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Evaluation of the performance of the user cases: Schools

Work Package 3b

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Executive Summary

The overall objective of the CITI-SENSE project (EU FP 7) was to develop "Citizens' Observatories" to empower citizens and citizens' groups: (i) to contribute to and participate in environmental governance; (ii) to support and influence community and policy priorities and the associated decision making; and (iii) to contribute to European and global monitoring initiatives.

Within the project, three focused Empowerment Initiatives (EIs) have been organised as cooperative efforts between researchers and local stakeholders – in Barcelona, Belgrade, Edinburgh, Haifa, Ljubljana, Oslo, Ostrava, Vitoria and Vienna. This document describes the evaluation of performance of the empowerment initiatives that has addressed indoor air quality in schools (WP3b) in Belgrade, Edinburgh, Haifa, Ljubljana and Oslo.

The schools wanted a shift of focus

The initial aim of the schools initiative was to support citizens' participation in improving the indoor environment in their schools. The original idea of this case study was to give the schools the possibility to monitor their indoor environment and then identify measures for improving the indoor air quality.

However, through discussions with the schools in the pilot phase it became clear that their main interest was how the project could be used for educational purposes. The school administration and the teachers wanted to give the students, through participating in the project, a better understanding of air pollution, what it is, how it affects their health and what measures can be taken. In addition, they saw the participation in CITI-SENSE as a means to develop the students' understanding of scientific thinking – asking scientific questions, planning experiments, reading graphs, analysing data and forming conclusions.

In practice, the schools took over and changed the purpose of the case study to a new one, of engaging pupils in monitoring and in learning about the environment and using this as part of their formal schoolwork, within the school curriculum. This change was entirely consistent with the CITI-SENSE aim of supporting empowerment of participants (empowerment: *enhancing an individual's or group's capacity to make effective choices, effective in the sense of enabling them to transform those choices into desired actions and outcomes*) and so was welcomed by the project team.

Being a "user-led citizen science project" the main objectives were changed according to the users' needs. The school case study should therefore be evaluated based on this revised objective.

The engagement activities in the schools

Five locations have been involved in the school initiatives - Belgrade, Edinburgh, Haifa, Ljubljana and Oslo. A total of 18 schools and more than 1000 students were involved throughout the project period. The main engagement activities included:

- Correspondence and meetings with school administration, staff and students
- Lectures and information campaigns

- Installation of sensor units and organising measurement campaigns
- Science projects (primary and high schools)
- Training of students, guidance and motivation
- Nature Days
- Student conferences and competitions (national and international)
- Questionnaires/surveys to track students engagement and awareness raising
- In-depth interviews with students and teachers

Lessons learned

The original plan for the school case studies was highly dependent on air quality sensor units and ICT support tools to be developed by other teams within CITI-SENSE. Due to technical problems and delays of both sensors units and ICT tools , the schools did not have the necessary tools to conduct their planned research in indoor air quality.

The risk of a total failure of the empowerment initiative due to the technical problems and delays was identified quite early in the project. The school partners decided to buy off-the-shelf sensors to measure the most important parameters, such as temperature, relative humidity and CO_2. This turned out to be a very good decision and made it possible to go ahead with the planned activities.

The lack of sensor units during the pilot case study had a positive side in the sense that it forced a shift of focus from ”the use of advanced sensor units” to acitivities that led to engagement and empowerment of the students and teachers in environmental issues. This was particularly evident in the Ljubljana case study where several engagment activities have been carried out that did not rely on the use of sensor units at all, such as the Bike and Balloon campaign described in Appendix IV, Section 1.4.

The school case studies demonstrate the interest of both students and teachers in participating in research projects, and that they are able to perform studies of high quality.

Working together with schools requires close cooperation and transparency since the schools require a relatively high degree of control in defining activities and educational goals. Therefore, it is crucial to be flexible and willing to adjust the scientific work according to the needs and wishes of the schools.

While working also with younger students, we realised that they provided us with unexpected, but great results. Providing them room for creativity is probably more important for engagement with high school students, but at the same time guiding from teachers and scientists is also required. This applies especially for data management.

Non-sensor related engagement activities, such as the Nature Days and the Bike and Balloon campaign in Ljubljana proved to be suitable ways to raise awareness and engagement in air quality issues.

When it comes to use of sensors and other technology, it is important to know the products’ capability and limitations in order to manage expectations. It is crucial that the technology (sensor pods, software etc.) to be used by the teachers and the students is user-friendly. Many of the off-the shelf sensors on the market are ready to use with minimal set-up effort

and a stable/reliable dataflow. The sensors very often measure the parameters that the schools are most interested, that is temperature, relative humidity and CO_2. These sensor units are therefore well suited for engagement and teaching purposes in the schools.

Studies like ours, where close interdisciplinary liaison is required (teachers, students, scientists), it is important to recruit experienced and strongly motivated teachers. Engagement of the students is often very much dependent on the teacher's skills.

Our activities with the schools have demonstrated that students may be valuable collaborators for citizen science or citizens' observatories projects. They can measure physical parameters, collect observations and perceptions while beeing supported by experienced teachers and scientists. Furthermore, they can provide insight into the priorities and goals of the participants as well as the drivers and barriers for improving school environments. However, there are some challenges that need to be overcome to realize this potential:

- Successful cooperation with schools requires the ability to adapt to curricula and relatively strict schedules. Smaller delays may result in a full year loss.
- Students are motivated when they are free to implement their own ideas and priorities into the projects. This may lead to datasets that are difficult to re-use or compare with others.
- Indoor environments vary widely between rooms and with usage, and meaningful interpretation of measurements and other results often requires that a lot of context be recorded with the measurements. This is not always practicable/feasible. Despite the challenges, there is a tremendous potential of empowering the schools when providing them with tools to conduct research in their premises.

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1 Introduction

The overall objective of the CITI-SENSE project (EU FP 7) was to develop "Citizens' Observatories" to empower citizens and citizens' groups: (i) to contribute to and participate in environmental governance; (ii) to support and influence community and policy priorities and the associated decision making; and (iii) to contribute to European and global monitoring initiatives.

Within the project, three focused empowerment initiatives (EIs) have been organised as cooperative efforts between researchers and local stakeholders – in Barcelona, Belgrade, Edinburgh, Haifa, Ljubljana, Oslo, Ostrava, Vitoria and Vienna.

This document describes the evaluation of performance of the empowerment initiatives that has addressed indoor air quality in schools. Five locations have been involved in the school initiatives – Belgrade, Edinburgh, Haifa, Ljubljana and Oslo.

Haifa did not originally plan to participate in the school case study, but decided to join the case study after the pilot phase. Thus, the activities in Haifa has not been mentioned in the earlier deliverables.

This main report presents a summary of the activities and the evaluation of performance of the empowerment initiatives, whereas detailed descriptions of the activities in each of the locations are described in separate Annexes (I-VI), with products of research in Annex VI.

2 Aims and Objectives

As described in the CITI-SENSE DoW (Bartonova et al., 2012) and in D3.1 (Høiskar et al., 2013) and D3.2 (Robinson et al., 2015), the initial aim of the schools initiative was to support citizen participation in improving the indoor environment in schools.

After interaction with the schools during the pilot phase, it became clear that the schools' main motivation to be involved in the project was for educational purposes. The schools were interested in activities that would fit well into their curriculum and that would give the students better understanding of air pollution, how it affects their health and measures that can be taken. In addition, they saw the participation in the project as a means to give the students a better understanding of scientific thinking – asking scientific questions, planning experiments, reading graphs, analysing data and forming conclusions.

Based on the feedback from the schools the focus of the case study changed to that of engaging pupils in monitoring and in learning about the environment and using this as part of their formal schoolwork, within the school curriculum. This change was entirely consistent with the CITI-SENSE aim of supporting empowerment of participants (empowerment: *enhancing an individual's or group's capacity to make effective choices, effective in the sense of enabling them to transform those choices into desired actions and outcomes*) and so was welcomed by the project team.

Being a "user-led citizen science project" the main objectives were changed according to the users' needs, and the aim of the school case study shifted to:

- Engaging students and teachers in monitoring and learning about the indoor and outdoor environment
- Awareness raising and competence building within air quality issues.

3 Methods

This section will briefly describe the methods that were used to engage with/empower the citizens as well as the products and tools that have been developed/used for engagement activities. In addition, the methods used to evaluate the performance of the use cases are described.

3.1 Recruitment of users

In the main study, each location was expected to work with a minimum of three schools. The methods for recruiting schools varied between the cities.

Some partners had already established a good relationship with one or several schools through similar projects in the past e.g. the biomonitoring projects in Ljubljana and the SINPHONIE project in Belgrade. These schools were invited to participate in the CITI-SENSE project.

The partners also invited selected schools in their city to participate in the case study and arranged meetings with the school administration, teachers and other stakeholders at schools that were interested in participating.

3.2 Interaction with the user to identify their needs

In all the cities, introductory meetings were arranged with the school administration, head masters and teachers. A brief presentation of the CITI-SENSE project was given, emphasizing the overall objectives for the school empowerment initiative and the case study. In addition, the plans for developing and testing sensor units and data services in the project were presented.

In these meetings, the schools were generally very positive about engaging in the case study. However, they all emphasized that the activities should be adapted to fit into the school curriculum and be a tool for the teachers to reach the goals set in the curriculum. Based on this feedback, the engagment activities were to a large degree focused on the students and their teachers.

Many of the students were engaged in science projects related to air quality inside and outside their school building. This was an activity that fit very well into existing curriculums. But also activities such as the Nature Days arranged in Ljubljana (Appendix IV, Section 1.4) and other campaigns that were arranged were designed together with the teachers to line them up with the schools' curriculum.

The partners identified relevant engagement activities with the schools and the needs for tools to support the activities. The tools developed and used in the different locations varied and were dependent on the users' needs identified in the meetings with the schools.

3.3 Tools and products

This section gives a brief overview of the tools and products delveloped to support the engagement activities at the schools in the different locations.

The main tools that were developed with orused by the students were:

- Air quality sensor units
- Science project descriptions
- Webpages/Facebook
- Tools to perform surveys
- Teaching materials (lectures, brochures)

Throughout the project, the partners had a large degree of freedom on how to use the available resources, as long as the activities would contribute to citizens' empowerment through the availability of environmental data, and a high ethical standard could be maintained.

3.3.1 Air quality sensor units

For the pilot phase[1], AirBase Sensor units were used in Haifa, Oslo, Edinburgh and Ljubljana, whereas DNET provided sensor units (EK700 DunevNet) for Belgrade.

The AirBase and DunevNet units provided data through the company's proprietary web interfaces, including near real time visualisation. Due to events affecting the supplier's marketing strategies, further development and use of the AirBase unit within the project was halted for all cities except Haifa. It was thus decided that air quality sensors provided by Atmospheric Sensors (AS), an entity cooperating closely with consortium partner Alphasense, should be used for the full implementation phase for the four remaining cities.

For the first year of the full-scale implementation, no CITI-SENSE developed hardware was available. Hence, to be able to follow the strict time plan set by the schools, several commercially available indoor air quality monitors were purchased and used for the first year.

For the second year of the full implementation, static sensor units from Atmospheric Sensors (AS) were used in all locations, except in Haifa. The AS units were supplemented by IC-meters in Oslo and Belgrade and Netatmo units in Ljubljana. In addition, some schools were given the possibility to use a TSI DustTrak to measure particles or other available technology from the partner institutes. In Haifa, they continued to use the AirBase units throughout the project.

Four of the cities also received radon sensors from Obeo for the full implementation phase. Some of the sensor units used in the school case studies are shown in Figure 1.

[1] The school case study was done in two phases, with an evaluation between them. The aim of the first phase (the pilot phase) was to identify users and users' needs, develop and test a first version of the technological and information solution as basis for a wider deployment in the next phase – the implementation phase.

Atmospheric Sensor

(http://atmosphericsensors.com)

AirBase

EK700 DunevNet

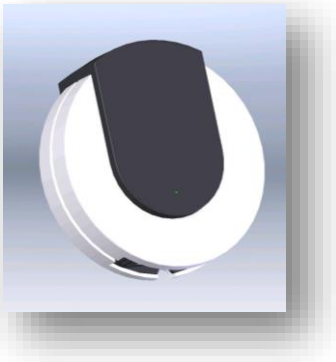
IC-Meter
(http://www.ic-meter.com/)

Dust Traq

(www.tsi.com)

NETATMO

(https://www.netatmo.com)



Obeo Radon sensor

(www.obeo.no)

Figure 1: Some of the sensor units used in the school case study during the pilot study and the full-scale implementation.

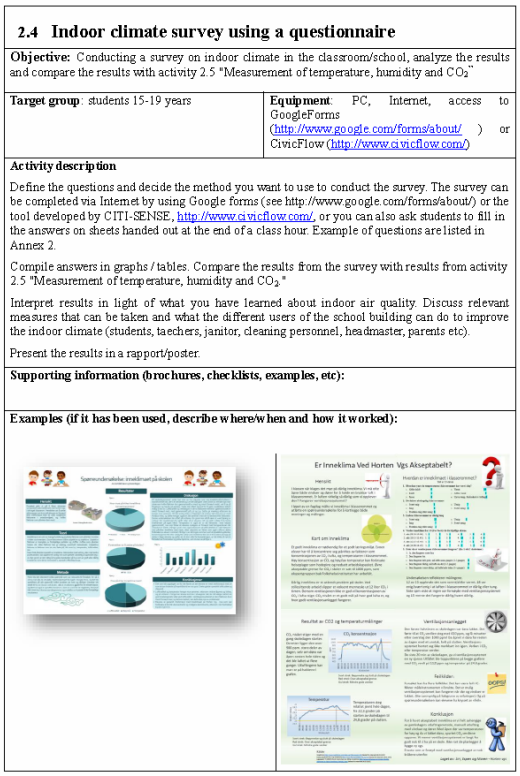
3.3.2 Teaching materials

Different teaching materials such as presentations and hand-outs, manuals for the sensors and brochures about the case studies were designed in the different locations. Materials were shared between the partners when suitable, however they needed to be translated to the local language and often adjusted to the age of the students as well as the needs of the individual schools.

Figure 2: Example of brochure for the primary schools at the beginning of the pilot studies.

3.3.3 Science project descriptions

The students were encouraged to design their own science projects. However, a list of ideas for research activities for older pupils/students and teachers in the schools involved in the CITI-SENSE project was made into a guidance tool. Similarly, awareness raising activities were designed together with the schools giving visual examples for ideas.



2.4 Indoor climate survey using a questionnaire

Objective: Conducting a survey on indoor climate in the classroom/school, analyze the results and compare the results with activity 2.5 "Measurement of temperature, humidity and CO_2"

Target group: students 15-19 years

Equipment: PC, Internet, access to GoogleForms (http://www.google.com/forms/about/) or CivicFlow (http://www.civicflow.com/)

Activity description

Define the questions and decide the method you want to use to conduct the survey. The survey can be completed via Internet by using Google forms (see http://www.google.com/forms/about/) or the tool developed by CITI-SENSE, http://www.civicflow.com/, or you can also ask students to fill in the answers on sheets handed out at the end of a class hour. Example of questions are listed in Annex 2.

Compile answers in graphs / tables. Compare the results from the survey with results from activity 2.5 "Measurement of temperature, humidity and CO_2".

Interpret results in light of what you have learned about indoor air quality. Discuss relevant measures that can be taken and what the different users of the school building can do to improve the indoor climate (students, taechers, janitor, cleaning personnel, headmaster, parents etc).

Present the results in a rapport/poster.

Supporting information (brochures, checklists, examples, etc):

Examples (if it has been used, describe where/when and how it worked):

2.6 Modelling of CO_2 level / air exchange rate in classrooms

Objective: Learning how to calculate CO_2 levels / air exchange rates using a simple mathematical model

Target group: students 15-19 years

Equipment: PC, Excel, Internet

Description of activities:

Activity 1: Discuss sources of CO_2 and mechanisms to remove CO_2 from the room. Why is CO_2 an indicator for air exchange rates? How does the number of people in the classroom affect the CO_2 levels and learning environment?

Activity 2: Use measurements of CO_2 to calculate the air exchange rate, see separate note

Activity 3: Use measurements to calculate how much CO_2 each student produces

Activity 4: Can you use CO_2 measurements in the classroom to see how many students are present?

Activity 5: How many students can be in the classroom if CO_2 level should always be below 1000ppm

Activity 6: How long can a school lesson last before CO_2 levels in your classroom exceed 1000ppm?

Supporting information (brochures, checklists, examples, etc):

Separate note and Excel sheet with simple model from Sverre

Examples (if it has been used, describe where/when and how it worked):

Example of poster (in Norwegian)

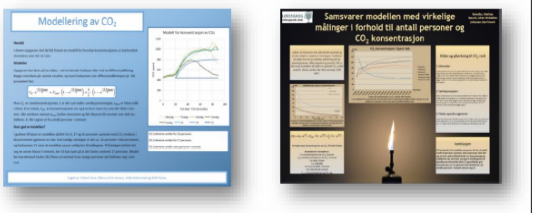


Figure 3: Example of ideas for science projects

Figure 4: Example of ideas for awareness raising projects

3.3.4 Tools to perform surveys

The CivicFlow application (www.civicflow.com) developed by CITI-SENSE partner U-Hopper was used to perform surveys before and after engagement activities.

The application was also made available for some of the schools so that the students could use it in their science projects. Google forms and paper-based surveys were also tools that could be used by the students.

3.3.5 Web-pages

Web pages for the school case study were developed and included general information about the project as well as tools for downloading the data from the Atmospheric sensors.

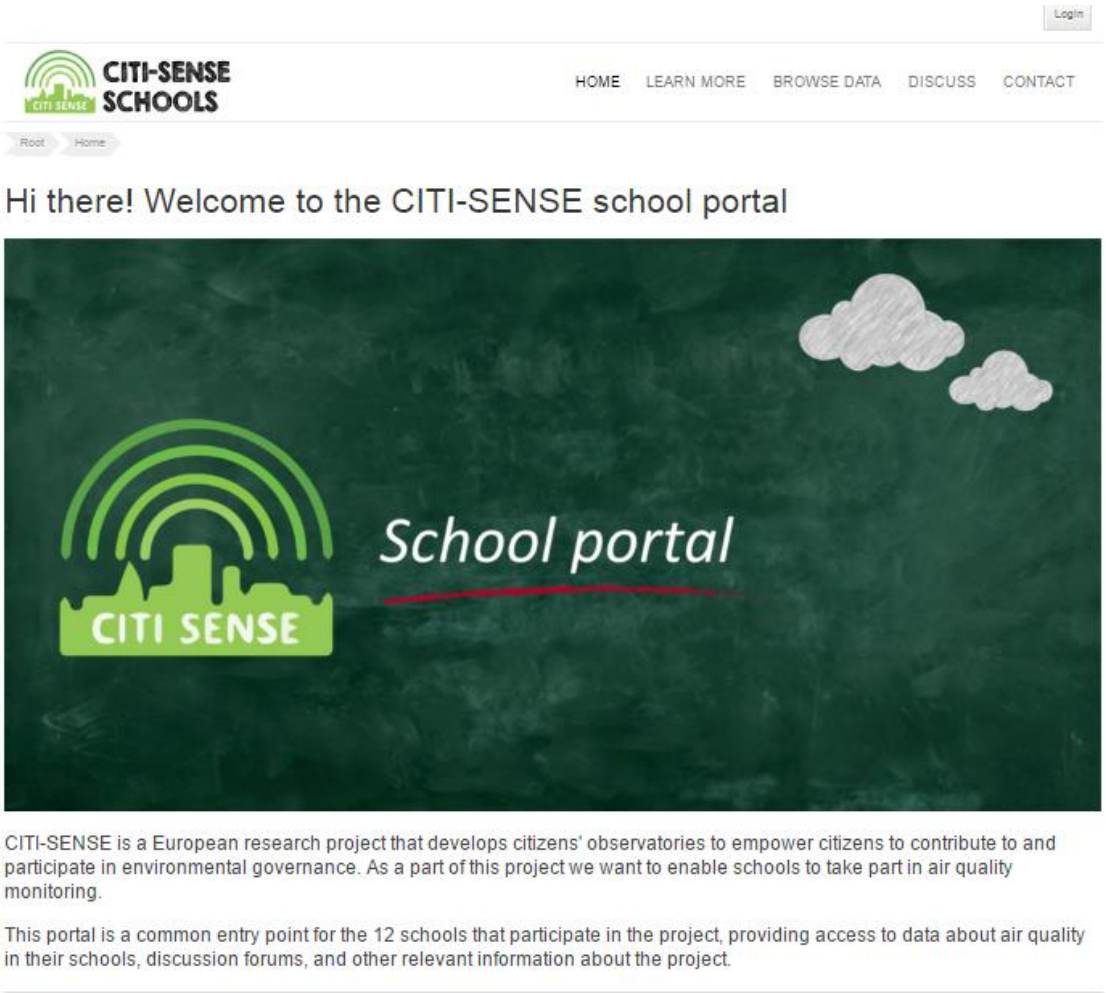


Figure 5: The CITI-SENSE school web page - http://schools.citi-sense.eu

A high school in Ljubljana designed their own webpage (http://vic.citi-sense.eu/en-us) that was used to promote their participation in the CITI-SENSE project.

They also established a Facebook page that they used for awareness raising purposes (https://www.facebook.com/CitiSenseGimVic?fref=photo).

3.4 Engagement activities

Adapting to the needs of the teachers and students/children of different age, climatic conditions, cultural settings and school systems, a large range of activities was identified and implemented in the various locations.

Not all activities were carried out at all places and some activities were only suitable for a group of students. A detailed description of the engagement activities at the different locations are described in Appendixes I-V. The main activities that were carried out in the school case studies were:

- Correspondence and meetings with school administration, staff and students
- Lectures and information campaigns
- Installation of sensor units and organising measurement campaigns
- Science projects (primary and high schools)
- Training of students, guidance and motivation
- Nature Days
- Student conferences and competitions (national and international)
- Questionnaires/surveys to track students engagement and awareness raising
- In-depth interviews with students and teachers

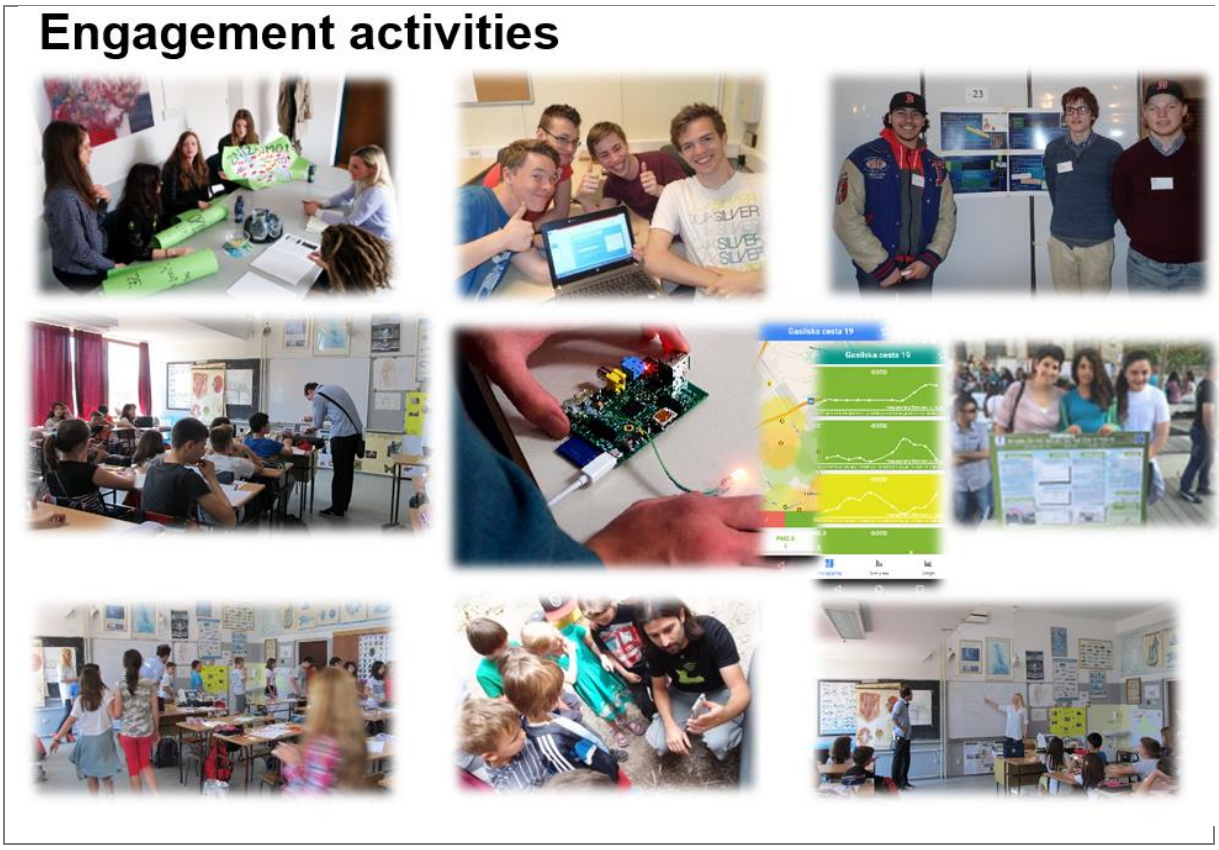


Figure 6: Some pictures showing some of the activities and the children's enthusiasm and creativity

3.5 Empowerment evaluation

In most of the locations, the evaluation was carried out through interviews and questionnaires. The questionnaires were typically given to the students/children before and after the engagment activities. However, not all locations used questionaires to evaluate the empowerment initiative since the schools were reluctant to conduct yet "another questionnaire".

In some locations, selected groups of students were interviewed as well as some of their teachers. Some of the interviews were transcribed and translated to English and given to the CITI-SENSE support team for engagment and empowerment for further analysis.

4 Results

4.1 Recruitment of Users

The recruitment of schools was very successful in most locations. The schools were very interested in participating in the project and appreciated the educational value of the activities within the project. The schools and students also appreciated the interaction with "real scientists".

This aspect was also important as many schools were interested in participating in national and international school competitions. The opportunity to work with and receive guidance from scientists was therefore considered very valuable for the students.

During the pilot case study, all cities were able to recruit new schools for the main study. Both primary schools, secondary and high schools were engaged in the project. A more detailed description of the recruitment process, mapping of stakeholders and information about the schools that participated in the full implementation is given by Robinson et al., 2015 ("CITI-SENSE Deliverable D3.2"). Table 1 gives an overview of the schools involved in the full implementation.

Table 1 Overview of the schools that were engaged in the CITI-SENSE school case study.

Participating school	Level	Country
▪ Horten Videregående skole ▪ Lørenskog Videregående skole ▪ Lambertseter Videregående skole	High School High School High School	Norway
▪ Šesta Beogradska Gimnazija ▪ Geological and Hydrometeorological High School "Milutin Milankovic" ▪ 20 Oktobar Elementary School	High School High School Primary School	Serbia
▪ Osnovna šola Vodmat ▪ Gimnazija Vič ▪ Osnovna šola Spodnja Šiška	Primary School High School Primary School	Slovenia
▪ Holyrood High School, Edinburgh ▪ Broughton Primary School, Edinburgh ▪ Castleview Primary School, Edinburgh	Secondary school Primary School Primary School	United Kingdom
▪ Ironi vav ▪ Habonim ▪ Dinur ▪ Israelia ▪ Tel Chai	Secondary school Primary school Primary school Primary school Primary school	Israel

A total of 18 schools and more than 1000 students were involved in the school case study throughout the project period, see Figure 7. In addition, more than 30 teachers were directly involved in the engagement activities.

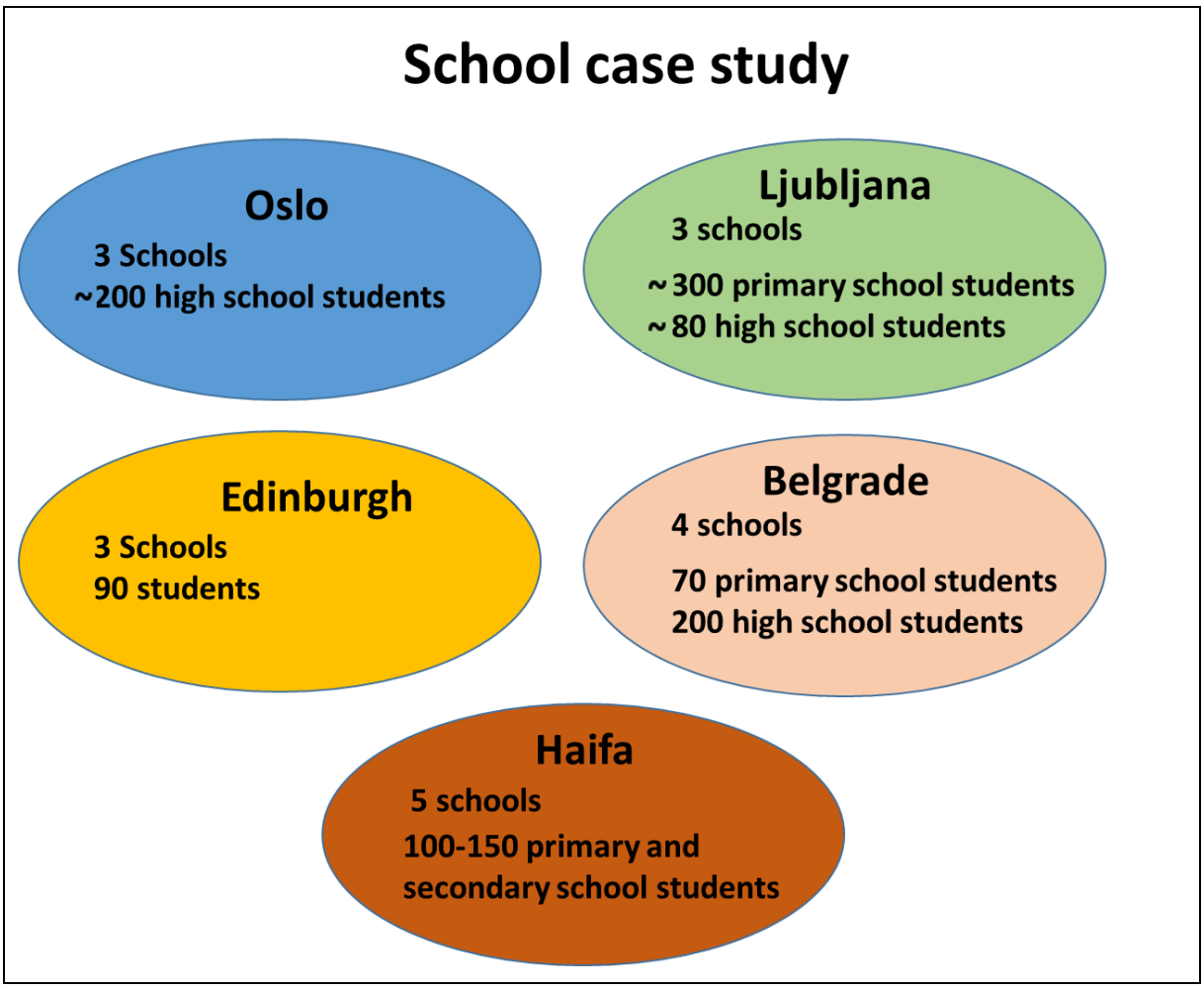


Figure 7: Overview of the number of schools and students engaged in the CITI-SENSE project.

4.2 Overall user objectives

The motivation for the schools to participate in the CITI-SENSE project was to a large degree the same in each location. The schools were mainly intersted in the educational value of participating in the project so that the project would provide their students with:

- Better understanding of air pollution both inside and outside the school
- Better understanding of why indoor and outdoor air pollution are important for health
- Better understanding of measures that may be taken to improve the environment
- Better understanding of scientific thinking – asking scientific questions, planning experiments, reading graphs, analysing data and forming conclusions

When asking the high school students about their main motivation for participation (only done in Oslo and Ljubljana), they answered that they wanted to learn more about indoor environment and research methods, but many also wanted to improve the environmental

conditions. The students also wanted to work with scientists, get access to knowledge not otherwise available through the regular school programme, as well as to exercise their specific skills e.g. programming real world applications.

4.3 Specification of the user needs

4.3.1 Hardware needs

Due to the long time needed to develop the hardware (sensor units and data platform) and the relatively short time available for the school projects, no attemptshave been made to involve the users in the design and specifications of the harware.

However, some feedback was given by the students and teachers that is of importance for choosing or designing sensors to be used within the schools:

- The sensor units must be easy to install
- The data transfer should not only rely on access to a wireless network at the schools. Some schools do not grant access to the wireless network.
- An easy-to-use solution to display online measurement data so that the children and/or teachers can follow the situation in the classroom and also be sure that the sensor is actually working
- The sensor units need to have a very low noise level
- The most desired sensors for schools were CO_2, temperature and humidity

4.3.2 Data services

The most important data sevice for the participants was the ability to easily download historical data/“near real time” in a format that was convenient for further processing (such as Excel). In addition, an easy to use plotting tool for looking at historical data would be useful for the youngest children.

For the students that wanted to develop their own phone app it was crucial to get access to real time data through API’s in a format they could easily use.

4.3.3 Supporting services

In most schools, the teachers did not have the relevant background to teach air quality topics and therefore lectures from the CITI-SENSE scientist were necessary and very much appreciated. In addition, to ease the burden of the teachers and increase the relevance of the student projects, direct guidance for the student groups by the participating scientists was wanted.

For the youngest children, the participating scientist had to help them to download the data from the sensors, as well as reduce and average the data and make graphs.

It was important to prepare short explanations/manuals on how to use the sensor units and how to access the data from the different devices.

4.4 Evaluation of tools, products and services

4.4.1 The sensor units

The case study demonstrates that sensor units are excellent tools for engaging students in environmental issues, both for the youngest children in primary schools and the students at high school level. However, it is crucial that the sensor units are easy to use and come with a good (and easy to understand) documentation of how to use the devices, what they measure and the quality of the measurements.

The following sections give a brief overview of the experience the school partners gained during the project with the sensor units that were tested in the case study.

Atmospheric Sensors –sensors and data products

Only the measurements of temperature (T), relative humidity (RH) and carbon dioxide (CO_2) were used. Sensors for other parameters were considered unfunctional, uncalibrated or in other ways unreliable, and were not used by participants.

One of the schools reported that the noise from the sampling fan was considered too annoying for extended classroom use.

The CITI-SENSE web page for data downloading from the school case studies (http://schools.citi-sense.eu/) was very useful. The web-page offered a tool for downloading of the data in Excel documents. However, the webpage for download was extremely slow, and the time lag between measurements and update was some hours. Some of the students were hampered by this, because they wanted to analyse results from short-term interventions. The Atmospheric sensor pods were delivered without a proper user guide and technical documentation.

Figure 8: The Atmospheric Sensor Unit

IC-meters – sensors and data products.

IC meters were only used to measure T, RH and CO_2, however, they also provided a noise sensor. These units were easy to install and the webpage was intuitive and responsive. It provided an easy to use downloading tool as well as readymade graphs and weekly/monthly reports.

Measurements were uploaded to the server every 5 minutes, via the client's own WiFi/Internet or using GSM.

Netatmo – sensor and data products

Several of the schools were content with the off-the-shelf Netatmo they acquired. This device had a functionality for actively checking the current air quality. By pressing a button on top of the device the current air quality was indicated with colour codes (green=good, yellow= medium, red=bad). This functionality was particularly useful for the youngest children.

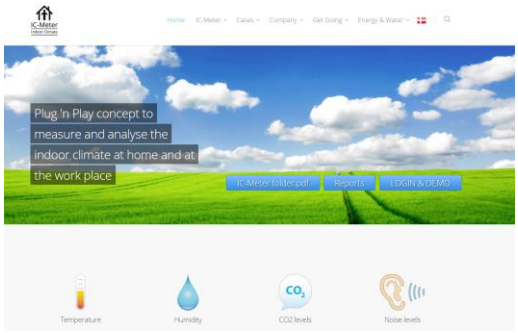


Figure 9 The IC-meter web-page

Data can be easily accessed in real time both on the web and on the Netatmo App. The app also receives information from the nearest AQ monitoring station and displays a pollution index for outdoor air quality.

The Netatmo relies on access to a wireless network for data transfer. This may be a problem in some schools that will not grant access to their school network.

4.4.2 The CivicFlow application

The CivicFlow application (www.civicflow.com) developed by U-Hopper was used by some locations to perform surveys before and after engagement activities. The application is relatively easy to use and has several different options for engaging with the public via web widgets and mobile app for smartphones.

The application was also made available for some of the schools so that the students could use it in their science projects. Some students found the CivicFlow application to be a useful method to collect data about environmental perceptions. Others preferred to use Google forms or paper-based surveys. Many students preferred the latter option as it gave a very high response rate.

4.4.3 Supporting services

Both, introductory lectures, suggestions for student projects and guidance during the project were given positive evaluation from the participants in final group interviews.

4.5 Empowerment evaluation

The original plan for the school case studies was highly dependent on air quality sensor units and ICT support tools to be developed within CITI-SENSE (WP8, WP6 and WP7). Due to technical problems and delays of both sensors units and ICT tools, the schools did not have the necessary tools to conduct their planned research in indoor air quality.

The risk of a total failure of the empowerment initiative due to the tecnical problems and delays was identified quite early in the project. Thus, the school partners decided to buy off-the-shelf sensors to measure the most important parameters, such as T, RH and CO_2. This turned out to be a very good decision and made it possible to go ahead with the planned activities.

The lack of sensor units during the pilot case study had a positive side in the sense that it forced a shift of focus from ”the use of avdanced sensor units” to acitivities that led to engagement and empowerment of the students and teachers in environmental issues. This was particularly evident in the Ljubljana case study where they had several engagment activities that did not rely on the use of sensor units at all, such as the Bike and Balloon campaign described in Appendix IV, section 1.4.

The empowerment evaluation was carried out mainly through interviews with students and teachers before and after the engagement activities. Some of the interviews were transcribed and translated to English and the analysis will be presented in the final report of the CITI-SENSE support team for engagement and empowerment (D5.5: ”Evaluation of the empowerment initiatives”).

The feedback from the students and teachers has been very positive in most cases. The teachers highly appreciated that the engagment activities supported the school curriculum, and also the support and guidance that the students received from the scientists involved in the project was positively highlighted.

Not all locations used the same questionnaires and it is not possible to directly compare results from one location to another. In Haifa the results from the questionaires show that the students attained an overall sense of achievement and had positive feelings during participation. This is in agreement with feedback from students also in other locations. In Haifa, the students stated that the participation had increased their awareness towards air quality issues and also that their knowledge of air pollution had impoved.

Similar results were found in the Oslo case study, where approximately 60 % of the students stated that they had learned something useful about indoor air quality during the project. Also, approximately 50% of the students stated that they had learned more about research methods and that the participation in the projects had contributed to or may contribute to a better indoor climate.

In Ljubljana, the high school students stated that the students appreciate the opportunity to participate and liked to work with scientists (Robinson et al, 2015). Also, the engagement activities showed that air quality issues are well understood also by the youngest ones.

5 Contribution to Citizens' Observatories

5.1 Lessons learned

The school case studies show that the students and teachers are very interested in participating in research projects, and that they are able to perform studies of high quality.

When approaching schools to ask them to participate in science projects, it is important to focus on collaboration and working together with the schools to define the activities and the educational goals. The schools want to have a relatively high degree of control, and it is therefore crucial to be flexible and willing to adjust according to their needs and wishes.

Also young students e.g. ten years old are capable of conducting valuable research. Giving the children room for using their creativity can give unexpected but great results. However, the children need help from their teachers and local scientists to define and lead the activities. In addition, technical help was needed at the primary school level e.g. for data downloading, processing and analysis of the data.

Non-sensor related engagement activities, such as the Nature Days and the Bike and Balloon campaign in Ljubljana, proved to be very good ways to raise awareness and engagement in air quality issues. This is particularly the case for the youngest children.

It is important to know what your products are capable of, as well as to know their limitations when approaching schools to avoid that the schools have too high expectations. It is crucial that the technology (sensor pods, software etc.) to be used by the teachers and the students are user-friendly. Many off-the shelf sensors on the marked are ready to use with minimal set-up effort and a stable/reliable dataflow. Very often the sensors measure the parameters that the schools are most interested in, that is temperature, relative humidity and CO_2. These sensor units are therefore well suited for engagement and teaching purposes in the schools.

In studies like ours, where it is imperative to work together, it is important to recruit experienced and strongly motivated teachers. Engagement of the students is in many cases very much dependent on the teacher's skills.

Students may be valuable collaborators with citizen science or citizens' observatories projects. They can measure physical parameters, collect observations and perceptions, while beeing supported by experienced teachers and scientists. Furthermore, they can provide insight into the priorities and goals of the participants as well as the drivers and barriers for improving school environments. However, there are some challenges that need to be overcome to realize this potential:

- Successful cooperation with schools requires adaptation to curricula and relatively strict schedules. A two-week delay may imply a full year lost.
- Students are motivated when they are free to implement their own ideas and priorities into the projects. This may lead to datasets that are diffcult to re-use or compare with others.

- Indoor environments vary widely between rooms and with usage and meaningful interpretation of measurements and other results often requires that a lot of context be recorded with the measurements. This is not always practicable/feasible. Despite the challenges, there is a tremendous potential of empowering the schools when providing them with tools to conduct research in their premises.

5.2 Expectation of Impact

In many of the locations the schools have clearly stated that they are interested in future participation in similar projects and the collaboration between the schools and the scientific partners are expected to continue beyond the project period.

Many schools adapted better practices, e.g. in ventilating the classrooms as well as planted the seeds for self led air quality activities within the school also without the future help of the scientists. There is a clear market for off-the-shelf, easy to use sensors for schools, yet they need to be marketed as currently schools are not aware of such products.

5.3 Recommendation for public bodies

Air Quality in the living environments is one of the topics that needs more attention through the education process. Researchers need to collaborate with students at widespread audience, to educate them on how to reduce their own exposure to air pollution, how to keep and build a healthier environments and improve air quality and to involve them in research studies relating to air pollution by using simple devices and modern IC technologies.

The CITI-SENSE project has shown that collaboration between schools and research institutes can be very useful – both for the schools and the scientific communities. The collaboration can be encouraged by introducing programs providing budget for activities, national competitions with prizes etc.

Many schools heard about the project and were interested in participating. However,the limited amount of sensor pods available within the CITI-SENSE project set a limitations of the number of schools and students that could be involved in the case study. Readymade low-cost kit for schools would be useful to intergrate studies of indoor and outdoor air quality in school work.

It is also recommended that a long-term funding is secured for a national (or international) “hub”, providing easy upload of and access to data and results from school research on the environment, especially air quality in the indoor and outdoor environment.

The data could be of considerable value for the authorities and make it possible to follow the development of indoor air quality in schools over time. This kind of data would also be of considerable interest for the scientific community.

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Annex