I know what a neural net is	0,4	1,4	1,0
I know how to train a neural network	0,4	1,4	1,0
I know problems which can occur training AI	0,2	2,0	1,8

This course was a course for beginners, only very few had previous knowledge on programming at all. Therefore, we could see that our learning materials were also suitable for beginners. It was recommended to provide also more preparation and basic materials. Those have been added to our collection in IO3.

2.2.4 Practitioner Evaluation

The evaluation of two representative learning scenarios occurred with two OER experts and two teachers. The learning scenarios ‘AppInventor: Creation of a TODO list – Creating a TinyDB’ and ‘AppInventor: Outdoor App’ were evaluated for this purpose.
No negative comments were mentioned about the learning scenarios. Furthermore, sev-eral improvement ideas were articulated, such as that the work sheets contain “quite a lot of text”. Another proposition was to use the CC BY SA license since it can exclude user or target groups (e.g., private schools). Further ideas for learning scenarios are the internet sites ‘IT 2 School’ and ‘AppCamps’, which provide CC BY SA learning material for schools for computer science. Moreover, it is recommended to provide graduated assistance to

reach every pupil as well as to adapt the complexity of the worksheets to the learning level of the students. If there are students who say, "I can do that already", the tasks should not be too easy from the start. To reach students with little previous knowledge, one idea is to distribute stacks of flashcards in different skill levels as needed. It is also helpful to develop learning scenar-ios which are independent of the school infrastructure or to provide infrastructure if needed. A positive aspect about the learning scenarios was mentioned, which was that they are “attractively designed”.
The learning scenarios were rated by the criteria “integration into the curricula”, “understandability” and “integration into the curricula”. Only the first criterion was discussed, and thus the others are not further considered. The integration into the curricula is easy if the programming environment is provided in a browser and if the programming language is platform independent. Furthermore, the integration into the curricula is moderate or difficult if installations are needed to conduct the learning scenarios. Another possibility is that an external service provider takes over the hosting. The integration of the learning scenarios into the curricula is difficult if tablets are missing and if there are troubles with Wi-Fi.#
Future ideas for learning scenarios or CS projects in information systems are collected and include the following: measurement of the CO2 exposure, projects that address the data collection and projects using a fine dust sensor. When brainstorming for further projects, other aspects emerged that should be considered, such as the data protection laws, especially regarding the online accounts and which data were collected. Another challenge was mentioned regarding ‘hardware’ since it could pose a problem and that online programming could be an alternative when the service operates online.

To summarize the German events, we have achieved positive results, in particular regarding competence development. Also, the learning scenarios had positive feedback from both teachers and students. All improvements suggested during this evaluation were incorporated in the scenarios / worksheets.

2.3 Evaluation based on the trials (Italy)

Overall, 45 students and 56 teachers participated in the Italian events.
Regarding the focus topics / competencies, POLITECNICO DI BARI focused on the synergies between Citizen Science and Cultural Heritage.

2.3.1 Competency-based students evaluation: IoT & Cultural heritage in the environment of Fablab

This trial used an adapted evaluation framework focusing on the digital literacy and data/critical thinking competencies. The course involved a student group in hands-on activities in Fablab focused on preserving, restoring and reproducing cultural heritage good. The main goal of the courses was to understand how we can make cultural heritage more accessible with the help of IoT tools and digital innovation. Students analysed different case studies, different technologies and methods to work on the several themes with the support of worksheets prepared by Fablab Poliba. After the situation analysis, students were involved in the group discussions and drawing of conclusions.

45 pupils (40 boys and 5 girls) from 7th to 10th grade participated in the first evaluation case. 40 of them evaluated the course. Most of the students learned about the course via flyers/posters/emails with their school (77,5%) and by their teachers (22,5%).

The next evaluation section is the competency self-assessment of the basic competencies of the students (see the Table 1 below), where a positive trend can be observed in relation to basic competencies.

Table 1: Self-assessment of the basic competencies from the pupils (first evaluation case).

Basic competencies	Median before	Median afterwards
I know what is a sensor	3	4
I know what is a 3D model	1	3.5
I know what is a 3D printer	1	4
I know what is scanning process	0	3

In the area of Digital literacy and digital fabrication competencies (see Tables 2 and 3 below), it is noticeable that the median for the above competencies "before" was 0 or 1, while “after” the course the children rated their competencies near maximum - 3 or 4.

Table 2: Self-assessment of the data competencies from the pupils (first evaluation case course).

Data competencies	Median before	Median afterwards
I can collect data.	1	3
I can analyze data.	1	4
I can display measurement data (e.g., on the display).	0.5	3.5
I can interpret the results of data (e.g. the result of a 3D scan).	1	3
I can open data in a programme and look at it.	0	3
I know what a data library is.	1	4
I know the difference between data and metadata.	0	2
I can handle data into software.	0.5	2.5

Table 3: Self-assessment of the digital fabrication competencies from the pupils (first evaluation case course).

Digital fabrication competencies	Median before	Median afterwards
I understand the main definitions of 3D printing.	1.5	4
I can set up a 3D model ready to print.	0	3.5

I can use slicing software.	0	3
I can analyse a printed model.	0	4
I know what a machine path is to instruct a 3D printer.	0.5	3
I can handle a 3D model.	1	3.5

Self-assessed scientific inquiry competencies also developed positively (see Table 4 below).

Scientific inquiry competencies	**Median before**	**Median afterwards**
I can formulate a research question.	1.5	3.5
I can choose data for my research	0.5	3.5
I can present the results of an investigation (e.g., mapping a cultural asset/good).	1	4
I understand the scientific process (problem definition, formulation of research questions, planning, collection of data, analysis ...., summary of results).	1.5	4
Scientific/computer science/digital fabrication interests		
I am interested in science.	3	4
I can imagine studying something in the direction of computer science/digital fabrication.	1	3.5

45 students (16 male and 29 female) from 9th to 10th grade partecipated in the second evaluation case. Regarding the assessment of the self-evaluation competencies, we used the same questionnaire and we can notice the same positive trend before and after the course, reached again a maximum evaluation.

Summarizing the results, an overall increase in assessed competencies can be noted. The values in digital literacy, data/critical thinking and digital fabrication competencies reached a value near the maximum. The values in scientific inquiry competencies and basic competencies were high. In particular in the area of digital fabrication strong increase can be noticed after the course, rating positive for the learning by doing type of activity.

2.3.2 Competency-based teachers evaluation: Accessibility of cultural heritage

The course involved 56 teachers and teacher traniners – they had a full day workshops and a round table. The main goal of the sessions was to analyze the teaching methods on showing students how digital innovation can improve the accessibility of cultural heritage asset. Teachers were working on learning scenarios focused on scanning and LDM 3d printing for cultural heritage accessibility. The demo sessions were hosted in Fablab Poliba and worksheets have been prepared by us to lead the teaching/learning efforts. After the sessions teachers were involved in a round table to discuss and evaluation their competences.

As a start, the workshop format and learning materials were briefly evaluated. After this evaluation part, teachers suggested how learning scenarios and worksheets can be improved. As a result, some additional materials were designed and more discussion topics were included. However, in general the scenarios and related learning activities were seen as of high quality and transferable to other schools and contexts. The teachers were willing to include them in their lectures and recommend them to others. At the end teachers were reflecting on their experiences with the learning scenarios in the classroom context by selecting how much the given statements apply (1- does not apply at all, 5 - fully applicable) (see Table 5 below).

Table 5: Teachers reflection on their experience with the scenarios in the classroom context.

Statements	**The average evaluation (1-5)**
The scenarios were understandable and useful	5

The scenarios can strengthen interest in Citizen Science	4
The learning scenarios (about citizen science) can be integrated in school.	4
The learning scenarios are helpful for school lessons.	5
The learning scenarios can be easily adapted for school lessons.	3.5
The Citizen Science approach is feasible for schools.	4.5

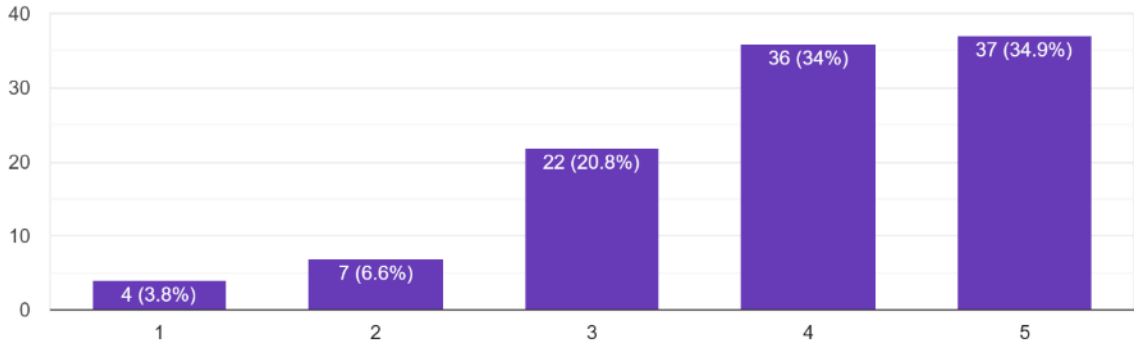
To summarize the Italian events, we have achieved a strong interest and positive results, expecially regarding competence development. Students were very satisfied with the experience, evaluating the competences as the maximum after taking the course. Teachers and teacher trainers also reflected on a positive experience, taking the fablab experience back to their school and university contexts. All improvements suggested during this evaluation were incorporated in the scenarios / worksheets.

2.4 Evaluation based on the trials (Greece)

Overall, 120 students and 2 teachers participated in the Greek large-scale trials. Pupils were from Grade 5 (firth class of primary school, 100%), out of whom 106 students completed the questionnaire.

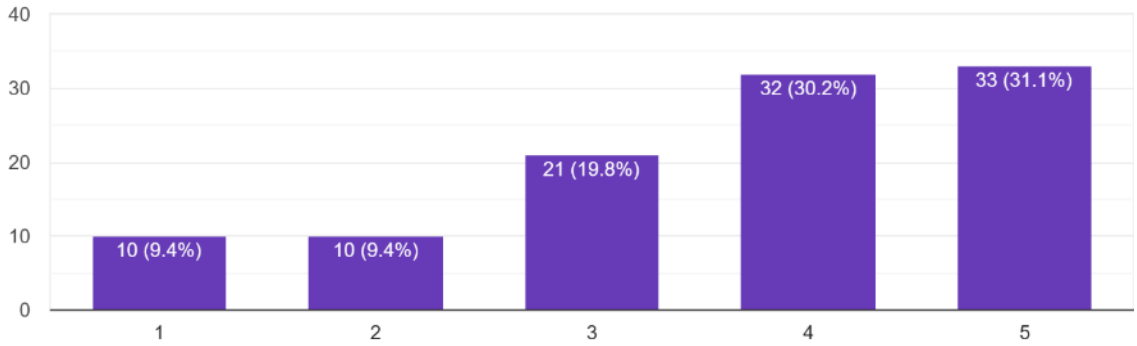
In the Soft Skills Workshop we discussed how the data recorded by our school's seismograph can be used to inform the relevant authorities of an upcoming earthquake. The collection of scientific data by students and schools is part of a large movement called citizen science and can be of great help in several situations such as early warning of a major earthquake. The gender ratio was about 47% male and 53% female. The activities regarding earthquakes were delivered during the Soft skills session of the curriculum.

For the **assessment of the competencies,** questions addressing the relevant with the activity competences were used. In the pupil's (competency-)self-assessment, a '1' means that they are not able to do a task, while a '5' means that they rate themselves as being highly proficient at doing the task. The following Table provides a first overview of the median of the pupils self-assessed data handling competencies.

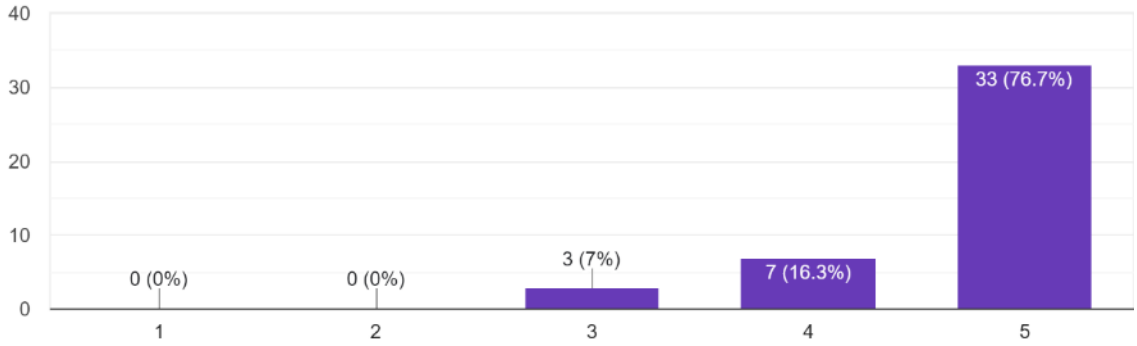


I can explain data that appear on the seismograph screen

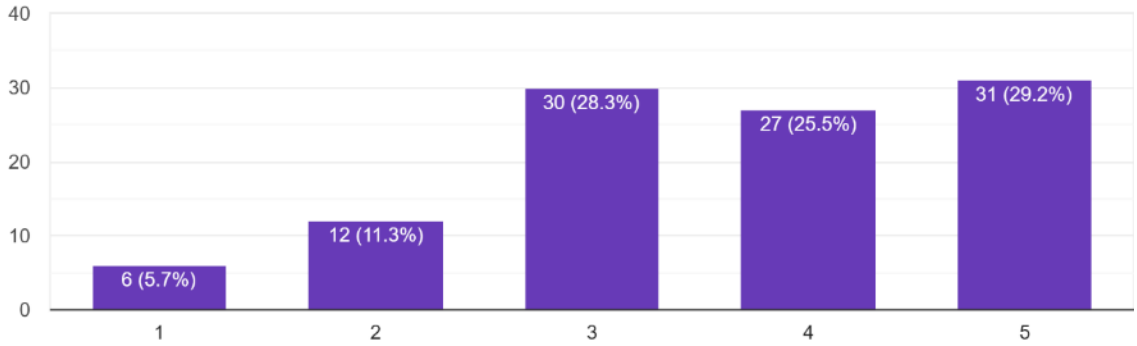
.



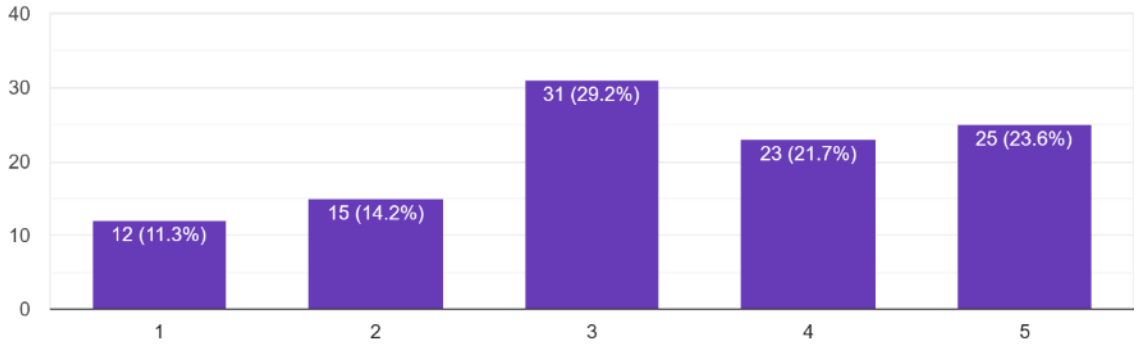
I can tell from the earthquake image if the earthquake happened near or far



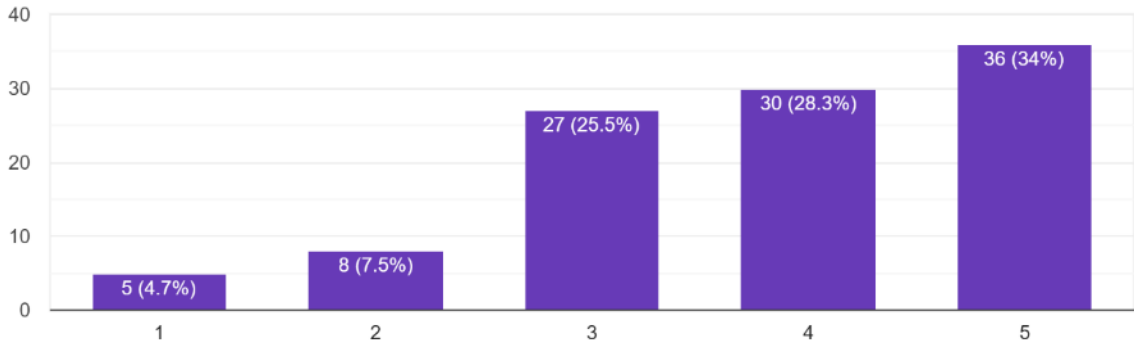
I can locate the epicentre of the earthquake from the seismograph data



I can explain the results of the earthquake epicentre exercise

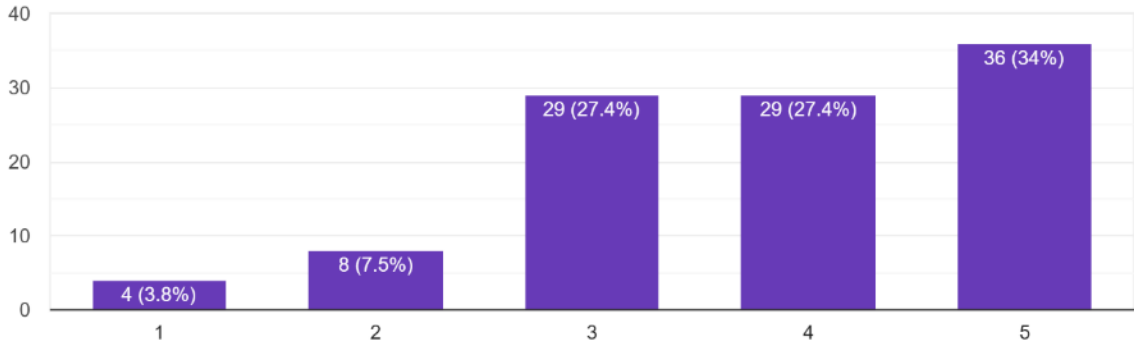


I can use the app to find the epicentre of the earthquake

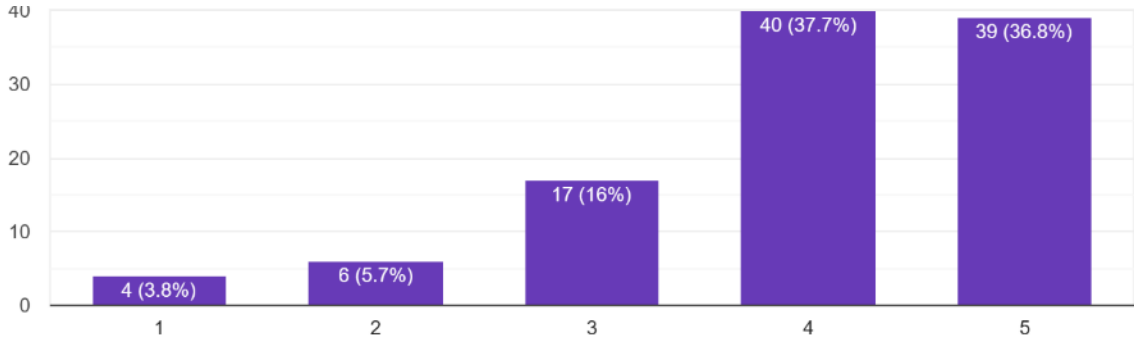


I can do the exercise for different earthquakes

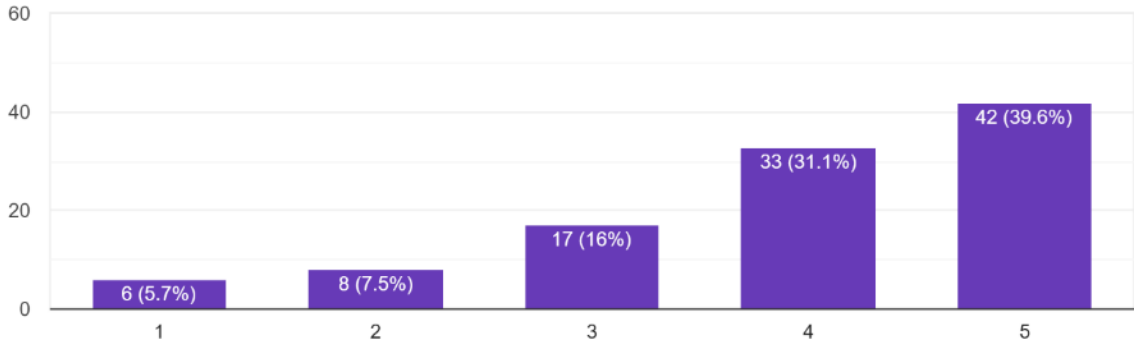
In the area of ***scientific inquiry*** competencies here follow the outcomes.



I can formulate a research question



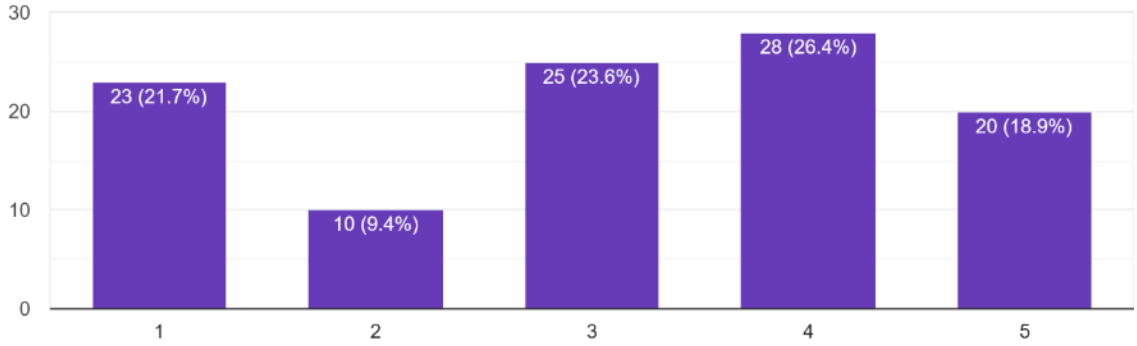
I can present the results of an investigation.



I have an understanding of the scientific process (problem definition, formulation of research questions, planning, collection of data, analysis ...., summary of results).

Summarising the results, it is important to note that the self-assessment of competencies is subjective since it is possible that some students over- or underestimate themselves. It is also questionable how competent are pupils at this age in assessing their competences. This evaluation nevertheless provided an initial impression of whether the learning scenarios promote and increase competencies. Other evaluation possibilities must be considered in the future in order to make the measurement of competency acquisition more objective. Overall, students strongly agreed (selecting the option 5 on the Likert scale) that 18% were motivated to work further on the topic of earthquakes after participating in these activities, 58% that they learned significant things on the specific topic, and 45% that overall, their level of knowledge about earthquakes was higher after participating in the activity.

Regarding future career choices here follow the replies regarding the statement “I can imagine studying something in the direction of science later”. A percentage of ~19% strongly agreed on the statement and 26% agreed on a ⅘ scale, which we think is quite substantial for students at this age. In principle, we see that the percentages are somewhat lower of this target group, however, this is understandable in view of the complexity of the activities, which we think are successful. In any case this will be taken under consideration for further iterations.



I can imagine studying something in the direction of science later on.

2.5 Evaluation based on the trials (Lithuania)

Overall, 40 students and 10 teachers participated in the Lithuanian events.

Regarding the focus topics / competencies, VILNIUS TECH focused on the synergies between Citizen Science and fake news (misinformation).

2.5.1 Competency-based students evaluation: Fake news course

This trial used an adapted evaluation framework focusing on the digital literacy and data/critical thinking competencies. The course involved 2 student groups (first group of 27 students in the event of 2 days, the second group with 13 students and the event of 1 day). The main goal of the courses was to understand that not all information on the Internet and social media outlets is relevant and reliable, to learn how to critically evaluate it and to understand what can and cannot be published online. Possible scenarios for safe behaviour online we suggested. Students analysed different case studies of misinformation with the support of worksheets prepared by VILNIUS TECH. After the situation analysis, students were involved in the group discussions and drawing of conclusions.

27 pupils (10 boys and 17 girls) from 7th to 10th grade participated in the first evaluation case. All of them evaluated the course.

For the **assessment of the competencies,** a questionnaire was used. In the pupil's (competency-)self-assessment, a '0' means that they are not able to do a task, while a '4' means that they rate themselves as being highly proficient at doing the task. The following Table provides a first overview of the median of the pupils self-assessed digital literacy competencies.

Table 1: Rating of the digital literacy competencies from the students

Digital literacy competencies	Median before	Median afterwards
I understand the main definitions of fake news.	1	4
I can analyze the media messages.	0	4
I can use lateral reading.	1	4
I know how to use the checklist in the evaluation of information sources.	0	4
I can evaluate the trustworthiness of my news feed	0	4

In the area of Digital literacy competencies (see Table 1), it is noticeable that the median for the above competencies "before" was 0 or 1, while “after” the course the children rated their competencies the maximum - 4.

Table 2: Rating of the Data/critical thinking competencies from the students

Data/critical thinking competencies	Median before	Median afterwards
I know where to check if the message is fake.	1	4
I can check the credibility of the source.	0	4
I understand the importance of validating information.	2	4
I understand the consequences if I do not fact check the information I receive	2	4

Regarding the evaluation of the self-evaluations on Data/critical thinking competencies (see Table 2), again there can be seen a maximum evaluation after taking and participating in the course.

13 children (5 boys and 7 girls) from 9th to 10th grade participated in the second evaluation case, all of them participated in the course evaluation.

For the **assessment of the competencies,** the same questionnaire was used. The following table provides a first overview of the median of the pupils self-assessed digital literacy competencies.

Table 3: Rating of the digital literacy competencies from the students

Digital literacy competencies	**Median before**	**Median afterwards**
I understand the main definitions of fake news.	2	4
I can analyze the media messages.	2	4
I can use lateral reading.	1	4
I know how to use the checklist in the evaluation of information sources.	0	4

I can evaluate the trustworthiness of my news feed.	3	4

In the area of Digital literacy competencies (see Table 4), it is noticeable that the median for the above competencies "before" was from 0 to 3, while “after” the course the children rated their competencies the maximum - 4.

Table 4: Rating of the Data/critical thinking competencies from the students

Data/critical thinking competencies	**Median before**	**Median afterwards**
I know where to check if the message is fake.	2	4
I can check the credibility of the source.	2	4
I understand the importance of validating information.	3	4
I understand the consequences if I do not fact check the information I receive	3	4

Regarding the assessment of the self-evaluations on Data/critical thinking competencies (see Table 2), again a maximum evaluation can be noticed after participation in the course.

Summarizing the results, an overall increase in assessed competencies can be noted. The values in digital literacy, data/critical thinking competencies reached the maximum in both groups. Since the students were of different age groups (first group from 7th to 10th grade, second group from 9th to 10th grade), the primary better evaluation can be seen in terms of the competences even before taking the course in the second group. But after the course, all groups reached the maximum evaluation.

2.5.2 Competency-based teachers evaluation: Fake news in the context of citizen science course

The course involved 10 teachers – they had a full day workshop. The main goal of the courses was to analyze the teaching methods on showing students that not all information on the

Internet and social media is relevant and reliable, help them critically evaluate it and to understand what can and cannot be published online. Teachers were working on learning scenarios focused on fake news with the help of citizen science. The worksheets have been prepared by VILNIUS TECH to lead the teaching/learning efforts. After the workshop teachers were involved in the discussion and evaluation of their competences (all teachers participated in the evaluation by filling questionnaires).

As a start, the course format and learning materials were briefly evaluated. After this evaluation part, teachers suggested how learning scenarios and worksheets can be improved. As a result, some additional materials were prepared and more discussion topics were included. However, in general the scenarios and related lessons were seen as of high quality and transferable to other schools and contexts. The teachers were willing to include them in their lectures and recommend them to others.

At the end teachers were reflecting on their experiences with the learning scenarios in the classroom context by selecting how much the given statements apply (1- does not apply at all, 5 - fully applicable) (see Table 5).

Table 5: Teachers reflection on their experience with the scenarios in the classroom context

Statements	**The average evaluation (1-5)**
The scenarios were understandable and useful	5

The scenarios can strengthen interest in Citizen Science	4
The learning scenarios (about citizen science) can be integrated in school.	4
The learning scenarios are helpful for school lessons.	5
The learning scenarios can be easily adapted for school lessons.	4
The Citizen Science approach is feasible for schools.	4

To summarize the Lithuanian events, competence development was focused on positive results – students were evaluating the competences as the maximum after taking the course, teachers also were reflecting a positive experience. All improvements suggested during this evaluation were incorporated in the scenarios / worksheets.

2.6. Summary

Overall, our evaluations have shown that the learning scenarios and materials are suitable to develop competencies in the main areas of the project. In all countries, the approaches were seen positively and have led to increased competencies for the participants. As a limitation, we can state that we have not done comparative studies with different teaching / learning methods. This could be an opportunity for future research.
As a summary, we can state that the Citizen Science approach has shown as feasible and motivating in different subjects and contents. Also, our approach to teach the key competencies of scientific thinking and data handling has been successful.

3 Good Practices

Based on our experiences, we have selected good practices for Citizen Science Projects in schools. The focus is to include samples

- Which have a **clear and measurable impact** on the community
- Involve students and community **in all phases** of the CS project, especially regarding data interpretation and analysis
- Include **key competencies** such as data handling and scientific thinking
- **Results** such as learning materials are open and accessible

3.1 Good practices Germany

In the following, we describe some main initiatives and projects as starting points and good practices in Germany. We describe both, bigger initiatives as well as concrete projects which can serve as starting points for idea development and inspiration.

3.1.1 Initiatives

Bürger schaffen Wissen: https://www.buergerschaffenwissen.de/en
Bürger schaffen Wissen (Citizens Create Knowledge) is the central platform for citizen science in Germany. The platform presents, connects and supports Citizen Science projects since November 2013. Its main purpose is to give an overview of citizen science projects to illustrate the concept of citizen science, to further develop the landscape of citizen science and so increasing its visibility within the German public and discourse. Bürger schaffen Wissen is a joint project by Wissenschaft im Dialog (gGmbH) and the Museum für Naturkunde Berlin - funded by the German Ministry of Education and Research (BMBF).

Bürger schaffen Wissen has three main objectives: inform, connect and create. It provides information about citizen science and current developments in research as well as about its projects and joint working groups through its various online channels. It connects actors across different disciplines and institutions and promotes active discussions in its annual conference (Forum Citizen Science) and workshops. It works on the conceptual development of citizen science by cooperating with the working groups in its network and being involved in the European Citizen Science Association to foster international cooperation.

The platform provides a starting point and links to projects and their results:
https://www.buergerschaffenwissen.de/en/projects

Citizen Science Germany https://www.citizen-science-germany.de/
Citizen Science Germany is the second main portal that showcases the important contribution of citizens in advancing research topics. The website presents various citizen science projects that involve the collaboration of researchers and citizens, such as monitoring biodiversity, measuring air quality, or exploring cultural heritage.

Umwelt im Unterricht https://www.umwelt-im-unterricht.de/
Umwelt im Unterricht (Environment in Education) is a special service provided by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) that offers a wide range of educational materials for teachers to prepare lessons on current topics related to the environment. The initiative publishes a "Topic of the Month" every month with background information and teaching materials for primary and secondary school levels. The topics cover various fields such as climate change, biodiversity, sustainable development and other areas of work of the ministry. The materials are based on current events and examples that illustrate long-term relevant questions.
The initiative has a specific focus on Citizen Science for teachers and provides a variety of learning and teaching materials: https://www.umwelt-im-unterricht.de/hintergrund/citizen-science-buergerwissenschaft-die-grundlagen-und-moeglichkeiten-fuer-die-bildungspraxis

Stiftung Kinder forschen https://www.stiftung-kinder-forschen.de/en/
Stiftung Kinder forschen (Children Research Foundation) is a non-profit organization that promotes early education in the fields of mathematics, computer science, natural sciences and technology (MINT) and education for sustainable development (ESD) in Germany. The foundation aims to empower children to shape their future and act sustainably. The foundation was founded in 2006 as Stiftung Haus der kleinen Forscher (House of Little Researchers Foundation) and changed its name in 2021.

The foundation offers various programs and services for educators, children and parents, such as training courses, online platforms, learning materials, competitions and awards. The foundation also conducts research and evaluation on early STEM education. The foundation provides a variety of open materials for Citizen science projects and related educational activitie

The Known Unknown
The Known Unknowns is a study that collects and analyzes information about the volunteers who participate in citizen science projects in Germany. The study illustrates the complexity and the dilemmas that arise between the theoretical aspirations and the pragmatic and procedural realities in practice. The study also suggests strategies to increase diversity and inclusion in citizen science. We have included this study in the good practices as it provides support to projects when identifying and involving different stakeholder groups.
The study is available online: https://www.mdpi.com/2071-1050/13/20/11553

3.1.2 Projects

In the following, we provide short descriptions of projects which have clearly documented their approaches and results. We do not rank of value these projects but would like to show a variety of projects in different sectors and fields.

Sea Hero Quest: https://seaheroquest.alzheimersresearchuk.org/wiki/
Sea Hero Quest is a mobile game that helps researchers to understand the mental process of 3D navigation, which is one of the first skills lost in dementia. The game was designed by British game company Glitchers in 2016 in association with Alzheimer's Research UK, University College London and the University of East Anglia and with funding from Deutsche Telekom. The game was played by 4.3 million people around the world. The data from the game is used to create a global benchmark for spatial navigation and improve diagnostic approaches for early disease detection. The game is also available for researchers to create and manage their own studies using the app. A virtual reality edition of the game was released in 2017.

Recent publications

- Spiers, H. J., Coutrot, A., & Hornberger, M. (2023). Explaining world-wide variation in navigation ability from millions of people: citizen science project sea hero quest. Topics in cognitive science, 15(1), 120-138.
- Coutrot, A., Patai, E., Silva, R., Manley, E., Weiner, J. M., Dalton, R. C., ... & Spiers, H. J. (2018, November). Cities have a negative impact navigation ability: Evidence from mass online assessment via Sea Hero Quest. In Society for Neuroscience.

Plastikpiraten: https://www.plastic-pirates.eu/de
Plastikpiraten (plastic pirates) is a citizen science project that involves school classes and youth groups in collecting and documenting plastic samples at streams and rivers in Germany. The project aims to contribute to the research on the occurrence and pollution of plastic waste in and along German waterways. The project was first launched in 2016 by the Kieler Forschungswerkstatt and partners with funding from the German Federal Ministry of Education and Research (BMBF). It was continued in 2018 and 2019 as part of the research focus "Plastic in the Environment". In 2020, the project was expanded to the countries of the trio presidency and renamed as Plastic Pirates - Go Europe!

The project provides detailed action materials for the participants to identify and count different types of plastic waste, such as cigarette butts, foil or packaging parts. The data is then published on a digital map and analyzed by scientists from the Kieler Forschungswerkstatt. The project helps to raise awareness about the impact of plastic pollution on rivers, seas and ultimately ourselves.

Recent publications

- Kiessling, T., Knickmeier, K., Kruse, K., Brennecke, D., Nauendorf, A., & Thiel, M. (2019). Plastic Pirates sample litter at rivers in Germany–Riverside litter and litter sources estimated by schoolchildren. Environmental Pollution, 245, 545-557.
- Dittmann, S., Kiessling, T., Kruse, K., Brennecke, D., Knickmeier, K., Parchmann, I., & Thielb, M. (2022). How to get citizen science data accepted by the scientific community? Insights from the Plastic Pirates project.

Moskito Atlas: https://mueckenatlas.com/

Moskito Atlas is a citizen science project that involves citizens in collecting and sending mosquito samples from their surroundings to research institutions in Germany. The project aims to contribute to the surveillance and monitoring of native and invasive mosquito species and related diseases in Germany. The project was launched in 2012 by the Leibniz Centre for Agricultural Landscape Research (ZALF) and the Friedrich-Loeffler-Institut (FLI). The project provides detailed instructions and materials for the participants to catch, freeze and submit mosquitoes, which are then identified by experts in entomology. The project has received more than 177,000 mosquito samples from over 31,000 participants so far. The data is used to create a digital map of mosquito distribution and diversity in Germany and to analyze the potential risks of mosquito-borne diseases. The project also helps to raise awareness about the impact of climate change and globalization on mosquito ecology.

Recent publications

- Pernat, N., Kampen, H., Ruland, F., Jeschke, J. M., & Werner, D. (2021). Drivers of spatio-temporal variation in mosquito submissions to the citizen science project 'Mückenatlas'. Scientific Reports, 11(1), 1356.
- Pernat, N., Kampen, H., Jeschke, J. M., & Werner, D. (2021). Citizen science versus professional data collection: Comparison of approaches to mosquito monitoring in Germany. Journal of Applied Ecology, 58(2), 214-223.

Selee https://www.selee.de/

Selee is a citizen science project that aims to research rare diseases in collaboration with citizens by using digital applications. The project adopts a participatory approach as it is important to recognise the active role of patients and their families as informed partners. The project also involves citizens beyond those affected to increase the visibility and understanding of rare diseases. The project uses various methods to engage citizens in the research process, such as surveys, workshops, focus groups and user stories. The project also develops a digital application that allows citizens to collect and share data on rare diseases, as well as to exchange experiences and network with other participants

Recent publications

- Neff, M., Storf, H., Vasseur, J., Scheidt, J., Zerr, T., Khouri, A., & Schaaf, J. (2022). Identifying project topics and requirements in a citizen science project in rare diseases: a participative study. Orphanet Journal of Rare Diseases, 17(1), 1-12.
- Neffa, M., Schaafa, J., Scheidtb, J., Khourib, A., Zerrb, T., & Storfa, H. (2022). SelEe-Rare diseases citizen science research. https://pos.sissa.it/407/024/pdf

SoCiS: Social Citizen Science zur Beantwortung von Zukunftsfragen

SoCiS (Social Citizen Science for answering future questions) is a research and capacity building project on Citizen Science in the social sciences and humanities – Social Citizen Science (SCS). The project explores the innovation potentials and preconditions of SCS for addressing grand challenges, such as social cohesion, sustainability or democracy. The project addresses questions such as: Why and on which topics do citizens participate in SCS? How are citizens involved in the projects and what role does digitalisation play? What are the differences and interfaces between SCS projects organised inside and outside academic institutions? How is scientific quality ensured? Can SCS projects make a contribution to promoting political participation, strengthening trust in science and addressing

a broader population. The project also produces outputs for improving SCS and funding practice, such as guidelines, policy papers and an Open Educational Resource.

Recent publications

- Göbel, C., Mauermeister, S., & Henke, J. (2022). Citizen Social Science in Germany—cooperation beyond invited and uninvited participation. Humanities and Social Sciences Communications, 9(1), 1-11.
- Henke, J. (2022). Can Citizen Science in the Humanities and Social Sciences Deliver on the Sustainability Goals?. Sustainability, 14(15), 9012.

3.2 Good practices Italy

Based on Italian experience, we have selected three good practices carried out in the FabCitizen project, followed by a selection of Citizen Science projects developed in Italy in the framework of European programmes, which although investigating topics different from ours, can be considered as good references for CS projects in schools.

3.2.1 Initiatives from FabCitizen Project

MAPPING CULTURAL ASSET

This initiative, developed as part of the overall FabCitizen project, aims to create learning experiences for students and teachers that provide them with methods and tools to collect and interpret data on spaces and objects of our cultural heritage. Through the learning activities, participants were introduced to concepts such as stereophotogrammetry and 3D scanning, and explored the differences between data, metadata and information useful for the preservation and accessibility of our heritage.

Website: https://fabcitizen.eu/

IoT AND CULTURAL HERITAGE

This initiative, developed as part of the overall FabCitizen project, aims to create learning experiences for students and teachers that allow them to explore the complex world of new technologies and how they can be linked to cultural heritage by facilitating their use and accessibility for a wider audience using simple tools. Through learning activities, participants were introduced to the concepts of virtual and augmented reality, artificial intelligence and the metaverse, and how new IoT applications enable communication between the physical and virtual worlds, moving from atoms to bits to push the boundaries of cultural heritage.

Website: https://fabcitizen.eu/

PRESERVING, RESTORING AND REPRODUCING CULTURAL HERITAGE

This initiative, developed as part of the overall FabCitizen project, aims to create learning experiences for students and teachers that provide them with tools and methods to understand the process of reproducing an object through digital fabrication, exploring the new frontiers of digital cultural heritage.

Through learning activities, participants were introduced to 3D modelling in an open source environment, experiencing the transition from bits to atoms through machine code generation and reproduction through 3D printing (FDM, LDM).

Website: https://fabcitizen.eu/

The experiences have revealed a broad involvement of the different stakeholders, which has led to reflection on the possibility of integrating these citizen science experiences in a more structured way into school education at different levels. The Politecnico di Bari has even submitted a proposal for funding under the 'Territorial Pacts for Higher Education in Enterprise', a measure that provides co-financing to universities under the PNRR - National Plan for Recovery and Resilience - to promote the interdisciplinary nature of courses and the training of innovative and highly specialised professional profiles, in order to improve and extend university training programmes, also through their integration with related research, development and innovation activities. The Fablab Poliba, as a university research centre, has proposed a specific innovative didactic and orientation course for pre-university education, with particular reference to the STEM disciplines (Science, Technology, Engineering and Mathematics), also integrated with other humanistic and social disciplines through a "citizen science approach", which has been funded for three years.

3.2.2 CS Projects in EU-programmes

CSMON-LIFE
University of Trieste, , Lazio Parks Agency, Community Environment, CTS, Agronomic Insitute of Bari, Divulgando, Department of Plant Biology (Sapienza, Rome), Zoology (Torvergata, Rome)
CSMON-LIFE (Citizen Science MONitoring) is the first Italian citizen science project on biodiversity, funded in Italy by the European Commission under the LIFE+ programme. The initiative involves the general public and aims to involve citizens in the study, management and conservation of biodiversity, creating an active collaboration between citizens, the scientific community and institutions.

Website: http://www.csmon-life.eu/

MONICA
ENEA Research Center
MONICA, an acronym for "Cooperative Air Quality MONItoraggio Cooperativo della Qualità dell'Aria" and was developed in the ENEA Research Center in Portici by a team of researchers from the Advanced Sensoristics Laboratory.
It is a smog tracker, a system consisting of a device with sensors capable of measuring pollutants and a smartphone app. The device is just a little bigger than a portable hard disk, and is perfect for the handlebars of a bicycle, but also for a stroller or scooter.
As a sort of "antismog navigator", MONICA shows you the air pollution on your travels, and you can look for the least polluted road to travel!

Website: http://www.citizenscience.enea.it/progetto-monica

CleanAir@School
ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale), SNPA (Sistema Nazionale Protezione Ambiente), EEA (Environmental European Agency)
The project CleanAir@School was created with the aim of involving schools in many European cities in the process of raising awareness of one of the most important environmental issues for the health of citizens, air quality. The project is an environmental education and Citizen Science initiative of the EPA Network (the network of European environmental agencies), coordinated by the EEA (European Environment Agency).
There are currently 82 member schools, distributed in 32 Italian municipalities.

Website: https://www.isprambiente.gov.it/it/progetti/cartella-progetti-in-corso/aria/cleanair-school

DA MUSEO A MUSEO
Maremma Natural History Museum
Hikers and users in general, are invited to collect data on the presence of spontaneous fauna and flora species along the route and to report their observations to the Maremma Natural History Museum, through the Naturæ Social Mapping project. Data, collected in a Citizen Science perspective, will be useful to increase the biodiversity knowledge of the area. The project is divided into six different areas, for each one relative paths were selected and tested. More information and .gpx file for each path are available on the Museum site. The project leaflets are available at all the museums that take part in the project and they show the list of museums in each area, their contacts and a description of each path as well. A QR code allows downloading the relative * .gpx file to use in the field.
The Da Museo a Museo project aims to connect the Grosseto Province museums (South Tuscany, Italy) through a selection of hiking trails, accessible by sustainable mobility (public transport, bicycle, etc.).

Website: https://eu-citizen.science/project/261

NATURA SULLE MURA
Maremma Natural History Museum
The ancient, still almost complete city walls of Grosseto (one of the few examples in Italy), consist of large embankments and green areas colonized over time by several wild species of animals and plants. The event aims at creating a list of the wild organisms living in this green area surrounding the city centre with the help of the public. “Natura sulle mura” (nature on the city walls) was conceived and organized by the Maremma Natural History Museum, locate in the city centre, quite close to the XVI century city walls. Participants can freely register in specific dates and move from the museum to the city walls to carry out one hour of field survey. They are asked to take pictures and to identify organisms with the support of the iNaturalist app or with the support of some experts available at the museum. They facilitate the process of data validation before sharing the results with the Scientific Community. Specific webpages dedicated to the event show a live update of the findings (live maps and pictures taken), thanks to the services provided by iNaturalist’s APIs. At the end of the day, a ranking is drawn up

based on the number of observations and identification made. Participants gaining the best three positions in both categories are awarded with gadgets and other prizes.
The aim of the project is monitoring biodiversity living on the earthworks of the ancient city walls in Grosseto (South Tuscany), producing a database of the wild living organisms that populate this specific urban environment.

Website: https://eu-citizen.science/project/247

InNAT

InNat started in 2017 from a collaboration of three Italian institutions: Ministero della Transizione Ecologica, Consiglio per la Ricerca in Agricoltura e l'Analisi dell'Economia Agraria – Centro di ricerca Difesa e Certificazione based in Florence, and Arma dei Carabinieri, with its Centro Nazionale Carabinieri Biodiversità "Bosco Fontana" as the coordination center. Initially, the main aim of the present project has been the creation of a Citizen Science program based on the development of a website and an app (InNat) capable of collecting records on 30 target insect species, all protected under the Habitat Directive (HD), coming from citizen scientists. The Citizen Science program has then been implemented, adding more recordable target species: up to date the project concerns 34 insect species (8 dragonflies, 2 ortopterans, 7 beetles and 17 butterflies), one endemic crayfish, 3 plant species and 2 habitats, all of which included in the HD annexes. Therefore, InNat represents an essential and fundamental instrument for involving citizens in nature conservation and it also allowed the increase in number of the biodiversity data all over our national territory.
Expert-validated data are freely and publicly available on www.innat.it and they are constantly shared with Network Nazionale per la Biodiversità (NNB), the national database belonging to Ministero della Transizione Ecologica.
The aim of the project is iInvolving citizens in nature conservation is one of the main aims for InNat. For this reason, two platforms have been created, a website and an app, both capable of collecting records of the 40 protected target entities coming from citizen scientists. More specifically, our 40 targets, all protected under the European Habitat Directive, include 35 animal species, 3 plant species and 2 habitats.
Other important aims are the implementation of monitoring instruments and the verification of the implementation of Conservation Measures (according to the Habitat Directive), within the 130 State Natural Reserves managed by Arma dei Carabinieri.

Website: https://eu-citizen.science/project/281

SIMILE (Informative System for the Integrated Monitoring of Insubric Lakes and their Ecosystems)

SIMILE is a recently started three years project financed by the Interreg Italy-Switzerland 2014-2021 program. It involves partners from the scientific and technical sector (Politecnico di Milano – Lecco Campus; Fondazione Politecnico; Water Research Institute - National Research Council; SUPSI - University of Applied Sciences and Arts of; Southern Switzerland) and from the institutional sector (Lombardy Region; Ticino Canton) working in synergy. Its monitoring system strongly benefits the information derived from the analysis of Sentinel 2 and Sentinel 3 imagery, in situ authoritative data plus high frequency sensors placed on buoys, and user-contributed georeferenced data, produced with a Citizen Science approach. A

Business Intelligence (BI) platform, i.e. a web data-driven decision support system, will allow the integration, analysis, and synthesis of the information derived from these different types of data. Regarding the citizen science approach, the project has recently developed a free and open source cross-platform mobile App (SIMILE-Lakes Monitoring), where volunteers are asked to upload georeferenced photographs and eventually descriptive tags and measurements related to lakes quality (e.g. presence of algae, foams, litters or measures of transparency, temperature, pH). It also works as a collector of public events related to lake preservation (mapathons, clean-ups), as direct way of communication between authorities and citizens and as an educational tool to increase citizens' awareness on lake ecosystem.
This project has for primary goal the protection of water quality for the insubric Lugano, Maggiore and Como lakes through a geoinformatic coordination of existing monitoring systems with new data collection methods. Being a project focused on a cross-border region (Italy-Switzerland), its aim fits the purpose of SDG 6 also by strenghtening their coordinated management and stakeholder participation in the processes of knowledge and monitoring of the water resource.

Website: https://eu-citizen.science/project/171

Recent publications:

- Agnello, G; Sforzi, A; Berditchevskaia, A. (2018), Verso una strategia condivisa per la citizen science in Italia. DITOS Consortium: London, UK.
- Lewenstein B.V. (2003), Models of Public Communication of Science & Technology, Public Understanding of Science,18.
- Magnani S. (2014), La Scienza di tutti. Iniziative di Citizen Science nel mondo, Università degli Studi di Milano-Bicocca Centro Interuniversitario MaCSIS http://www.macsis.unimib.it/wp-content/uploads/2015/02/CitizenScience_WP_4_2014.pdf.
- First Italian Citizen Science Conference Book of abstract https://www.accademiaxl.it/wp-content/uploads/2019/03/CSconference_Rome2017_abstractsBOOK.pdf
- Bartoccioni, F., Gliozzo, G., Lorenzi, C., Sforzi, A., Haklay, M. (2016), A focus on local public participation in scientific research: citizen science in the Italian landscape. First International European Citizen Science Association (ECSA) Conference, Berlin, 19-21.
- Crucitti P. (2015), Citizen Science: la ricerca a portata di tutti. Natura e Società, n. 2: 2-4.
- Crucitti P. (2015), La Citizen Science. Scienze e Ricerche, n. 17: 11-14.
- Crucitti P., Amori G., Battisti C. E Giardini M. (2013), Check-list degli Anfibi, Rettili, Uccelli e Mammiferi dell'area "arcipelago mentanese - cornicolano" (Campagna Romana, Lazio). Bollettino del Museo Civico di Storia Naturale di Verona, n. 37 (Botanica Zoologia): 29-46.
- Crucitti P., Battisti C. E Giardini M. (2014), Paesaggi frammentati e biodiversità. Ecoscienza, n. 3: 63- 65.
- Crucitti P., Brocchieri D., Bubbico F., Castelluccio P., Emiliani F., Francioni G. E Tringali L. (2015), Check-list di gruppi selezionati dell'entomofauna dell'area "Arcipelago Mentanese- Cornicolano" (Lazio). Boll. Soc. Entomol. Ital., n. 147: 3-29.

- Martellos S. (2017), Il ruolo dell'informazione e della Citizen Science, Biologia Ambientale, n. 31: 147-150.
- Criscuolo L., Oggioni A., Carrara P., Lanucara S., Campanaro A., Freppaz M., Lami A., Maggioni M., Matteucci G., Pugnetti A., Rogora M. (2015), La Citizen Science e la Rete Italiana per la Ricerca Ecologica di Lungo Termine (LTER-Italia): esperienze nei siti d'alta quota, XIX Conferenza Nazionale ASITA, Lecco: 295-296.
- Lenzi A., Casali A., Bardiani M., Di Stefano C., Hardersen S., La Civita F., Miozzo M., Petriccione B., Redolfi De Zan L., Romano M., Ruocco M., Andriani V., Campanaro A. (2023), La citizen science per monitorare specie e habitat protetti: i dati del progetto LIFE ESC360 nel Network Nazionale della Biodiversità, Reticula, n. 33: 29-43.

3.3 Good practices Greece

3.3.1 Projects

Big data against childhood Obesity

The number of children and adolescents with obesity is high and still rising every year. Children with obesity have a higher risk of developing various diseases later on, compared to children without obesity. The reasons why some children become obese are complex. Behaviours that determine an individual's weight are influenced by many factors in the living environment, such as transportation options, food advertisements, safety, food prices, and more. In turn, the living environment is affected by public health policies. Combined, these are components that determine obesity rates.

BigO collects and analyses anonymous data on children's behavioural patterns and their living environment. By using advanced analytics and sophisticated visualisations, BigO extracts data-driven evidence on which local factors are involved, and how these factors influence childhood obesity in Europe. As an open platform, BigO is envisioned as a tool for local public health authorities.

This is done in various steps. School aged children become citizen scientists by collecting data about their behavioural patterns and local environment, using the myBigOapp. This data is anonymised and used to create complex statistical models to analyse how behaviour and the environment influence the prevalence of obesity. This anonymous information can be used to predict how policy changes could influence obesity rates, and can be used to compare different communities on a group level. With this information, BigO will be able to advise clinics and public health authorities on how to develop and plan effective programs and policies, in an attempt to reduce childhood obesity. BigO aims to redefine the way obesity-related policy strategies are designed and used in European societies.(https://bigoprogram.eu/big-data-against-childhood-obesity/)

REINFORCE
The REINFORCE project (Research Infrastructures FOR Citizens in Europe) aims to engage and support citizens to cooperate with researchers and actively contribute in the development of new knowledge for the needs of science and society.
https://www.zooniverse.org/projects/mrniaboc/reinforce-wp5; https://www.reinforceeu.eu/

D-NOSES
D-NOSES will empower citizens to become a driving force for change through RRI, citizen science and co-creation tools to map and measure the problem, and co-design solutions with key quadruple helix stakeholders.
This 3 year-long project is supported by key experts in RRI, citizen science and co-creation (IBERCIVIS, IFC, MFC, ECSA), International Associations (MIO-ECSDE, ISWA, AMIGO), odour and sustainability experts, including universities and SMEs (POLIMI, DESEE, APEA, ENV, ECO), local administration (CMSJM and SOFIA SM) and public bodies (LIPOR). D-NOSES will reverse the way in which odour pollution is commonly tackled (i.e. a non-transparent, private process involving either the odour emitting industry or the local city council, with no citizen involvement and poor access to data and information) by applying a holistic approach to researching, building and suggesting an appropriate regulatory framework, which can act as a basis of the future odour pollution control efforts.
https://dnoses.eu/

DITOs
The Doing-it-Together science project (DITOs) has been a milestone in the development of ECSA. It was the first EU-funded project to significantly enhance the capacities of the organization by multiplying staff and also giving us some money to do knowledge sharing activities. After three years, we have now successfully concluded the project. Many new initiatives, most prominently the EU-citizen.science Coordination and Support Action along with other EU and national projects, follow in its footsteps. A good moment to share some highlights of our work in DITOs.
https://www.ecsa.ngo/2019/06/14/some-highlights-from-the-ditos-project/

Envirocitizen
is a project that aims to research how to encourage environmental citizenship through engagement with citizen science. The project is funded by the EU Horizon 2020 fund and will last for three years. The work is being coordinated by the University of Stavanger in partnership with:

Citizen science has the potential to do more than create good science; it can create engaged citizens. Birding activities, in particular bird counting and bird ringing, have some of the longest citizen science traditions in the world. They hold great potential for developing environmental citizenship which encompasses the rights and responsibilities that individuals and collective society have toward nature. We aim to change the context in which existing collection happens in order to build more aware environmental citizens.
https://www.envirocitizen.eu/

Crowd4SDG
is a Horizon 2020 Research and Innovation Action supported by the European Commission's Science with and for Society (SwafS) programme. Through an innovation

cycle called GEAR (GATHER, EVALUATE, ACCELERATE, REFINE), the transdisciplinary Crowd4SDG consortium of six partners will promote the development of citizen science projects aimed at tackling the Sustainable Development Goals (SDGs), with a focus on climate action.The goal of the Crowd4SDG project is to research the extent to which Citizen Science (CS) can provide an essential source of non-traditional data for tracking progress towards the SDGs, as well as the ability of CS to generate social innovations that enable such progress. Based on shared expertise in crowdsourcing for disaster response, the transdisciplinary Crowd4SDG consortium of six partners will focus on SDG 13, Climate Action, to explore new ways of applying CS for monitoring the impacts of extreme climate events and strengthening the resilience of communities to climate-related disasters. While the CS projects developed in the three GEAR cycles of Crowd4SDG will all aim to address the SDG 13, Climate Action, each GEAR cycle will explore a specific sustainability dimension of climate preparedness, in connection with another SDG: sustainable cities (SDG 11), women empowerment (SDG 5) and human rights (SDG 16). A wide range of stakeholders, from the UN, governments, the private sector, NGOs, academia, innovation incubators and maker spaces will be involved in advising the project and exploiting the scientific knowledge and technical innovations that it generates. (https://crowd4sdg.eu/)

CoAct

proposes a radically new approach to face four “wicked” social global issues by engaging vulnerable citizens acting as in-the field competent co-researchers. The approach represents a new understanding of the underexplored field of Citizen Social Science and will result in the implementation of new or improved science-related policies. CoAct’s ambitious Research and Innovation activities will respond to issues related to Mental Health Care, Youth Employment, Environmental Justice and Gender Equality in Barcelona, Vienna, Berlin, Buenos Aires and in European Eastern countries. CoAct will define and develop a general framework for Citizen Social Science as a participatory research co-designed and directly driven by citizen groups sharing a social concern. The methodological framework will be first incubated in a consortium with Research Organizations, NGOs and global networks of Open Science and Open Data activism. Expertises from Computational Social Science, Participatory Action Research, Citizen Science evaluation or Citizen-generated Data will be incorporated to conceive a transdisciplinary Citizen Social Science that place vulnerable citizens at the center of Research and Innovation cycles, as co-designers and co-researchers. Secondly, three mission-oriented Actions and at least three Research Pilots will be led by vulnerable citizen groups with the support of Knowledge Coalitions formed by public bodies, CSOs and social innovators. The common effort will harness novel, simultaneously global and local, socially robust knowledge and scientifically reasoned measures to promote social change. An Open Citizen Science toolkit, Open Source digital platforms, and Capacity Building activities to improve data and science literacy, including a PhD Summer School, will be delivered. To demonstrate the scientific relevance and the social impact of CoAct!, a dynamic co-evaluation process with new tools will be done and shared. (https://eu-citizen.science/project/106)

CitieS-Health

Citizens leading the research on urban pollution & health: Aim was to Co-design citizen science projects linking urban environment and health; Citizens to be involved in all phases

of research; Create a toolkit for the development and promotion of similar citizen science projects. 5 pilots in different cities took place: Air pollution and health, Biomass burning and health, Noise pollution and health, Industrial pollution and health, Public spaces and health Projects experience and results: https://www.citieshealth.eu/wp-content/uploads/2022/09/Summary-CitieS-Health-website.pptx_compressed.pdf

FRONTIERS
FRONTIERS involved numerous teachers in the design and development of innovative classroom activities in collaborative way by developing a network where teachers collaborated with other teachers but also with the outreach teams of large-scale research infrastructures. Being part of a professional network encouraged interaction and provided them with opportunities to enrich their practices and professional context through cooperation within and between schools, universities, and frontier research institutions, collaborative reflection, development and evaluation of instruction, exchange of ideas, materials and experiences, quality development, cooperation between teachers, students and researchers and support and stimulation from research.(https://www.frontier-project.eu/)

Food waste experiment (Svinnkollen)
"In Svinnkollen, students helped to develop and test an app to investigate their food waste at school. The app told about today's menu and the climate impact of the various dishes. Using artificial intelligence, the app calculated how much climate impact the thrown food has - both for each individual student, and for the class as a group.
https://forskarfredag.se/forskarfredags-massexperiment/svinnkollen/
https://forskarfredag.se/forskarfredags-massexperiment/svinnkollen/lararmaterial/

3.4 Good practices Lithuania

3.4.1 Initiatives

VILNIUS TECH initiative: CITIZEN SCIENCE HUB

The main goal of this initiative is to create a platform supporting community and partners of Vilnius Tech in conducting Research & Innovation based on active engagement of civil society and principles of RRI.
Objectives of the center:

- to raise awareness about benefits of Open Science, CS, and principles of RRI;
- to prepare training resources in local language;
- to promote the implementation of RRI, CS and Open Science principles into different stages of the research process;
- to create networking opportunities for community members willing to participate in co-creative research;
- to facilitate the development of new competencies and skills in Vilnius Tech.

- Values: Life-long learning; creativity; co-creation; openness & transparency; sharing of know-how; community-driven.

Activities in the CSH:
Communication and dissemination with a focus on awareness raising on RRI, Citizen Science and Open Science principles; network building and maintenance (with special focus given on sharing the know-how and finding partners with relevant experience, tools); strengthening international cooperation with partners having experience with RRI, Citizen Science and Open Science; education and training of the community.

CITIZEN SCIENCE ASSOCIATION

The Citizen Science Association has been operating in Lithuania since April 2020.
The Association aims to bring together researchers and practitioners who study and engage in citizen science.
The Association acts as a communication and coordination centre for the growing citizen science community.
The Association organises events to promote science, present research and citizen science projects.
The Association cooperates closely with international organisations promoting citizen science in the European Union.

PAUKŠČIAI PRIE MANO NAMŲ

The Lithuanian Ornithological Society organises initiatives to count birds visiting gardens and yards. In this initiative, citizens are encouraged to monitor birds in their own garden, backyard or favourite park, where more birds gather in winter. A web-based data collection application is used for data entry and submission.

RŪŠIŲ RALIS

The Species Rally aims to contribute to a better understanding of Lithuania's biodiversity. Each year, the Rally gives citizens the opportunity to visit a different area of Lithuania and learn from some of the most renowned Lithuanian natural science experts. The event is now in its 6th year and offers engaging lectures and training sessions.

3.4.2 Projects

Horizon project CLIMAS - Climate change citizens engagement toolbox for dealing with Societal resilience
The ambition of the current project is to support a transformation to climate resilience by offering an innovative problem-oriented climate adoption Toolbox, co-designed together with stakeholders by applying a values-based approach, design thinking methods, and citizen science mechanisms. It is expected that the use of the Toolbox will anticipate possible tensions, points of controversy, and dilemmas vis-a-vis the adaptation to resilience - therefore enabling empowerment and engagement strategies that produce a society "resilient by design".

In addition, CLIMAS will include the empirical component for testing this Toolbox and formulating scientific-based guidelines for policymakers on how to shift Climate Assemblies from technically based deliberations that belong to climate change experts to multi-stakeholders deliberations based on solving the dilemmas from a bottom-up, more societal and value-based perspective.
CLIMAS outcomes will positively influence policy development and awareness-raising process and offer sustainable strategies to enhance the acceptance of citizens' led decisions by policymakers.

INCENTIVE is a cross-national 3-year long Coordination and Support Action (01/02/2021- 31/01/2024), supported by the European Union within the framework of the Horizon 2020 programme.

It aims to demonstrate the potential of citizen science through the co-creation, establishment and assessment of Citizen Science Hubs (CSH) in four European Universities:

- University of Twente (the Netherlands)
- Autonomous University of Barcelona (Spain)
- Aristotle University of Thessaloniki (Greece)
- Vilnius Gediminas Technical University (Lithuania)

By doing so, the project will accelerate the transition of these institutions to more inclusive, open and democratic innovation and scientific governance, under the principles of Responsible Research and Innovation. Moreover, the project seeks to deliver a legacy to European and international research institutes on how to create and operate their own CSH with the aim to secure a democratic and collaborative way of designing, implementing and monitoring scientific progress and technological growth.
INCENTIVE aims to demonstrate the potential of citizen science through the co-creation, establishment and assessment of Citizen Science Hubs in four EU Universities: University of Twente (NL), Autonomous University of Barcelona (ES), Aristotle University of Thessaloniki (EL) and Vilnius Gediminas Technical University (LT).
By doing so, the project accelerates the transition of these institutions to more inclusive, open and democratic innovation and scientific governance, under the principles of Responsible Research and Innovation. The project seeks to deliver a legacy to European and international research institutes on how to create and operate their own Hub with the aim to secure a sustainable future.

Erasmus+ AIware project

Artificial Intelligence and in particular machine learning has become a highly discussed topic in society. People are concerned about the enormous progress which might lead to both challenges and opportunities for the job market and for individual careers. However, Artificial Intelligence has not made it into the curricula of most countries in Europe. This is the starting point for the AIware project: We aim at creating a ready to use solution for schools consisting

of a model curriculum, learning scenarios and materials for different aspects of AI for teachers and students of grade 7-12.
Artificial Intelligence has already changed the job market and individual careers - AI-powered algorithms outperform human beings in different aspects of personal and business life. Many job types even for well educated people will disappear in the coming years. It will be a key competency for people to understand how to utilize AI in their jobs and personal life productively. Furthermore, concrete competencies are necessary regarding the creation and utilization of AI-based systems, e.g. to analyze, interpret and utilize different types of data. Last but not least, dangers and concern need to be taken into account.

CS4WELFARE project

The aim of this project is to explore the potential of citizen science as an innovative way to involve citizens in solving social problems in local communities and to develop recommendations for interested institutions and groups. The idea of citizen science as an innovative form of citizen engagement is widely used abroad, but in Lithuania, citizen engagement in scientific activities is only at an early stage. Therefore, this project will explore how citizen science can be used as an innovative form of citizen participation and engagement to address social problems in local communities, revealing the barriers to engagement and the motives for engagement.

BRONĖS PAJIEDAITĖS TAKAIS

A citizen science project at Vytautas Magnus University, analysing and presenting biodiversity research carried out by VMU students in interwar Lithuania. The project searches for self-sustaining colonies by using smartphones to determine the global position (GPS) of their location. The project is based on the scientific discoveries of B. Pajiedaitė, a VMU student from the interwar period.

AMBER

The EU-funded AMBER project develops tools, models and datasets that allow hydropower companies and river managers to maximise benefits and minimise environmental impacts. In Lithuania, the project focuses on preserving the biodiversity of Lithuania's rivers. Citizens are invited to use a mobile app to collect data on the location of dams and other obstacles in rivers. AMBER seeks to apply adaptive management to the operation of barriers in European rivers to achieve a more effective and efficient restoration of stream connectivity. To do this, we are developing tools, models, and toolkits that will allow hydropower companies and river managers to maximize benefits and minimize ecological impacts. This will improve energy security, help protect jobs, and boost European competitiveness, particularly in rural economies.
This project will also help protect global biodiversity in rivers by decreasing fragmentation, promoting habitat connectivity, and evaluating the merits of different restoration actions through developed tools.

Annex A: Evaluation form for teachers

Evaluation forms for Teachers template: Evaluation for teachers_template.docx

Survey for the course "XX" (2022)

Event name:

Question 1: Which school grades and subjects do you teach? (Necessary)

School grades:

Subjects:

Question 2a: At what type of school do you teach? (Necessary)

☐ Primary school ☐ Secondary school (Type: _____)

☐ High school (Type: _____)

Question 3: Please tick your gender. (Necessary)

☐ Male ☐ Female ☐ Other

Question 3: Reflecting on your experiences on piloting the scenarios in the classroom context, how much do the following statements apply to your students? (Necessary)

	Does not apply at all				*Fully applicable*
The learning and working atmosphere was pleasant for my students.	☐	☐	☐	☐	☐
The content was clearly communicated to my students.	☐	☐	☐	☐	☐
The instructions for the tasks were understandable and helpful for my students.	☐	☐	☐	☐	☐
The learning and working hours were appropriate for my students.	☐	☐	☐	☐	☐
The course has strengthened my students' interest in topics of:					
Citizen Science	☐	☐	☐	☐	☐
Computer science	☐	☐	☐	☐	☐
Subject 2 (free to adapt)	☐	☐	☐	☐	☐
Subject 3 (free to adapt)	☐	☐	☐	☐	☐
My students would love to attend such a course again and they would also recommend it to others.	☐	☐	☐	☐	☐
All in all, my students enjoyed the course.	☐	☐	☐	☐	☐

Question 4: Reflecting on your experience of this course, how much do the following statements apply to you? (Necessary)

Which kind of scenarios did you implement in your class? Write down the name.

	Fully applicable				*Does not apply at all*
I am able to integrate the learning scenarios (about citizen science) easily into my lessons.	☐	☐	☐	☐	☐
The learning scenarios are helpful for my lessons. ☐		☐	☐	☐	☐
The learning scenarios can be easily adapted for my lessons.	☐	☐	☐	☐	☐
The pedagogical approach (inquiry / service learning) is appropriate.	☐	☐	☐	☐	☐
The Citizen Science approach is feasible for my school.	☐	☐	☐	☐	☐
I would like to integrate CS into my lessons.	☐	☐	☐	☐	☐

Question 8: Please also tell us: What did you particularly like?

Was there anything you absolutely did not like?

☺
☹

Competences

Please try to assess for yourself how well you can do the following things BEFORE and AFTER the course.

- 0 (I can) not at all
- 1 (I can) a little
- 2 (I can) quite well
- 3 (I can) well
- 4 (I can) perfect

Competence	**BEFORE**						**AFTER**				
	0	**1**	**2**	**3**	**4**		**0**	**1**	**2**	**3**	**4**
Basics about the topic-related activity (not obligatory)											
I know what a condition is (if / else).											
I know what a breadboard is and what a microcontroller is.											
I know what a loop is											
I know what a sensor is.											
Topic-related competencies (e.g. microcontroller programming) (not obligatory)											
I can find, save and reuse programmes.											
I can connect various components to the senseBox (e.g. LED, sensor...).											
I know how to load a programme onto the microcontroller.											
I can connect the senseBox to the Internet.											
I can find errors in blocks											
I can write a programme using blockly.											

Topic-related competencies (e.g. topic XY) (not obligatory)											
Topic-related competencies (e.g. topic XY) (not obligatory)											
Data											
I can retrieve data.											
I can analyze data.											
I can display data.											
I can interpret the results of data.											
I can open data (in a programme).											
I can visualize data (e.g. with Excel).											
I know different data formats (e.g. .csv file, .xlsx file).											
I can convert data into another format.											
Scientific inquiry skills											
I can formulate a research question.											
I can present the results of an investigation.											
I have an understanding of the scientific process (problem definition, formulation of research questions, planning, collection of data, analysis ...., summary of results).											

I am interested in science.						■					
Future											
I can imagine studying something in the direction of science later on.						■					

Annex B: Questions for a training event

Question 1: Which school grades and subjects do you teach? (Necessary)

School grades:

Subjects:

Question 2a: At what type of school do you teach? (Necessary)

☐ Primary school ☐ Secondary school (Type: _____)

☐ High school (Type: _____)

Question 3: Please tick your gender. (Necessary)

☐ Male ☐ Female ☐ Other

Question 3: Reflecting on your experiences on piloting the scenarios in the classroom context, how much do the following statements apply to your students? (Necessary)

	Fully applicable				*Does not apply at all*
The learning and working atmosphere was pleasant.	☐	☐	☐	☐	☐
The content was clearly communicated.	☐	☐	☐	☐	☐
The instructions for the tasks were understandable and helpful.	☐	☐	☐	☐	☐
The learning and working hours were appropriate.	☐	☐	☐	☐	☐
The course has strengthened my interest in topics of:					
Citizen Science	☐	☐	☐	☐	☐
Computer science	☐	☐	☐	☐	☐
Subject 2 (free to adapt)	☐	☐	☐	☐	☐
Subject 3 (free to adapt)	☐	☐	☐	☐	☐
I would love to attend such a course again and they would also recommend it to others.	☐	☐	☐	☐	☐
All in all, I enjoyed the training.	☐	☐	☐	☐	☐

Question 4: Where did you get the information for the course offer?

(Please tick each statement that applies. Multiple answers are therefore possible).

☐ Information event at school ☐ Other teachers

☐ Flyers / posters / newspapers ☐ Website

☐ Social media ☐ Association / education related organization

☐ Other; namely: _____

Question 5: What were your reasons for enrolling in this course?

_____

Question 6: How would you rate the didactic quality?

The content structure of the training is logical/comprehensible.	☐	☐	☐	☐	☐
The training is well organized.	☐	☐	☐	☐	☐
The material is illustrated with examples.	☐	☐	☐	☐	☐
The meaning/benefit of the topics covered is conveyed.	☐	☐	☐	☐	☐
A connection is made between theory and practice/application.	☐	☐	☐	☐	☐
The participants are encouraged to think about the material.	☐	☐	☐	☐	☐
The topics covered are examined critically/from different angles.	☐	☐	☐	☐	☐

Question 7: How would you rate the general use?

I learned through the training.	☐	☐	☐	☐	☐
My knowledge level is much higher after the training than before.	☐	☐	☐	☐	☐
I learn something meaningful and important.	☐	☐	☐	☐	☐
The training motivates me to deal with the contents myself.	☐	☐	☐	☐	☐
Attending the training is worthwhile.	☐	☐	☐	☐	☐

Annex C: Evaluation form for students

Template for students: Final evaluation for students.docx
Note: Discussed in the team on the 9th March 2022, on the 29th March 2022, on the 6th April 2022

Final survey autumn holiday course 2021

Event name:

_____

Question 1: Which school class / grade level are you in? (Necessary)

School grades:

Subjects:

Question 2: What type of school do you attend? (Necessary)

☐ Primary school ☐ Secondary school (Type: _____)

☐ High school (Type: _____)

Question 3: Please tick your gender. (Necessary)

☐ Male ☐ Female ☐ Other

Question 4: Where did you get the information for the course offer?
(Please tick each statement that applies. Multiple answers are therefore possible).

☐ Information event at school ☐ Teachers

☐ Flyers / posters / newspapers ☐ Parents

☐ Social Media ☐ Friends

☐ Website

☐ Other, namely: _____

Question 5: Why do you participate in this course?
(Please tick each statement that applies. Multiple answers are therefore possible).

☐ Because I wanted to do it and I decided to do it myself.

☐ Because teachers at my school recommended it to me.

☐ Because classmates / friends have attended this or another course.

☐ Because that's what my parents wanted.

☐ Because this course is part of my school course.

☐ I signed up for other reasons:

_____

Question 6: Reflecting on your experience of this course, how much do the following statements apply to you? (Necessary)

	Fully applicable				*Does not apply at all*
	☐	☐	☐	☐	☐
The learning and working atmosphere was pleasant.	☐	☐	☐	☐	☐
The content was clearly communicated.	☐	☐	☐	☐	☐
The instructions for the tasks were understandable and helpful.	☐	☐	☐	☐	☐
The learning and working hours were appropriate.	☐	☐	☐	☐	☐
The course has strengthened my interest in topics of:					
Citizen Science	☐	☐	☐	☐	☐
Computer science	☐	☐	☐	☐	☐
Subject 2 (free to adapt)	☐	☐	☐	☐	☐
Subject 3 (free to adapt)	☐	☐	☐	☐	☐
I would love to attend such a course again and they would also recommend it to others.	☐	☐	☐	☐	☐
All in all, I enjoyed the event.	☐	☐	☐	☐	☐

Question 6: How would you rate the didactic quality?

The content structure of the training is logical/comprehensible.	☐	☐	☐	☐	☐
The training is well organized.	☐	☐	☐	☐	☐
The material is illustrated with examples.	☐	☐	☐	☐	☐
The meaning/benefit of the topics covered is conveyed.	☐	☐	☐	☐	☐
A connection is made between theory and practice/application.	☐	☐	☐	☐	☐
The participants are encouraged to think about the material.	☐	☐	☐	☐	☐
The topics covered are examined critically/from different angles.	☐	☐	☐	☐	☐

Question 7: How would you rate the general use?

I learn through the training.	☐	☐	☐	☐	☐
My knowledge level is much higher after the training than before.	☐	☐	☐	☐	☐
I learn something meaningful and important.	☐	☐	☐	☐	☐
The training motivates me to deal with the contents myself.	☐	☐	☐	☐	☐
Attending the training is worthwhile.	☐	☐	☐	☐	☐

Question 7: Please also tell us: What did you particularly like?
Was there anything you absolutely did not like?

☺
☹

Competencies

Please try to assess for yourself how well you can do the following things BEFORE and AFTER the course.

Note: Maximum of 10 competencies to be evaluated in order to not to overwhelm the students.

- 0 (I can) not at all
- 1 (I can) a little
- 2 (I can) quite well
- 3 (I can) well
- 4 (I can) perfect

Competence	**BEFORE**						**AFTER**				
	0	**1**	**2**	**3**	**4**		**0**	**1**	**2**	**3**	**4**
Data											
I can retrieve data.											
I can analyze data.											
I can display data.											
I can interpret the results of data.											
I can open data (in a programme).											
I can visualize data (e.g. with Excel).											
I know different data formats (e.g. .csv file, .xlsx file).											
I can convert data into another format.											
Scientific inquiry skills											
I can formulate a research question.											

I can present the results of an investigation.											
I have an understanding of the scientific process (problem definition, formulation of research questions, planning, collection of data, analysis ...., summary of results).											
I am interested in science.											
Future											
I can imagine studying something in the direction of science later on.											