“The Air We Measure: A Math-Driven Citizen Science Inquiry”,

Scientix® is the community for science education in Europe. It is an initiative of European Schoolnet (EUN) that aims to promote and support a Europe-wide collaboration among STEM teachers, education researchers, policymakers and other educational stakeholders to inspire students to pursue careers in the field of Science, Technology, Engineering and Mathematics (STEM).

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Learning Scenario ID

Title

The Air We Measure: A Math-Driven Citizen Science Inquiry

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Citizen Science & EU Mission

HackAir

EU Mission Addressed

Climate-Neutral & Smart Cities

Summary

This Learning Scenario engages students in analysing local air quality using the HackAir citizen science project, aligned with the EU Mission Climate-Neutral & Smart Cities. Students collect PM2.5 and PM10 data, apply mathematical and statistical methods to interpret their findings, and communicate their results through graphs and presentations. Through this real-world inquiry, they develop data literacy skills while contributing to a meaningful environmental initiative.

Keywords

HackAir, Air Quality, Statistics, Citizen Science, Data Analysis

Aim of the lesson

By the end of the lesson, students will be able to collect, analyse, and interpret real air quality data using mathematical and statistical methods. They will understand how their findings contribute to the HackAir citizen science project and recognise the relevance of mathematics in addressing real-world environmental challenges.

License

Overview

Citizen science project	Please indicate which citizen science project your Learning Scenario will be based on.

Climate Adaptation	
Budburst	☐
eBird	☐
European Butterfly Monitoring Scheme	☐
Observation.org	☐
Cancer	
Foldit	☐
Oceans & Waters	
Marine Debris Tracker	☐
Plastic Pirates	☐
DRYvER	☐
Eye on Water	☐
CrowdWater	☐
Climate-Neutral & Smart Cities	
Hush City	☐
HackAir	☒
Globe at Night	☐
BiciZen	☐
Soil Mission	
Soil Plastic	☐
TeaComposition Initiative	☐
LandPKS	☐

If you're using a different project (not listed above) but still related to one of the five EU Missions, please indicate the project name below:

Subject(s)	**Primary subject:** • **Mathematics** (Statistics, Data Analysis, Graphical Representation, Measures of Central Tendency and Dispersion) **Interdisciplinary links:** • **Environmental Science / Geography** (Air quality, sources of pollution, environmental factors influencing PM levels) • **ICT / Computer Science** (Use of the HackAir app, digital data collection, data processing tools) • **Civics / Citizenship Education** (Understanding environmental responsibility, the role of citizens in monitoring air quality, decision-making for healthier cities)
Topic(s)	Analysing Air Quality Data Using Statistical Methods
Age of the learners	14–15 years old (1st year of upper secondary school)
Preparation time	Indicate how many hours per subject are needed to prepare this Learning Scenario.
Total implementation time	Indicate how many hours per subject are needed to carry out all the activities described.
Teaching material	Online materials and resources: • Links to tools and platforms (e.g. Padlet, Kahoot, Genially) • Links to supporting content (e.g. YouTube videos, articles, downloadable PDFs) Physical materials: • Paper, glue, pens, printed worksheets, or other supplies needed
Responsible Use &	Reflect on how you will ensure students' data and privacy are protected. Consider aspects such as:

Student Privacy	• the need for parental or guardian consent, • the use of teacher- or school-managed accounts instead of individual ones, and • avoiding the upload of personal or identifiable information (faces, names, or precise locations).

The Learning Scenario Activities

Activity Plan

Name	Procedure	Duration	STEM criteria codes
Introduction to Air Quality & HackAir	Teacher introduces the concept of air pollution (PM2.5, PM10), explains how HackAir works, and shows examples of data collected by citizens. Students learn how to install the app and understand the data units. Discussion about why citizen-generated data is valuable for environmental monitoring.	15 minutes	S1, S4
Data Collection in the Local Environment	Students go outside (around school or home area) and use the HackAir app to measure PM2.5 and PM10 values at several locations. They record GPS location, time of day, weather conditions, and PM readings. Students upload their measurements directly to the HackAir platform.	45 minutes	S2, S5, S7
Data Organisation and Statistical Analysis	Students enter collected measurements into a shared spreadsheet. They compute mean, median, mode (if applicable), range, variance, and standard deviation for PM2.5 and PM10. They compare results between locations and identify anomalies, trends or patterns.	45 minutes	S3, S6, S9
Creating Graphs and	Students create bar charts, line graphs, and scatter plots to visualise air quality differences across	45 minutes	S3, S8

Name	Procedure	Duration	STEM criteria codes
Interpreting Results	locations or time. They interpret the graphs using mathematical vocabulary and discuss factors influencing the results (traffic, weather, proximity to roads, vegetation).		
Conclusion & Sharing Findings	Students summarise what the data reveals about local air quality. They prepare a short presentation or infographic for the class or school community. Students reflect on how their measurements contribute to the HackAir citizen science database and how such data can support cleaner, climate-neutral cities.	30 minutes	S10

Assessment

A combination of formative and summative assessment methods will be used to evaluate students' mathematical understanding, data literacy skills, and engagement with the HackAir citizen science project.

Formative Assessment

1) Classroom discussion (concept check)

The teacher checks students' understanding of air quality indicators (PM2.5, PM10), units, and data variability through guided questions during the introduction.

2) Observation during field data collection

The teacher monitors how students use the HackAir app, record measurements, and follow the data collection protocol. Feedback is provided in real time.

3) Ongoing feedback on statistical calculations

As students compute mean, median, range, variance, and standard deviation, the teacher checks their calculations and helps correct misconceptions related to formulas and interpretation.

4) Peer review of graphs

Students analyse each other's bar charts, line graphs, and scatter plots using a short checklist (clarity, accuracy, correct labeling). This helps deepen understanding of data visualisation.

Summative Assessment

1) Final data report / mini-project

Each group submits a short written or digital report including:

- collected HackAir data
- statistical analysis
- graphs and visualisations
- interpretation of results
- conclusions about air quality in the selected locations

Assessment criteria: accuracy of calculations, clarity of graphs, quality of interpretation, connection to real-world contexts.

2) Presentation of findings

Groups present their results to the class, explaining key mathematical insights, differences between locations, and potential causes of pollution levels. This evaluates communication and understanding.

3) Short quiz on statistical concepts

A brief quiz assesses individual understanding of:

- measures of central tendency (mean, median)
- measures of dispersion (range, variance, SD)
- reading and interpreting graphs

4) Reflection paragraph

Students write a short reflection on what they learned about data interpretation, citizen science, and how mathematics can help analyse environmental problems.

Reflect on your Development Process

Add here your personal reflection on the creation of your Learning Scenario (max 200 words per question). Here below are a few questions that can help you brainstorm.

1. **Choosing your project:**

   When I started exploring different citizen science projects, I focused on finding one that would authentically connect mathematics with a real-world issue relevant to students' everyday lives. Although several projects offered interesting scientific contexts, I wanted an activity that would allow my students to work with real data, practice statistical skills, and clearly see the impact of their contributions. HackAir stood out because it provides immediate, accessible measurements of air quality and integrates naturally with the mathematics curriculum for first-year secondary students, especially topics such as data collection, graphical representation, and statistical analysis.

   Another important factor was student motivation. Air quality is a topic they can relate to, especially in urban environments, and it encourages them to think critically about their own surroundings. The project also aligns with the EU Mission "Climate-Neutral & Smart Cities," which made it meaningful beyond classroom learning.

   Finally, the combination of fieldwork, digital tools, and mathematics created a well-rounded learning experience. HackAir offered the balance I was looking for: a simple yet powerful citizen science activity that enriches mathematical understanding while fostering awareness of environmental issues.

2. **Designing activities:**
   When designing the activities for this Learning Scenario, my priority was to balance two essential elements: staying faithful to the HackAir project protocol and ensuring that each step meaningfully supported my students' mathematical learning goals. I began by breaking down the scientific process used in HackAir—data

collection, documentation of conditions, and uploading the results—and then aligned each phase with specific mathematical skills from the curriculum.
Field measurements became an opportunity to gather authentic datasets, giving students a concrete reason to compute mean, median, variance, and standard deviation. Organising data into tables and graphs allowed them to practise core statistical competencies while seeing how their mathematical decisions influenced the clarity of their findings. I also ensured that the HackAir protocol was respected by emphasising accurate recording of time, location, and weather conditions, which helped maintain data quality and credibility.
To support engagement, I structured activities so that students alternated between outdoor exploration, digital skill-building, and collaborative analysis. This variety helped maintain motivation and encouraged active participation. By concluding with a presentation and reflection, students were able not only to demonstrate their mathematical understanding but also to recognise the broader impact of their contribution to a citizen science initiative.

3. **Inquiry in action:**
In designing this Learning Scenario, I intentionally embedded each step of the scientific inquiry process so that students could experience how mathematical thinking supports real-world investigations. The inquiry began with students asking their own questions about local air quality—for example, whether pollution levels differ between school grounds and nearby busy roads. These questions naturally led them to form simple hypotheses that could be tested through data collection.
The HackAir project provided an authentic structure for gathering evidence. Students collected air quality measurements following the project's protocol, which ensured the reliability of their dataset. Once in the classroom, their focus shifted to organising and analysing the data using statistical tools. Calculating measures such as the mean, median, range, and standard deviation allowed them to interpret the variability and significance of their findings in a mathematically rigorous way.
Graphing the results helped students visualise trends and compare different locations, deepening their understanding of how mathematical representation supports scientific interpretation.
Finally, students communicated their findings through presentations and discussions, reflecting on both the mathematical insights and environmental implications. By following this full inquiry cycle, students experienced mathematics as an essential tool

for investigating and understanding a real-world environmental challenge.

4. **Learning from the process:**
   When I design my next Learning Scenario based on a citizen science project, I will build on the insights gained from creating this one and intentionally adjust several elements of the process. Rather than immediately selecting a project, I will start by more thoroughly exploring a broader range of citizen science initiatives to better evaluate how each aligns with learning outcomes and curricular needs.

   I will also plan more time for student input at the early stages of project selection. In the future, I will involve students in choosing the environmental question or location they want to investigate, giving them greater ownership of the inquiry and likely increasing their engagement.
   In terms of instructional design, I will place more emphasis on scaffolding the data analysis phase. Although statistics fits naturally with HackAir, I will develop additional student-friendly supports, such as step-by-step guides or digital templates, to help them work more independently with real-world data.
   Finally, I will aim to include a stronger community or school outreach element. In a future scenario, I will encourage students to share their findings beyond the classroom—perhaps with school leaders or local stakeholders—so they can experience the broader impact of citizen-generated data.

   STEM Alignment and Competency Development

STEM Strategy Criteria

1. STEM Learning

L1 – Real-world context and relevance
The Learning Scenario uses real air quality data collected by students through HackAir, helping them understand pollution levels in their own local environment.

L2 – Inquiry-based learning
Students will ask questions, form hypotheses, collect data, analyse results, and draw conclusions, fully engaging in the scientific inquiry cycle.

L3 – Integration of STEM subjects
Although the main subject is mathematics, the project connects naturally with environmental science, ICT, and citizenship education.

L4 – Use of digital tools and technology
Students will use the HackAir mobile app and digital spreadsheets to collect, organise, and analyse data.

2. STEM Teaching

T1 – Active, student-centred learning
Students take responsibility for measuring, recording, and interpreting real environmental data.

T2 – Collaborative learning
Fieldwork and analysis tasks are performed in small groups, encouraging collaboration and communication.

T3 – Problem-solving and critical thinking
Students interpret trends, compare locations, and consider factors influencing air quality, practising mathematical reasoning and evaluation.

3. School Leadership and Culture

C1 – Involvement in STEM initiatives
By participating in a European citizen science project, the school contributes to broader STEM and environmental education goals.

4. Partnerships

P1 – Collaboration with external organisations
HackAir and the EU Mission "Climate-Neutral & Smart Cities" represent meaningful external partners in real-world data collection.

5. Inclusiveness

I1 – Accessibility for all learners
The project is suitable for all students regardless of ability level, as it relies on simple digital tools and everyday environments.

6. Continuous Professional Development (optional)

D1 – Teacher participation in STEM-related learning
Taking part in this MOOC demonstrates engagement in professional development and the adoption of innovative teaching practices.

A. Instruction

★ [A1] Personalization of learning

★ [A2] Problem and project-based learning (PBL)

★ [A3] Inquiry based Science Education (IBSE)

Optional: reflect on how you addressed these criteria in your lesson plan

In this Learning Scenario, all three Instruction criteria (A1, A2, A3) are addressed.
Through personalization of learning (A1), students will choose the locations where they want to measure air quality, decide which environmental questions interest them most, and interpret their data in ways that connect to their own surroundings. This gives them ownership over the learning process and makes the mathematical analysis more meaningful.

The activity also follows a project-based learning approach (A2). Students work through a complete mini project: identifying a real problem (air pollution in their area), collecting data, analysing it using mathematical tools, and presenting their findings. This structure encourages responsibility, collaboration, and extended engagement with a real-world challenge.

Finally, the Learning Scenario is strongly grounded in Inquiry-Based Science Education (A3). Students will ask questions, develop simple hypotheses, collect empirical evidence with the HackAir app, analyse the data using statistics, and communicate their conclusions. By following each step of the inquiry cycle, students experience how mathematics supports scientific investigation and decision-making.

B. Curriculum implementation

★ [B1] Emphasis on STEM topics and competencies

★ [B2] Interdisciplinary instruction

★ [B3] Contextualization of STEM teaching

Optional: reflect on how you addressed these criteria in your lesson plan

In this Learning Scenario, all three Curriculum Implementation criteria (B1, B2, B3) are addressed.
The lesson places a strong emphasis on STEM topics and competencies (B1) by focusing on statistical analysis, data interpretation, and graphical representation, which are key mathematical skills in the curriculum. Students apply these competencies to real measurements, reinforcing both conceptual understanding and practical application.

The Learning Scenario also supports interdisciplinary instruction (B2). While mathematics is the central subject, the activity naturally connects with environmental science, geography, ICT, and citizenship education. Students not only perform calculations, but also consider environmental factors influencing air quality, learn to use digital tools, and reflect on societal implications.

Finally, the project ensures a high level of contextualization in STEM teaching (B3). By analysing air quality in their own community, students see direct relevance between mathematical concepts and everyday life. This real-world context increases motivation and helps students understand how mathematics can be used to investigate societal and environmental challenges.

C. Assessment

★ [C1] Continuous assessment

★ [C2] Personalised assessment

Optional: reflect on how you addressed these criteria in your lesson plan

In this Learning Scenario, both assessment criteria, continuous assessment (C1) and personalised assessment (C2), are integrated throughout the learning process.

This lesson makes strong use of continuous assessment (C1). During each phase of the project—data collection, statistical analysis, graph creation, and interpretation, the teacher will provide formative feedback to guide students' progress. Classroom discussions, observation during fieldwork, and monitoring of calculation accuracy will help identify misconceptions early and support ongoing improvement.

The scenario also includes elements of personalised assessment (C2). Students will choose their own measurement locations, which means the data they analyse will be personally meaningful to them. They will also be encouraged to communicate their findings in different formats (presentation, infographic, written report), allowing them to demonstrate understanding in ways that match their strengths. Individual feedback will help each student improve their mathematical reasoning, data interpretation, and communication skills.

Through this balanced approach, the assessment supports student learning continuously while recognising individual needs and learning paths.

D. Professionalisation of staff

★ [D1] Highly qualified professionals

☐ [D2] Existence of supporting (pedagogical) staff

★ [D3] Professional development

Optional: reflect on how these criteria are addressed at your school

At my school, the criteria related to professionalisation of staff are addressed primarily through the commitment of teachers to maintaining high professional standards and participating in ongoing development opportunities. Although we are located in a smaller and more remote community, our teaching staff is highly qualified (D1) and dedicated to delivering quality instruction despite limited external support.

The school does not have a fully developed pedagogical support team (D2), which means that teachers often rely on their own initiative and collaboration with colleagues to reflect on and improve their practice. Because of this, professional development opportunities become even more important. Participating in programmes such as this MOOC represents a key form of professional development (D3), enabling teachers to bring innovative approaches, such as citizen science and real-world data analysis, into the classroom.

Even with limited local resources, teachers remain committed to enhancing their skills and providing meaningful learning experiences for students.

E. School leadership and culture

☐ [E1] School leadership

☐ [E2] High level of cooperation among staff

☐ [E3] Inclusive culture

Optional: reflect on how these criteria are addressed at your school

In my own teaching practice, I do not often experience strong support from school leadership for STEM-related initiatives (E1), so I usually take the initiative myself when introducing new ideas like citizen science projects. Cooperation among staff (E2) is also limited in my daily work. While colleagues are supportive when needed, there is little structured or ongoing collaboration related to STEM teaching.

As for inclusive culture (E3), I do my best to adapt my lessons to different learners, but I sometimes feel that additional guidance or support services would help me respond more effectively to diverse student needs.

Despite these limitations, this Learning Scenario has encouraged me to continue exploring new approaches independently and to bring more real-world and citizen science activities into my mathematics teaching.

F. Connections

☐ [F1] with industry

★ [F2] with parents/guardians

★ [F3] with other schools and/or educational platforms

★ [F4] with universities and/or research centers

★ [F5] with local communities

Optional: reflect on how these connections were made in your lesson plan.

In my teaching practice, several forms of partnerships are well represented. We maintain good cooperation with parents and guardians (F2), who are supportive of school activities and often help reinforce students' engagement in projects like this one. We also collaborate with other schools and educational platforms (F3), which allows us to exchange ideas, share experiences, and participate in joint initiatives.

Additionally, we have established constructive partnerships with universities and higher education institutions (F4). These connections provide opportunities for workshops, expert guidance, and access to additional resources that enrich the learning experience.

Collaboration with the local community (F5) is also present and valuable, as it helps students relate their learning to real issues in their environment and increases the relevance of citizen science activities.

G. School infrastructure

★ [G1] Access to technology and equipment

★ [G2] High quality instruction and classroom materials

Optional: reflect on how these criteria are addressed at your school

In my school, both infrastructure criteria are well supported. We have reliable access to technology and equipment (G1), including computers, mobile devices, and internet connectivity, which enables students to participate in digital learning activities such as using the HackAir application and analysing data in spreadsheets.

We also benefit from high-quality instructional and classroom materials (G2). Classrooms are well-equipped for mathematics and STEM activities, and teachers have access to the resources needed to design engaging and meaningful lessons. This supportive infrastructure makes it easier to implement innovative approaches and integrate real-world data into everyday teaching.

About Scientix® and CROPS

Scientix® is the community for science education in Europe. An initiative of European Schoolnet (EUN). that aims to promote and support a Europe-wide collaboration among STEM teachers, education researchers, policymakers and other educational stakeholders to inspire students to pursue careers in the field of Science, Technology, Engineering and Mathematics (STEM).

CROPS is an EU-funded Horizon Europe project that will help citizen science projects grow and have a greater impact across Europe. The project will identify citizen science initiatives with the potential to expand their impact across the 5 EU Missions — Climate Change Adaptation; Cancer; Healthy Oceans and Seas; Climate-Neutral and Smart Cities; and Soil Health — and develop practical tools, protocols, and strategies to support the expansion of these initiatives. By connecting research with society, CROPS aims to tackle major challenges and contribute to Horizon Europe's vision of open, impactful innovation.

Annex(es)

Add any annex(es) for the Learning Scenario here. You can include your CROPS-MOOC-CS-Project-Planning-Worksheet (1).docx as an annex if you like (not mandatory).

Annexes.docx