BRITEC

BRINGING RESEARCH INTO THE CLASSROOM

BRITEC

Guidelines for schools and researchers

Erasmus+

BRITEC
BRINGING RESEARCH INTO THE CLASSROOM

Authors: Agata Goździk, Karolina Chodzińska, Dagmara Bożek, Jesús Clemente, María Clemente, Despoina Mitropoulou, Mieke Sterken, Panagiotis Angelopoulos, Evita Tasiopoulou, Agueda Gras-Velazquez, Martyna Bajorinaite

Publisher: Institute of Geophysics Polish Academy of Sciences

Please cite this publication as: Goździk, A. et al (2021). Bringing Research into the Classroom Guidelines for schools and researchers. BRITEC report. September 2021, Institute of Geophysics PAS, Poland

Keywords: Science, Technology, Engineering and Mathematics (STEM); Citizen Science; Participatory Science; School Education, research ethics

Design/DTP: Karolina Chodzińska

This report was produced within the project BRITEC: Bringing Research into the Classroom and has been funded with support from the European Commission within ERASMUS+ Programme, and corresponds to Output 2 of the project.

BRITEC

BRINGING RESEARCH INTO THE CLASSROOM

Table of contents

1. Introduction

Citizen Science (CS) research highlights the need for strengthening dialogue between researchers and schools and thus make introduction of Citizen Science in schools possible and successful. This report describes two sets of guidelines: one addressed to teachers, meant to set the groundwork for introducing scientific processes in the classroom, and one addressed to researchers, including recommendations on how to address students in schools. The report results from collecting feedback from researchers and teachers who participated in several pilot studies within the framework of the European BRITEC project (BRITEC: Bringing Research Into The Classroom). It is one part of a series of reports resulting from the project.

Within this project, researchers and teachers and students have been in direct contact with each other. Some of the researchers from the project countries (Belgium, Greece, Poland, Spain) organised face-to-face visits in schools, other researchers organised online meetings to talk to students about their work. To facilitate the communication, national online collaboration groups with the participating teachers and researchers were established by the BRITEC project managers in each country separately.

The guidelines are drawn from lessons learnt following these exchanges, and thus are subject to a co-construction process between participating schools and universities/research institutions on the introduction of research into the classroom. The aim is to address one of the key challenges of introducing Citizen Science in schools as identified by research in this area, among others: boosting the dialogue between learning communities and research experts. The innovation of this report lies in the development of norms and structures for the exchange between schools and researchers in a collaborative manner.

To deliver this report, partner institutions have completed five steps:

1. Selection of participating schools and researchers interested to engage in Citizen Science activities. Participating teachers and researchers were then invited to national online collaboration groups to ensure that communication and exchange of information was assured.

2. Facilitating dialogue between participating researchers and teachers. At the national level, structured workshops or online meetings with participating teachers and appointed researchers were organised. During these meetings, selected teachers worked with researchers to see how to include their participation in the classroom: what type of questions students might ask, how to address stereotypes, how to encourage children to pursue STEM careers, etc.

3. Researchers' visits at schools. The researchers joined the classrooms (on site or remotely) to talk about their work to the pupils, to present their ideas on Citizen Science pilots and to discuss the process of data collection and transfer.

4. Implementation of Citizen Science pilots (at least two national pilots in each partner country implemented by three or more schools). The results of the CS pilots in the form of science pills (short videos with researchers and teachers' testimonies, as well as lesson plans dedicated to CS pilots' implementation) are presented in the document *BRITEC case studies and researchers science pills*[1].

5. Organising Focus Group Interviews before and after the CS implementation. The aim of the interviews was to collect in-depth feedback regarding teachers' and researchers' opinions about working with schools in Citizen Science projects; to gather insights on participants' expectations and to what extent they were fulfilled with the collaboration; to identify the main challenges and tips on how to overcome them.

IG PAS role was to ensure that information from the national workshops, from the researchers' visits to schools, as well as the structured feedback from the participating teachers and researchers was collected and put to appropriate use in the development of the guidelines. Project partners were involved in this task, by coordinating the organisation of national workshops, school visits, implementation of CS pilots on national level, conducting Focus Group Interviews and following up on online surveys.

2. What does the term "Citizen Science" stand for?

Citizen Science refers to a new scientific paradigm where regular citizens participate In scientific research, supporting the professional scientists in as many ways as possible. That support might be in such areas as: contribution (participants take part in data collection stage only), collaboration (participants collect the data and are invited to analyze them as well) and even in some cases co-creation (participants take part in all stages of scientific research – from defining research questions to answering them through gathering data, analyzing them and presenting the results).

Citizens can take up different roles in a project: they can be: observers, funders, data analysts or data gatherers. This is why Citizen Science is sometimes called "participatory science" or "community-based participatory research".

To define that field of knowledge the European Citizen Science Association (ECSA), an international organization that was established in July 2013 during EU Green Week in Brussels, announced 10 Principles of Citizen Science[2] back in 2015:

1. Citizen Science projects actively involve citizens in scientific endeavor that generates new knowledge or understanding.

---

[1]https://britec.igf.edu.pl/?page_id=564

[2]ECSA (European Citizen Science Association). (2015). Ten Principles of Citizen Science. https://doi.org/10.17605/OSF.IO/XPR2N

2. Citizen Science projects have a genuine science outcome.
3. Both the professional scientist and the citizen scientist benefit from taking part.
4. Citizen scientists may, if they wish, participate in various stages of the scientific process.
5. Citizen scientists receive feedback from the project.
6. Citizen Science is considered a research approach like any other, with limitations and biases that should be considered and controlled.
7. Citizen Science project data and meta-data are made publicly available and where possible, results are published in an open access format.
8. Citizen scientists are suitably acknowledged in projects results and publications.
9. Citizen Science programmes are evaluated for their scientific output, data quality, participant experience and wider societal or policy impact.
10. The leaders of Citizen Science projects take into consideration legal and ethical aspects of the project.

Citizen Science projects

Nowadays we can list many examples of local and international-range projects in the field of Citizen Science. There are big online platforms available where project founders share information about their projects and invite future citizen scientists to participate. See a few examples of such platforms below:

- https://scistarter.org/ provides one the most comprehensive Citizen Science project finders, including over 1,600 listings. It covers mostly US projects, but some of them are international;
- https://www.zooniverse.org/ offers access to over 80 active online Citizen Science projects (September 2021), in sciences and humanities;
- http://eu-citizen.science as a central platform for Citizen Science in Europe.

The main goal of a Citizen Science project is to find the answers to some scientific questions set at the beginning of the project. To achieve this, data need to be gathered and analysed. The support of civil participants in these stages of a scientific project may speed up the process and may lead to obtaining more data.

Raising public awareness about scientific matters also specifically characterizes Citizen Science projects. The projects' participants get into contact with a real science and hence get to better understand how the scientific process works, so they can share that knowledge with members of their local communities.

Citizen Science can play a key role in societal transformation, especially when a project focuses on local (societal and/or ecological) problems. By raising awareness of the existing problem, such projects have the potential to bring societal issues on the political agenda. In terms of participants' motivation to take part in Citizen Science projects, we know that contributing to real science is a major driver, as well as the opportunity to closely witness what a scientist's job comprises and to understand the scientific processes that are carried out. For many it may also be a way of solving some societal concerns, make them more visible to the governing authorities.

Citizen Science education projects

Citizen Science projects are becoming more popular in schools. Some of the projects are even designed in accordance with school curricula. That is why nowadays we may distinguish "Citizen Science projects" and "Citizen Science education projects". What are the main differences between them?

Except for the researchers and participants (they are specific – students) in Citizen Science education projects teachers play a crucial role. They motivate students to help the scientists to achieve their project goals. Moreover, they support the communication between researchers and students and cooperate with scientists to assure project activities fit into the school curriculum.

In that type of projects, the role of scientists is different as well. They need to put extra effort in trainings for the teachers in scientific inquiry and science research methodologies. But they save time they would otherwise spend more on looking for and training the project participants instead.

3. Benefits and challenges of bringing Citizen Science initiatives into classrooms

Turning students to become citizen scientists may bring several benefits for all three stakeholders: researchers supervising the initiatives, teachers broadening their educational skills, and participating students.

The first important benefit of Citizen Science in formal educational contexts is that schools can introduce vast numbers of citizens (i.e., students) to participatory science, increasing the chances for continuity in time because year after year they are teaching the same topics to new students and hence bringing in new participants each year. Students feel more engaged in their learning process, if they participate in genuine scientific investigations and feel that they contribute to important research activity. In Citizen Science education projects, the usability aspect – linking the scientific activities to real life issues/practices, which makes the science more attractive to students may be one of the motivations for engagement in such initiatives. This aspect may be especially important for students who do not see the 'relevance' of what they usually learn at school, as many concepts from the curriculum seem remote from their everyday life.

Citizen Science initiatives also offer opportunities for teachers' professional development and access to up-to-date scientific knowledge and discoveries. For teachers it may be getting to know best practices from other teachers, obtaining good quality materials concerning research, and learning new methodologies. Teachers and students participating in international projects have an opportunity to see what happens in Europe in the context of STEM education.

Therefore, connecting Citizen Science and schools seems like a natural step. As suggested by Harlin J. et al.[3] Citizen Science as an educational tool would appear to be a win-win situation: teachers and students get authentic access to science in action, including scientific research questions, processes, data and data analysis, all of which promotes engagement with science and learning opportunities. Meanwhile, scientists get many enthusiastic volunteers (the students) along with team leaders and data quality filters (the teachers), while also expanding public awareness of their research topics and findings.

According to scientific studies, Citizen Science education projects seem to increase scientific literacy[4], and even more importantly – positively alter attitudes towards science[5]. Moreover, their value may go beyond science-specific learning outcomes, as the main impacts may be motivational and transformative[6].

A summary of the benefits for various groups of participants in CS initiatives is listed below[7]:

---

[3]Harlin, John & Kloetzer, Laure & Patton, Dan & Leonhard, Chris. (2018). Turning students into citizen scientists. 10.2307/j.ctv550cf2.35.

[4]Zoellick, Bill & Nelson, Sarah & Schauffler, Molly. (2012). Participatory science and education: Bringing both views into focus. Frontiers in Ecology and the Environment. 10. 310-313. 10.2307/41811396.

[5]Vitone, Tyler & Stofer, Kathryn & Steininger, M. & Hulcr, Jiri & Dunn, Robert & Lucky, Andrea. (2016). School of ants goes to college: Integrating citizen science into the general education classroom increases engagement with science. Journal of Science Communication. 15. 10.22323/2.15010203.

[6]Harlin, John & Kloetzer, Laure & Patton, Dan & Leonhard, Chris. (2018). Turning students into citizen scientists. 10.2307/j.ctv550cf2.35.

[7] **Own compilation** inspired by: Pettibone, L., Vohland, K., Bonn, A., Richter, A., Bauhus, W., Behrisch, B., Borcherding, R., Brandt, M., Bry, F., Dörler, D., Elbertse, I., Glöckler, F., Göbel, C., Hecker, S., Heigl, F., Herdick, M., Kiefer, S., Kluttig, T., Kühn, E., Kühn, K., Oswald, K., Röller, O., Schefels, C., Schierenberg, A., Scholz, W., Schumann, A., Sieber, A., Smolarski, R., Tochtermann, K., Wende, W., und Ziegler, D. (2016): Citizen science for all – a guide for citizen science practitioners. Bürger Schaffen Wissen (GEWISS) publication. German Centre for integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Helmholtz Centre for Environmental Research (UFZ), Leipzig; Berlin-Brandenburg Institute of Advanced Biodiversity Research (BBIB), Museum für Naturkunde (MfN) – Leibniz Institute for Evolution and Biodiversity Science, Berlin.

Benefits for researchers	Benefits for teachers	Benefits for students
• New ideas, questions or methods and access to societal knowledge; • Possibility to get large datasets (spatially and temporally); • Access to information not available without participants (e.g. their habits, information on households etc.); • Saving time and effort on collecting data; • Increase of public understanding of the importance of research; • Collaboration with local societies, which may be crucial for their acceptance for future investigations in the same area.	• Contribution to scientific discoveries; • Access to new knowledge and scientific methods; • Collaboration with scientific institutions, which may result in future joint actions; • Access to new scientific and educational materials; • Increased of understanding of complex problems; • Professional development.	• Increase of understanding of complex problems; • Contribution to scientific knowledge and opportunity to help solving real problems; • Better understanding of science; • Increase of the level of interest in science and scientific methods; • Increase of the science literacy; • Sense of agency; • Fun.

Except for many advantages connected with Citizen Science projects there are disadvantages as well. Among some fears identified by scientists are those concerning the participants' attitude: they might not register observations accurately, they may have different interpretations or make mistakes, e.g. not register certain data.

Also, for the teachers participating in Citizen Science projects an additional effort in matching the project activity with regular professional duties and fulfilling the school curriculum might be needed. They may need support in efficiently finding CS initiatives that fit their classrooms specific needs. As stated in Harlin et al. (2018)[8], teachers often struggle to find a balance between strict curriculum requirements and the desire to find new and interesting ways to engage and motivate students.

More discussion on the benefits and obstacles is presented in the section 9 *Focus Group Interviews results* of this document, where the results from interviews with pilots' participants are discussed in detail. It includes the voices of teachers and researchers, who participated in the BRITEC CS pilots.

[8]Harlin, John & Kloetzer, Laure & Patton, Dan & Leonhard, Chris. (2018). Turning students into citizen scientists. 10.2307/j.ctv550cf2.35.

4. Implementation of Citizen Science education projects

As stated in the introduction, Citizen Science research highlights the need for strengthening dialogue between researchers and schools or thus: the need to successfully introduce Citizen Science in schools. That is why fruitful cooperation between teachers and schools is crucial in Citizen Science activities. Before starting a SC activity teachers should set the groundwork for introducing scientific processes in the classroom, and researchers ought to prepare recommendations on how to work with students in schools.

The BRITEC project distinguishes seven main stages within a Citizen Science project, which may help to organize the scientific collaboration in an effective way: co-creation, data collection, data transfer, data analysis, presentation of results, sharing information, and communication. Teachers and scientists may take those stages into consideration while discussing the possibilities of further cooperation in the field of Citizen Science. The tools useful for each step are presented in the report *BRITEC Citizen Science Toolkit*[9].

Citizen Science program leaders and scientists must clearly define the desired balance between learning goals and scientific goals in their projects. If broader learning goals are a priority, then that should be reflected in the activities of participants, and these goals should be stated explicitly[10]. Therefore, in this document we mainly focus on the co-creation type of the CS initiatives which lead to fulfilling expectations of all participants engaged in the implementation of the CS action.
A first important issue is to find the optimal balance between scientific goals and learning objectives. From the schools' perspective, the tasks for students should be consistent with learning goals, which are mainly defined by school curriculum. On the other hand, researchers are generally more focused more on scientific outcomes and research goals. This requires the careful design of tasks offering both scientific interest and educational potential, which is often difficult to obtain[11].
A second important aspect is that of supporting and training teachers. If researchers or other groups requesting Citizen Science contribution from schools want to collect valuable and reliable data and analyses, it is necessary to offer relevant teaching materials to ease the work of teachers in connecting them to their school curricula. Citizen Science initiatives should also offer opportunities for teachers' professional development. Some suggestions regarding the form of teachers' support are given below.

---

[9]https://britec.igf.edu.pl/?page_id=407

[10]Jordan, R. C., Ballard, H. L., Philips, T. B. (2012). Key issues and new approaches for evaluating citizen-science learning outcomes. Frontiers in Ecology and the Environment. 10, 307-309.

[11] Zoellick, Bill & Nelson, Sarah & Schauffler, Molly. (2012). Participatory science and education: Bringing both views into focus. Frontiers in Ecology and the Environment. 10. 310-313. 10.2307/41811396.

5. Guidelines for researchers

Collaboration with schools within the context of a Citizen Science projects might be a great opportunity for scientists. They save time looking for volunteers, have an opportunity to collaborate with local communities, which could be crucial for future investigations and experiments, and communicate their research aims and results to society.

However, offering support to teachers and the carefully designing the research, as to fit educational purposes, is important because otherwise it may be difficult for overworked teachers, constrained by busy curricula, to do both – engage themselves in new, complex activities and to engage their students in activities with no clear connections to the required curriculum[12].

5.1 Choosing the topic

The first step – before initiating the CS action – is to consider if the topic that is relevant for researcher is also suitable for a Citizen Science approach. In order to decide on the approach, researcher should take into consideration the following aspects:

1. Is the topic interesting for students?
2. Are the methods appropriate to answer the scientific question and compatible for Citizen Science?
3. Do the participants require specific knowledge? Are they able to learn and understand the scientific context?
4. Do the schools have suitable equipment and/or infrastructure? Are you able to provide them with the necessary tools?
5. Do you have enough time to properly prepare, train and support teachers in their implementation of the CS action?
6. Does the action require a long-term commitment? Do you have a plan on how to make the collaboration sustainable?
7. Are there any legal or ethical requirements to be considered?
8. What are the criteria of success of the action? Who is responsible for evaluating the action?

[12]Harlin, John & Kloetzer, Laure & Patton, Dan & Leonhard, Chris. (2018). Turning students into citizen scientists. 10.2307/j.ctv550cf2.35.

5.2 Planning a CS initiative

Once you answered the questions listed above and you decide to implement a Citizen Science methodologies in your research project, you may initiate your project, choose partners, methods and participants. When planning a CS initiative the following aspects should be considered[13]:

- **Roles and responsibilities:** What roles do the participants play and who is responsible for what?
- **Clearly defined goals:** It is important to define clear and concrete goals together with all participants at the beginning of the project.
- **Forms of participation:** How many people should be involved, and how can they contribute to the project? Is equipment or training needed for initiators or participants?
- **A clear research question:** It prevents collection of unnecessary or unusable data.
- **Legal requirements:** What legal requirements for data protection, communication and the involvement of individuals or groups of individuals should be considered? Are there any ethical issues to be considered?
- **Choice of methods:** How will the data be collected, evaluated and published?
- **Evaluation:** What types of objectives should be reached and how should they be measured?

5.3 Data aspects

Citizen Science projects often offer collections of big sets of various data. Therefore, such data must be treated very carefully. There are three important aspects:

1. **Legal requirements**

There are several legal issues to be defined before implementing a project, e.g., personal data protection, consent forms collected from participants, copyright issues. Data that includes confidential information concerning humans – whether as research subjects, or as citizen scientists, should be de-identified prior to sharing[14]. Project participants should be informed about the type of data used in the study and may want to have some control over how it is handled. The same applies to data

---

[13]Pettibone, L., Vohland, K., Bonn, A., Richter, A., Bauhus, W., Behrisch, B., Borcherding, R., Brandt, M., Bry, F., Dörler, D., Elbertse, I., Glöckler, F., Göbel, C., Hecker, S., Heigl, F., Herdick, M., Kiefer, S., Kluttig, T., Kühn, E., Kühn, K., Oswald, K., Röller, O., Schefels, C., Schierenberg, A., Scholz, W., Schumann, A., Sieber, A., Smolarski, R., Tochtermann, K., Wende, W., und Ziegler, D. (2016): Citizen science for all – a guide for citizen science practitioners. Bürger Schaffen Wissen (GEWISS) publication. German Centre for integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Helmholtz Centre for Environmental Research (UFZ), Leipzig; Berlin-Brandenburg Institute of Advanced Biodiversity Research (BBIB), Museum für Naturkunde (MfN) – Leibniz Institute for Evolution and Biodiversity Science, Berlin.

[14]Shamoo, A.E., Resnik, D.B., 2015. Responsible Conduct of Research, 3rd ed. Oxford University Press, New York.

ownership: the intellectual property issues ought to be discussed in the very beginning of the project. Depending on the type of research and the country where the CS action takes place, additional legislation may apply, especially when collecting health-related data or any other sensitive data and, where applicable, such data collection should be discussed in an ethics committee.

2. Data quality

The data collected by citizens may not meet scientific standards[15]. If the quality of data and research integrity is not satisfactory, the validity of the whole project is affected. Citizen Science projects may have more issues with data quality because of lack of training, some systematic errors or even fabricated or falsified data.

Therefore, scientists should consider some specific measures, to take in order to increase the probability of obtaining good quality data. First, it is advisable to provide citizens with appropriate training on the methodology of data collection and operation of scientific devices or measuring tools and/or applications. It is also crucial to provide citizens with detailed information on the research topic and make sure that they understand the scientific idea behind the project.

Scientists can review the data to find unusual findings that may point to potential problems, allowing them to ask citizens questions about the process to check if they correctly followed the instructions and guidelines. In some cases, some data redundancy may be introduced to compensate the lower quality of the data collection or data analysis. Thus, the same data to collect or analysis to be done may be assigned to a certain number (thus: more than one) of students and their contribution is then averaged or outliers are investigated and if needed removed.

3. Availability and access to data

Data collected within a CS initiative should be – in general – freely available. It should be decided before the action starts, where the data will be collected and how to make it accessible for other interested users and stakeholders.

It can be beneficial to use the IT infrastructure of organisations that have repositories to store and manage data for long periods of time. An overview of such repositories can be found at www.re3data.org. However, availability does not ensure the usability of data. It is important to also provide metadata using a good standards, so that data are well documented and easy to interpret.

---

[15]Riesch, H., Potter, C., 2014. Citizen science as seen by scientists: methodological, ethical, and epistemological dimensions. Public Underst. Sci. 23 (1), 107– 120.

5.4 Collaboration and communication with participants

Besides the different aspects related to data, another factor crucial to the success of Citizen Science in schools is collaboration with participants. At the beginning of the collaboration, it is important to clearly demonstrate the scientific goals and methods and explain the whole process, so that teachers fully understand researchers' needs and the overall purpose of their contribution. It could be realized by means of workshops, webinars or other ways that include direct contact between researchers and teachers. In case of the BRITEC project, we organized one-day workshops on national level to familiarize teachers with the CS pilots, their objectives, expectations, time loads etc.

It is also crucial to let teachers ask questions and discuss all their doubts. Organizers of the workshop should facilitate the dialogue and encourage all participants to be active and creative during such a meeting. The more questions appear and the more vivid the discussion is, the higher engagement of participants may be expected in the future. Such events might be also an opportunity to discuss individual needs, possible school equipment, the range of observations or available locations for measurements, etc. However, an even better occasion for such individual arrangements would be during a visit to school.

We strongly encourage researchers to visit the participating schools and meet the students. Such visits help to familiarize all participants with the scientific objectives and methods of the project, and to provide them with detailed guidance on how to do correct measurements and observations. It is also a good opportunity to go to the field, if the measurements are conducted outdoors and practice the research and/or reporting protocols. BRITEC scientists, who visited schools were very pleased with the contact and stated that the measurements conducted in such locations were more precise and accurate and the groups were more engaged and provided more data. For more feedback regarding the school visits, please, go to section 8.

One of the aims of the workshop for teachers and/or school visits is to develop the research protocol within a co-creation process. This is the brain-storming phase, where important issues arise: it concerns forming research definition, indicating research questions we are looking the answers for, gathering ideas, and describing the type of data we are going to collect. This co-creative phase mainly involves researchers and teachers, as students may sometimes not have enough background knowledge.

In the Annex you can find examples of research protocols used for BRITEC CS pilots. Please note that most protocols varied according to the different schools, as we wanted to adapt it to the conditions and equipment available at each school.

In case you are not able to organize a face-to-face event or finalize the protocol during such an event, you may develop it using some IT tools, as presented in the report *BRITEC Citizen Science*

Toolkit[16]. In the final section of this report we presented, six tools useful for co-creation: Padlet, Google Doc, Quip, Trello, Dropbox paper, and Bit.ai.

In order to ensure participants' engagement and proper implementation of the activities foreseen within a CS pilot, it is very important that researchers stay in constant contact with teachers. This could be done by different means of communication: e-mail, distribution lists, collaborative platforms (e.g. Basecamp, Slack or similar) or social media groups. In case of the BRITEC pilots, we communicated with our pilots' participants using:

- E-mails, dedicated Facebook group in national language and online meetings via Cisco Webex tool – in Poland
- E-mails, a dedicated Facebook group and an open Facebook page (@BRITECBelgium) in the national language, as well as Onedrive for file transfer, and Mural to facilitate focus group meetings - in Belgium
- GFOSS's educational sites, GFOSS's teachers registries, other official educational sites, mainly the Panhellenic School Network www.sch.gr, GFOSS's social networks - in Greece
- E-mails and GoogleMeet meetings - in Spain.

5.5. Recognition of participants

Finally, citizen scientists, who dedicated their time and efforts to the project have rights for recognition. This can be done in various ways, e.g., collective publication of results or naming participants as co-authors (the latter might be difficult in case of many participants, however) or in acknowledgements. They could also be recognized on the project website. Teachers often appreciate receiving a diplomas or certificates of participation, as these may serve as proof of professional development.

Participants should also be informed about the outcomes of their collective efforts. Some means of this feedback could be: sending newsletters with scientific results, informing by e-mail, organizing events (talks, webinars, educational programs, school visits etc.) or trainings. When organizing events, you may take into consideration inviting other stakeholders and opening the event to local communities.

[16] https://britec.igf.edu.pl/?page_id=407

10 tips on successful implementation of Citizen Science education project

1. Set the research background – explain the aim of the research, set terms, types of activities, numbers and ages of participants, etc. and sign an agreement with a school in which all this information is given in detail.
2. Pay attention to privacy issues – discuss the GDPR guidelines with teachers who are filming or taking pictures of the students. Check other legal requirements, taking into account the type of investigation and national legislation.
3. Match the project with the school curriculum - involving students in the research has to be useful for the teachers as well, e.g., the topics covered by the project have to link to the curriculum.
4. Match your expectations with the available technological equipment - usually, most of the school labs do not have the resources to do "real science". Thus, it is significantly important to provide students with the scientific equipment needed to work properly.
5. Take into consideration data sharing and intellectual property - scientist should inform the teachers on the type of data used in the project, as participants may want to have some control over how it is shared and used. The same concerns data ownership – the intellectual property issues ought to be discussed in the very beginning of the project.
6. Support teachers in scientific inquiry and science research methodologies - scientists should consider taking measures that could help to increase the quality of the data. They should provide the teacher with appropriate training on the methodology of data collection and operation of scientific devices or measuring tools, and detailed information on the research topic.
7. Use plain language that is understandable for non-scientists, in all stages of the collaboration.
8. Stay in touch with teachers and students. It helps to keep their engagement and will serve a better quality of data, as it may help you to prevent some systematic errors.
9. Highlight the school/students' participation in the project.
10. Exploit the data in fields agreed with school/teachers – students work, results and knowledge cannot be used for other purposes than those defined in the beginning of the project.

HAVE FUN AND BENEFIT FROM THE COLLABORATION!

6. Guidelines for teachers

For schools, participating in Citizen Science projects and collaborating with scientists might be challenging but inspiring as well. Students get the chance to be in direct a contact with "real science" and practice some theories they learn at school. For teachers it can also be an interesting opportunity to get to know new methodologies and tools that they might introduce in their school practice.

How to start an initiative? Harlin et al. (2018) [17] described three models for embedding Citizen Science in schools:

1. Adoption and adaptation of an existing programme
2. Autonomous local development
3. Partnership between scientists and teachers

The first model takes advantage of ready-to-use and widely tested Citizen Science initiatives worldwide. In such programmes initiators usually do not recruit schools actively but make their action available online for any interested party. Many of such programmes have developed educational materials, manuals, guidelines and specific protocols or even dedicated lesson plans.

Such initiatives may be highly regional, focused on specificity of the region, or go worldwide, like many projects on Zooniverse – one of the most recognized CS platforms. Another example of a Citizen Science project finder is SciStarter[18], a platform containing over 1600 projects. For more inspiration and where to find information on various ready-to-use and ongoing CS initiatives, please, read the section *Citizen Science platforms and chosen projects* of the report *BRITEC Citizen Science Toolkit*[19].

The second model mostly suits very motivated teachers who want to design their own CS initiative relevant for their local environment. Teachers play a major role here and become the initiator, responsible for planning and implementing the project. If you wish to initiate your own CS project, we encourage you to carefully read section 5 of this document.

In the BRITEC project we were focusing on the third model, which involves deliberate collaboration between researchers and teachers. This model requires more time and efforts dedicated to the

---

[17] Harlin, John & Kloetzer, Laure & Patton, Dan & Leonhard, Chris. (2018). Turning students into citizen scientists. 10.2307/j.ctv550cf2.35.

[18] www.scistarter.com

[19] https://britec.igf.edu.pl/?page_id=407

preparatory phase, but it may result in CS initiatives being better aligned with school curricula and resulting in higher educational outcomes.

In the preparatory phase, teachers should clearly inform about problems and constrains and develop a model that suits their needs and possibilities. Do not promise too much towards the researcher, if you know that due to curriculum restrictions you will not be able to fully implement the project.

Remember that you are allowed to ask for adapting the project and the scientific protocol to your capabilities. Discuss with researchers what tools or equipment is needed and – if your school does not have such equipment and cannot afford buying it – inform the researcher.

In case the action requires some field experiments or measurements, always check all safety procedures. Check, if the participation of your students requires signing informed consent forms by their legal guardians.

Take every opportunity to meet with researchers, discuss all your doubts. A very effective way of inspiring students to STEM and scientific careers is by inviting researchers to school. Such a meeting allows the a researcher to directly introduce the scientific topic with the students, and to explain the aims and methods of the research. However, it should not be only an academic lecture, but should include a question and answer (Q&A) session and some hands-on activity. If possible, try to run some first observations and measurements together with the researcher. Even if something seems very easy, some problems may occur, when you fill in the protocol for the first time. Check if the procedure is clear to you and your students. Do all the links work? Do you know, how to install the equipment (if any)?

Teachers participating in the BRITEC CS pilots assessed the researchers' visits very positively. Such meetings helped students to better understand the research topic and various stages of implementation of the pilot. Thanks to the direct contact with the scientist and the friendly atmosphere, the students were highly motivated to conduct all the tasks foreseen in the project. You may read more feedback from the school visits in the section 8 of this document.

From the start of your CS project: think about your students' motivation. If the project requires long-lasting engagement, plan some activities, which may help to keep students interested and engaged. If such activities could be organised together with the researcher, inform about it in advance.

There are various ways of ensuring data quality in CS projects. A data quality check may be done by teachers, by researchers or thanks to large datasets, the results may be averaged. It is worth clarifying at the beginning of the project whether a researcher expects you to do the first quality check of the data collected.

During implementation of the CS initiative, you should stay in touch with the researcher responsible for the CS project. You may choose a suitable way of communication: regular e-mails, newsletter, social media, webinars or face-to-face meetings. Discuss with the researcher which way is most suitable for both parties.

At the end of the CS project implementation, you may ask the researcher to share the results with all participants. This is not only a nice opportunity to thank the citizen scientists for their efforts, but more importantly – it is crucial for the development of their sense of significance concerning their input. It is also a good opportunity to share information about your participation in the scientific project with the local community. If possible, organize a meeting open for the society. Parents and grandparents of your students and local authorities could be very interested in knowing the principles of the CS project and the main outcomes of your participation.

Additionally, you will find below a list of questions. Make sure that you know the answers before you start with the implementation of the project.

List of questions for the preparation	List of questions for the implementation
Is the topic interesting for my students?	Is the scientific protocol clear to me and my students?
Do they have necessary skills to participate effectively?	Do we know how to conduct measurements/ observations?
Is the research topic connected to the curriculum? Do I need to justify the participation of students?	What licenses will be used for data/photos/ reports?
How long should the project take?	Who is responsible for collecting data and who for sending the reports?
Do participants require training? If so, how to organize it? Who will train me? Who will train the students?	Do all participants have access to the tool, which will be used to collect data/send protocols?
Do we need special equipment? Do we know how to use it?	How can I get in touch with the researcher in case of unexpected problems or questions?
Are there any legal or ethical requirements? Do I need signed consent forms from legal guardians of students?	Should I conduct the first check of the quality of data?
How will data be published/used? Will we get feedback on the outcomes?	How I keep my students motivated?

Below you may also find a short list of tips regarding effective collaboration with scientists:

1. Participate in trainings organized by the scientists and use the projects materials (manuals, guidelines, educational materials, factsheets) – it is a good background for asking questions and clarifying difficulties that may arise during the project.
2. Pass the project know-how to the students.
3. Cooperate with other teachers – they may have similar problems with data collection and analysis. They could also share their ideas on keeping students' engagement.
4. Facilitate communication between students and researchers.
5. Motivate students to participate in the process - introduce a prize for the "best class", reward those students, who are actively involved in the project, etc.
6. Organize students work in project - supervise the process of collecting and analyzing data.
7. Do the first quality-check of obtained data (if necessary and agreed with the scientist).
8. Present the data – if it is needed by the project, it is good to agree with the scientists on a method and a way of presenting data collected by the students. There are a few things worth thinking about: Whom to address a presentation? What effect is expected? What format would be the most suitable/understandable? What social impact will the findings have? Etc.

7. BRITEC Citizen Science pilots

In this section you will find information on the Citizen Science pilots implemented in schools on national level. BRITEC partners offered at least two pilots per country and all pilots were implemented by at least two schools. The outcomes from the implementation are presented in the report *BRITEC Case Studies and Researchers Science Pills*[20]. Here are the detailed descriptions of the pilots, which could also serve as examples of Citizen Science initiatives.

1. Ultraviolet radiation and Vitamin D

Organisation	**Institute of Geophysics, Polish Academy of Sciences**
Country	**Poland**
Topic	Ultraviolet radiation and Vitamin D
Names of researchers responsible for this pilot and their affiliation	Dr. Agnieszka Czerwińska, IG PAS

[20] https://britec.igf.edu.pl/?page_id=564

Research question	Can pupils gain adequate dose of vitamin D3 from UV radiation during time spend outdoors (e.g. field trips) ?
Description of the idea	Pupils can measure by themselves UV radiation to calculate vitamin D3 doses gain (using provided formulas). They can also calculate the risk of sunburn and 'safe' duration of tanning.
Suggested methods	UV measurements (or noting UV Index from provided forecasts) and observation of cloudiness and uncovered area of skin (style of clothing).
Suggested/ planned frequency of observations	Preferable field campaigns (during field trip with class). Measurements from 10am to 2pm, frequency 15-30 minutes.
Who should participate?	Whole class during field trips or individually during time spend outdoors.
How can participants be motivated? What are the benefits for participants?	The output can be useful during activities spend outdoor. Participants can gain information about positive and negative effects of tanning, which is very valuable information for their health.
How long should the project take?	It depends of the duration of field trips, that class will be participated in. If unable to organise field trip, then pupils can make observations on their own. The observations should be taken in the period from May to September – a few days in each month.
What equipment is required ?	We will use UV forecast provided by IG PAS (using webpage or smartphone application). UV meters can be used, but we will not provide them.
Do participants need training and if so, describe it shortly	Participants should participate in the training, which will be organized before field trip (measurements campaign). They will learn how to read UV Index from website or from smartphone application. Instructions will be given how to make observations of cloudiness. The most important thing for the researcher is to gain the knowledge about pupils' customs (their activity in the outdoor time, way of clothing) and local cloudiness. Thus they should make the observations only in the time, which they indeed spend outdoors.

2. Observing of seasonal change of river riparian vegetation and microclimate river conditions

Organisation	IG PAS
Country	**Poland**
Topic	Observing of seasonal change of river riparian vegetation and microclimate river conditions.

Names of researchers responsible for this pilot and their affiliation	Assoc. Prof. Monika Kalinowska
Research question	How seasons affect the river vegetation and microclimate river conditions. Monitoring of changes.
Description of the idea	Students will be involved in the monitoring of riverbank vegetation and meteorological conditions in different specific locations. They will provide data for further scientific analysis of seasonal changes of the vegetation and microclimate river conditions for a different type of the rivers.
Suggested methods	Taking photographs using smartphones. Taking simple meteorological measurements.
Suggested/ planned frequency of observations	The frequency of observation will depend on hydrological conditions of the specific place of observation. However, the minimum per month is recommended, and should not be less than once per season.
Who should participate?	Individual pupils and/or organized groups.
How can participants be motivated? What are the benefits for participants?	The project will show how commonly used electronic devices may give us valuable information about the environment. Students will have a chance to be involved in the gathering and analysing the scientific data.
How long should the project take?	One year
What equipment is required ?	To obtain the photographs: a smartphone with a camera or a camera is required. To conduct the meteorological measurements: the simple meteorological station (or available other devices) and thermometer to measure water temperature are required. Details about measurements will be discussed with school teachers taking in to account the available school equipment. The measurements of water and air temperature, air pressure, air humidity and cloudiness will be useful. If possible, also the shortwave solar radiation and wind speed may be measured.
Do participants need training and if so, describe it shortly	Yes, they will need the instructions on how to take photographs with specific rules and how to take the simple meteorological measurements. They will also need information on how to work safely close to the river.

3. Studies on phlebotomine sandflies populations, flying insects which transmit a disease called leishmaniasis

Organisation	Universidad Autónoma de Madrid (UAM)
Country	**Spain**
Topic	Studies on phlebotomine sandflies populations, flying insects which transmit a disease called leishmaniasis
Names of researchers responsible for this pilot and their affiliation	Rosa Gálvez and María Clemente, UAM
Research question	Which are the sandflies vector species of leishmaniasis in an endemic area like Madrid region (Spain)?
Description of the idea	leishmaniasis is a disease that can be transmitted to animal and humans through the bite of blood-sucking phlebotomine sandflies. It causes ulcers in skin, mucous and viscers. Leishmaniasis has been in the spotlight since 2009, when the largest human leishmaniasis outbreak in Europe affected the south-west area of the Madrid region. Moreover, Madrid region has been traditionally considered endemic for canine leishmaniosis. The control of leishmaniasis needs to be based on an in-depth knowledge and understanding of the biology of sandflies. The aim of the present project is to involve students in Citizen Science in and around the classroom to study sandfly populations in Madrid region (Spain).
Suggested methods	Our goal will be to analyse sandfly abundance and the spatial distribution of different species, with special attention paid to the competent disease carriers named *Phlebotomus perniciosus* y *P. ariasi*. The specimens will be captured at different time-points within the sandfly activity season in Madrid region (from the end of May to mid-October). Phlebotomine sandflies will be collected using light traps with air gate. The trap body is an acrylic tube containing a light (which attracts sandflies), a motor and a fan (which sucks attracted sandflies and prevents escape of collected specimens). The trap has a power cable that requires a 6 Volt. battery to work. An insect collection cage, made by fine nylon netting, is connected to the trap body and stores the flying insects. Sand flies will be selected among all other flying bugs captured under a binocular magnifier. There were transferred into Eppendorf tubes containing 70% ethanol until processing. Then, there were mounted on glass slides in for specific identification under a light microscope.
Suggested/ planned frequency of observations	We plan that pupils will choose several places around the school to collect sandflies. Geographical location (GPS data) and photos of traps will be made by the students using smartphones. Sand flies present nocturnal activity so traps will be placed late afternoon

	and recovered early morning next day. An enough number of traps must be used to assure a representative sample. The actual number required will depend upon a number of factors including the degree of accuracy desired, the manpower available, size of area involved, etc. Adequate location of light traps is important and best catches are made where cover is good and the humidity is relatively high. School garden surrounding area could be a good place. Places near residential areas or near buildings housing animals are also desirable. It is important not to put traps if there are signs of rain because adult sandflies will not leave their rest places to bite. Traps should be suspended 1 to 1.5 m above the ground and far away from other sources of artificial light or sites exposed to strong winds. A single trap usually reflects sandfly flight activity within a buffer of 250-500 meters of its location.
Who should participate?	Individual pupils, whole classes – to be decided during the workshop
How can participants be motivated? **What are the benefits for participants?**	Participants will get information about flying insects which transmit leishmaniasis, a very important topic regarding canine health in Madrid region.
How long should the project take?	To be decided during the workshop
What equipment is required ?	Sandflies light traps, binocular magnifiers, glass slides, Eppendorf tubes, petri dishes, entomological forceps, light microscopes, a smartphone with a GPS application and a camera, a notebook and a pen.
Do participants need training and if so, describe it shortly	Training on how to collect sandflies, to elucidate between sandflies and other similar flying insects, to identify different sandfly species

Additional information

Not decided yet: light traps will be handmade by the own students in a Fablab (Fabrication Laboratory).

4. **Cellspotting**

Organisation	Ibercivis
Country	**Spain**
Topic	Cellspotting
Names of researchers responsible for this pilot and their affiliation	J. A. Carrodeguas (Associate Professor at Biochemistry Department, University of Zaragoza.) J. Clemente-Gallardo (Associate Professor at Theoretical Physics department, University of Zaragoza and Ibercivis Foundation)
Research question	Can volunteer participation train a machine-learning platform to create an efficient system to analyze microscope images for cancer research?
Description of the idea	The project extends an old Ibercivis project named "Cellspotting", where citizens helped analyzing pictures taken from real cells under treatment in the cancer's drug delivery research. This participation based on image recognition will advance the study of cell death, known as apoptosis.
Suggested methods	The participation mechanism is to receive (via a web platform) images of a cell culture being studied from a microscope and, based on basic questions, to help determine the actual state of each cell. By compiling and adding answers to questions like "Is this cell alive?" or "Is there content release?" we will know what is happening in each cell culture, helping researchers to know in every moment how the samples of medicines applied to each cell culture are working. From those answers, a machine learning platform will be trained. At the end of the process, the system should be able to process the images automatically.
Suggested/ planned frequency of observations	There is no specific schedule
Who should participate?	All kinds of participation perfectly fit into the project. Ideally, students would be taught the meaning of the project in class, and they can access the platform either during a special class at the computer room of the school or at their homes.
How can participants be motivated? **What are the benefits for participants?**	Joining an interesting research problem combining two very active research areas: Biochemistry/Medicine (Cancer) and Computer Science (Machine learning).

How long should the project take?	To be decided with the teachers, there are no technical constraints.
What equipment is required ?	Only a computer with internet connection.
Do participants need training and if so, describe it shortly	Yes, they do need some training to understand what they are doing and the purpose of the project. In principle, the researchers would be willing to help teachers to prepare didactic material for the students.

5. Impact of traffic noise on people: "Build your own annoyance function"

Organisation	*Information Technology, Waves department* *Faculty of Engineering & Architecture, University of Ghent*
Country	**Belgium**
Topic	Impact of traffic noise on people: Build your own annoyance function
Names of researchers responsible for this pilot and their affiliation	Dr. Luc Dekoninck
Research question	What is the state of transport-related noise pollution in Flanders ?
Description of the idea	Traffic is a major source of noise pollution. Besides lowering noise emissions at their source, noise reduction is also attempted to reach by remediation measures in the environment (e.g. 'silent asphalt'). Noise exposure has been classically assessed using modeling, but new technologies allow for more and more direct measurements (sensing) of noise. In this project students walk through the entire process of an environmental impact study according the DPSIR protocol ('driving forces', 'pressure', 'state', 'impact', 'response'). They measure noise and assess how disruptive the noise is to them personally based on a standardized noise annoyance survey, document their exposure with different techniques and compare the weaknesses and strengths of the different exposure assessment techniques. In this way they get insights in the complexity of environmental impact research. This pilot study not only maps noise exposure of students or assesses their annoyance curves, but also aims to raise awareness about the effects of noise on people.
Suggested methods	Students complete a survey, count traffic (amount of vehicles passing by at a given location during one hour), near their homes

	and/or at school. Noise measurements are performed at the pupils' dwellings by use of a sensor (provided by the researcher). Using the traffic counts & existing sound maps, combined with the surveys the students completed, they l construct a so called 'noise annoyance function'. They then discuss the results and debate over the potential measures that can be taken to reduce noise exposure in their daily lives.
Suggested/ planned frequency of observations	Simulated exposure: • Retrieve noise exposure from available sources, noise maps by local or regional governments Manual exposure count at dwelling: • Count traffic at the dwelling (at least one hour by vehicle type and logged in five-minute intervals) Noise measurements: • Set up a low-cost noise monitor for 48 hours to one week, data provided in aggregated format • The short-term noise exposure time series is provided during the manual count episode for further exploration. • These frequencies can be adapted depending on the availability of materials and the willingness of the teachers (co-decision making), as well as potential restrictions imposed by e.g. the local or regional Covid-19 situation.
Who should participate?	Pupils and teachers. If possible also parents (to fill in the surveys).
How can participants be motivated? **What are the benefits for participants?**	Students learn how real environmental impacts are being assessed, from the start (measuring data, interpreting data, determine the source of pollution, brainstorming on the potential solutions to reduce the noise disturbance). Working with data collected in their own living environment and comparing living conditions within the classroom population. It feeds the awareness on the topic of noise and traffic. The low-cost noise monitoring system is validated and useful for scientific evaluation. This level of contribution to actual science is a strong motivational factor. The subject is also complex enough to provide them with a nice challenge and be proud of their accomplishments afterwards. A crucial component in the science project is the quality of documentation of the process and the metadata. The provided examples show how the different data is gathered in a database like format for analysis, evaluations, calculations, graphing and conclusion. For the students, this is a highly tangible subject: noise is something you can observe and encounter all the time. It is close to the participant's lives. For the teachers it is very interesting to use this topic for explaining mathematics and physics.

How long should the project take?	The duration of the project is flexible (1 week to 2,5 months, this can be scaled up depending on the availability of sensors). The time spent in the classroom is defined by the teachers. Examples can be organized as a collective activity in the classroom or after an introduction as a home-based task. When implementing the full trajectory, six sessions of two hours can cover the entire project.
What equipment is required ?	Noise sensor (in our study : INTEC sensors from Ghent University), official noise-disturbance surveys (standard questionnaries from the government, available online). A noise sensor is not readily available in a general context but the trends in IoT developments can provide this type of equipment on a larger scale.
Do participants need training and if so, describe it shortly	Students need to know how to manage some mathematical skills (calculating with logarithms, Excel, search for spatial information [available noise maps], geographical skills). The complexity of the exercises can be mapped to the level of the knowledge of the participating class. The required skills can be included as real-life examples with real-life personal data in different classes (math, technology, geography, physics, etc.).

6. Urban Climate and Human Bioclimate

Organisation	GFOSS
Country	**Greece**
Topic	Urban Climate and Human Bioclimate
Names of researchers responsible for this pilot and their affiliation	Dr. Lagouvardos Konstantinos NOA/IERSD Research Director Dr. Christos Giannaros NOA/IERSD Research Associate
Research question	1) a) Which are the characteristics of urban climate? b) What is the Urban Heat Island phenomenon? c) How climate change affects the urban climate? 2) a) Which factors determine the human bioclimate? b) How urban climate affects human bioclimatic conditions? c) Which parameters are the most important in thermal environment? d) Which factors and measures favor thermal comfort conditions? 3) a) Which are the characteristics of the local climate and thermal comfort conditions in the school neighborhood? b) Are there any hot spots (thermal discomfort areas)? Which could be effective adaptation and mitigation measures (sustainable development plan)?

Description of the idea	The combined effects of rapid urbanization, global warming, and Urban Heat Islands (UHIs; i.e., higher temperatures observed in cities compared to those of the rural surroundings) make the urban residents more vulnerable to the adverse health impacts arising from extreme heat conditions. The aim of the present project is to increase students' knowledge and awareness concerning the impacts of urban climate on humans. The students will learn about urban climate characteristics, UHIs and urban-scale climate change, and how these factors affect the human body. They will become "young scientists" examining the local climate in their school neighborhood in terms of meteorological and thermal comfort conditions. An "Urban Climate Game" will introduce them in the research process of collecting the necessary data, processing the data, discussing and analyzing the scientific problem, and proposing potential solutions.
Suggested methods	1) Introduction: A preparatory lecture in the beginning of the project will be given to introduce the scientific problem and research questions to the students. The methods and tools that will be applied will also be presented. 2) "Urban Climate Game": At least five locations having difference environmental characteristics will be defined in and around the school (e.g., shaded street, sunny park). The students will be divided in groups (e.g., 10 students) and they will walk through the different locations to take measurements of air temperature, relative humidity and wind speed. At the same time, they will have an anonymous thermal comfort questionnaire, in which they will record some general personal information (gender, age etc.) and some specific information at each location. Specific information will include time, activity (e.g., standing), location characteristics (e.g., shade), cloudiness (e.g., bright), clothing (e.g. light summer cloths), subjective thermal sensation (e.g. hot) and subjective perspiration grade (e.g., visible wet skin). The "Urban Climate Game" may also involve random people in the experiment areas, in order to increase the sample size and its representativeness. Furthermore, the provision of additional meteorological data to the senior high school students will be considered. The data will come from automatic ground-based weather stations located in the wider school region and in the city center, so that the students will be able to compare the different meteorological conditions of the areas. 3) Data processing: Microsoft Excel and RayMan model will be used for data processing. RayMan is a numerical tool with user-

	friendly interface that requires only primary meteorological variables (e.g., air temperature) to compute human thermal indices. 4) Results analysis and discussion: The results of data processing will be discussed with the students in the classroom. The main findings will be highlighted and the students will be supported to answer the research questions. 5) Outcome presentations: The students' research work will be summarized in presentations at the end of the project. The presentations will include the students' conclusions about the local climate and thermal comfort conditions in the school neighborhood, as well as their recommendations for adaptation and mitigation measures (e.g., greening actions) in the framework of a sustainable development plan.
Suggested/planned frequency of observations	The "Urban Climate Game" will take place at least three times throughout the school year 2019-2020, so that one experiment will be performed during autumn, one during winter and one during spring, in order to consider the seasonal characteristics of urban climate and human bioclimate. Additional ground-based meteorological data covering each experiment implementation month will be considered to be provided to the senior high school students.
Who should participate?	Students from junior high school and senior high school
How can participants be motivated? **What are the benefits for participants?**	It is expected that the students' outcome presentations will be exhibited to the school board and parents' associations, while local authorities will also be invited in the presentations. This is a strong motivation for students, as they have the chance to promote their research work and propose specific environmental measures that can potentially be applied in practice. In the same framework, the publication of the students' work in educational scientific conferences and journals will be considered. In overall, the project is expected to increase the students' knowledge and awareness about urban climate and its importance in human bioclimatic conditions, especially under the climate change conditions that the planet is experiencing. The students will also practice in conducting research and in exploiting the resulting outcomes in the framework of serving society and their community.
How long should the project take?	The project will run the school year 2019-2020.
What equipment is required?	The necessary equipment includes: a) one pocket weather meter capable of measuring indoor and outdoor air temperature, relative

	humidity and wind speed, and b) ground-based automatic weather stations. Both measuring tools will be provided by NOA/IERSD (www.me-teo.gr).
Do participants need training and if so, describe it shortly	Student's training involves: 1) One instructional lecture by the project's researchers, including the demonstration of the tools (weather meters, RayMan model, etc.) that will be used. 2) Practice in the methods and tools having the guidance of the teachers. 3) One demonstration on the daily operation of NOA/IERSD's ground-based weather stations, including the presentation of the different measure instruments.

7. Analysis of students' dietary habits

Organisation	GFOSS
Country	**Greece**
Topic	Analysis of students' dietary habits The project consists of data collection of meal photos taken by the class students. Students become "young scientists" collecting and analysing their dietary habits and that of their class.
Names of researchers responsible for this pilot and their affiliation	Prof. Anastasios N. Delopoulos, Electronics & Computer Division Dept. of Electrical & Computer Engineering Aristotle University of Thessaloniki Katerina Riviou, Ellinogermaniki Agogi Research & Development Department
Research question	The research questions that will be addressed: - type/time of daily meal (such as breakfast, lunch, dinner, snacks) - type of meal content (such as fruit, vegetable, home-cooked, retail packaged) - type of drink content (such as water, juice, sugary, energy, coffee, dairy)
Description of the idea	The project consists of data collection of meal photos taken by the class students (with use of their mobile phones and a mobile app) and the analysis of the photo content. Students become "young scientists" collecting and analysing their dietary habits and that of their class. Consent forms are signed by their parents. Students who return signed consent forms and agree to participate will receive registration tokens and instructions for

	downloading the mobile app. Students who do not agree to participate in the data collection, will be involved in the analysis. The project aims to address the societal problem of soaring obesity rates in children. The project will enable in school level, as well as individual level (students and their families) to plan and implement actions against obesity.
Suggested methods	The students download the mobile app from Play Store or App Store. They register using a token provided by the teacher and answer some questions about their health behaviours. For a period of two weeks the users take pictures of their breakfast, lunch, dinner, snacks and drinks. They take as many pictures as they can. The students annotate their pictures via the mobile app. At any point of time, the teacher can use the relevant portal and show in class meal graphs and pictures taken by the students. At the end of the two weeks period, the AUTH researchers will send a .csv file with all photo annotations to the teachers. The file includes information on the type and time of each meal (e.g. breakfast, lunch, dinner, snack, drink), the meal content (e.g. fruit, vegetable, home-cooked, retail packaged) and drink content (e.g. water, juice, sugary, energy, coffee, dairy). The students, working in groups, will extract statistical measurements from the csv file on the contents of the pictures in order to present important dietary habits of the whole class, such as the following recorded per week: • no. of breakfasts; • no. of fruit photos; • no. of retail vs home prepared meals; • no. of sugary drinks; • the time dinner is eaten. The groups of students will present their results to their classmates, stirring discussion about the analysis methodology and the health-related implications of the findings. **All photos and data collected will be anonymised and stored in the cloud. Only researchers will have access to.**

Suggested/ planned frequency of observations	Two weeks (including one weekend) to upload meal photos and annotate them.
Who should participate?	Students from EA school- secondary education level (whole classes).
How can participants be motivated? What are the benefits for participants?	Badge for the "science citizen"/student contributing the most data, the class contributing the most data will go for a daily excursion as a prize.
How long should the project take?	The project will run the school year 2019-2020.
What equipment is required?	Students will be using their mobile phones (following the limitations set by the Ministry of Education), approval for conducting the research will be sought by the Ministry of Education.
Do participants need training and if so, describe it shortly	Students will be informed via one-class period presentation – the mobile app and the installation process will be presented to them.

Additional information

The activities/data collection will allow the implementation of interdisciplinary research projects in the class.
School hours required:
1 h: Preparatory lecture by teacher
1 h: Data analysis; students analysing the collected photo meals
1 h: Outcome presentation and discussion in the classroom

8. BRITEC testimonies from school visits

Researchers' visits in schools, either face-to-face or online, proved to be a valuable activity engaging teachers and students. It was beneficial experience for students, who saw that scientists are just like any other people but their job was more exciting than typical 9:00 to 17:00 office work, and that researchers do not always wear white coats and perform their research closed in the lab. Teachers benefited as well. Scientists clearly explained scientific problems and research methods what made teachers feel more confident and capable of leading the students.

For example, in Belgium, following one of the visits dedicated to presentation of noise monitoring, teachers said that the presentation given by the researcher "was a very interesting change of subjects for our course in Engineering, by being in contact with an external researcher during these COVID times. The students acquired a very good view on what noise research encompasses and deepened their knowledge on this subject/matter". Students considered the presentation as interesting, with the bonus of being able to ask questions directly. Students mostly enjoyed the fact that the researcher was an expert in the field of noise measurements and they could learn a lot from him.

Another great example of a successful visit (online) was one dedicated to presentation of Radio Meteor Zoo. Teachers were happy with the level of complexity which was perfect in terms of pre required knowledge of the students, and the timing was estimated correctly. What was very interesting and surprising during this visit is the fact that students did not expect that real advancements in Science can be based on such trivial/simple tasks like “drawing rectangles where you see a pattern on your screen” – this activity is standing far away from the cliché image they had in mind about scientists with white lab coats performing experiments. Another teacher was enthusiastic about the presentation given by a researcher, which was built in such a way that even the students who had no prior knowledge whatsoever could still follow it. The students were able to answer questions posted by the researcher, and they were visibly interested in the matter. After the presentation the students wanted to start analysing the spectrograms on Zooniverse Radio Meteor Zoo immediately. They were very enthusiastic, and they discovered the platform Zooniverse. Some students were classifying more than 20 spectrograms during the next teaching hour.

Also, scientists were very happy with the outcome of the visits, either held online or face-to-face. They appreciated good communication and interaction with teachers and their commitment. Scientist said that “teachers’ commitment and students motivation were great and results were very good”. Scientists were enthusiastic when students were open and asked many questions, it proved that the students were interested in the topic and curious about the project and science in general. As one of the scientists said, “It was very useful that we had the possibility to go with the pupils to visit the site of the study together.”

For some scientists it was easier to interact with the older students (16-18 y/o) than the younger ones (12-14 y/o) because the older ones had already some knowledge about scientific processes. There were cases when communication was difficult due to online meetings forced by pandemic. Getting students to interact was also more challenging in case of online communication.

In case of Spanish Flebocollect pilot, the feedback from school visits was also very positive: “The experience was extremely positive. Taking part in this project has allowed me to know more about citizen science and the motivational effect it has on students. By participating in this project, students work on topics of interest related to health and diseases transmitted by blood-sucking insects in their immediate environment. In addition, they work on topics such as the scientific method and the repercussions that alteration of ecosystems can have on our health. Due to the delay in the implementation of this project because of the current pandemic, students have been proposed only to solve a problem based on real data collected by researchers, that is: Are sand-fly hand-made traps so effective as commercial ones?

This project has been implemented through several face-to-face sessions for children aged 12-13, a total of 57 students divided in three groups. The activity has been extremely successful from the perspective of the researcher and students. In fact, the students have rated the project with an average mark of 8.7/10."

Experience from the visit of a researcher implementing Cellspotting pilot was also very positive. As the researcher said: "I have some experience organizing citizen science activities but the visit to the school was genuinely remarkable. We scheduled two online visits because of the COVID situation. The pilot was organized as an activity of a Biology class for 16 years old students. One was at the beginning of the implementation, to introduce the project and the online platform which was used. The second was scheduled for 15 days later, and I presented the results of the project achieved with the students participation.

Because of the problems with Covid I was prepared for some unusual situation at schools and little interest from the students and, on the contrary, they participated more than in my previous experiences with school activities. This good attitude was probably due to the introduction of the activity by the teachers, because I was also very impressed by their enthusiasm (the teachers', I mean). In any case, this is not a purely subjective opinion: as the activity was done online in one of our webservers, I could monitor the activity of the students. This activity report was used by the teachers for evaluation of the activity. It was very high on average, but in a few cases it was undoubtedly impressive with more of 40 (4 students) or even 60 (two students) pictures analyzed."

In conclusion, the activity has been extremely successful from the perspective of this researcher.

Scientists also explained a little bit what kind of support would be useful for them for future visits at schools. They mentioned:

- online data platform;
- help in providing materials to schools;
- funds for simple additional equipment that could be left at school (public school usually do not have such resources);
- Other person involved (especially if the workshops on-site are organized).

Teachers after scientist visit:

Students enjoyed scientist's visits at school. They appreciated more face-to-face meetings, but they were limited due to the restrictions imposed by the pandemic. Online meetings got positive feedback as well. In most cases students were active during these visits and students' knowledge about real research practices increased after the visit. In the majority of cases students understood the purpose and processes behind the Citizen Science research they would carry out better. Teachers were happy with the interaction scientists had with students. They also appreciated that the scientist gave a clear and engaging explanation to students of the purpose of his/her work/research. Teachers also said that researchers' visits increased students' motivation to learn the curriculum content. In most cases the visits helped teachers to better understand how to coordinate the project at the school level.

Some teachers said that visits helped students to "better understand the meaning of the project and the various stages of its implementation. Thanks to the pleasant atmosphere at the meeting, the students believed in themselves and that they were able to perform the tasks. The students were also pleased with the direct contact with the scientist and were proud that they had been honored with the arrival of the scientist."

The visits were most appreciated in smaller schools, in smaller cities. As one of the Polish teachers said "by meeting with a scientist, students are more likely to engage in the project, understand its purpose, and know that they are doing something important." Many teachers said that each meeting with a scientist was a great experience for students and they learnt a lot. "We wish we had as many such meetings as possible," – one of the Polish teachers said.

Teachers also suggested that if students are not familiar with research methodology, then it would be helpful to prepare step-by-step manuals and guidelines for them that are more detailed and simple; factsheets with additional information.

Teachers suggested some activities and actions, which would be beneficial in implementation of future CS initiatives:

- to create video-tutorials for teachers to help them implement the project;
- to create a community of teachers and students working on the same project to chat and collaborate;
- to improve the interaction between researchers and students;
- to increase the number of joint events/visits during which the researcher informs students about the current status of the initiative and provides them with feedback and outcomes from the study.

Some teachers said that more time for the implementation of the project would be beneficial, and it would be much appreciated, if the topic of the CS initiative would be directly related to students' syllabus timetable.

9. Focus Group Interviews results

Citizen Science research highlights the need for strengthening dialogue between researchers and schools and thus make possible the successful introduction of Citizen Science in schools. For this to happen, the norms and structures for the exchange between schools and researchers need to be developed. To be effective, norms and structures must respond to the needs of involved parties. In order to achieve this goal in a collaborative manner, the project team conducted focused group interviews with researchers and teachers before and after implementation of pilots in each partner country. During these interviews, the team investigated the researchers' and teachers' attitudes and opinions on Citizen Science, expectations, thoughts and experiences on bilateral cooperation.

Researchers, in general, were very aware of the ethical issues and knew requirements while working with students under 18 years old. They emphasized the importance of close cooperation with the teachers in that case and whole co-creation process before implementing project at school.

On the one hand some of the researchers had concerns that their work in the project with civil participants would be time consuming, and that data collected by students may not be of good quality. They hoped that students' participation in the project help them obtain data, which would have been difficult to acquire by researchers themselves.

The implementation of the pilot phase of the project unfortunately met the pandemic situation, that had an impact on some expectations and plans. For researchers the main challenges were the lack of personal interaction with students and teachers. It was disturbing for running Citizen Science activities and involving students. This caused communication problems as well with understanding properly the process of data collection.

In general, researchers assessed the collaboration and interaction with teachers and schools as very good. Despite some difficulties mentioned, they emphasized teachers' involvement and support that was crucial for the whole project process.

Teachers had different expectations than the scientists and had a positive and concerned approach. They found having contact with a real science interesting and inspiring for the students, as they had an opportunity to realize that knowledge exists outside the classroom. They believed as well that such activities would improve their quality of life, and were convinced that the more involved they were, the better the results would be.

After the implementation the overall teachers' assessment concerning school participation in the pilot was positive. They also, like scientists, emphasized the negative pandemic impact on Citizen Science activities, but were happy that despite the difficulties students were enthusiastic about learning new things.

Teachers also suggested some improvements that might be useful in future initiatives for Citizen Science in the fields of technical support, trainings and educational materials for the schools from the scientists. They mentioned that support from school authorities in terms of work organization, strengthening cooperation between teachers, help to organize educational trips or visits of scientists' workplaces by the students would benefit in creation of comfortable conditions for carrying out such kind of activities.

Below we are presenting the main findings from the interviews, separately for researchers and teachers, before and after implementation of CS pilots.

Focused Group Interview with Researchers before the implementation of the pilots

1. **Knowledge and experience**

In general, the researchers already knew what Citizen Science was and some of them have already participated in CS projects, sometimes even as coordinators. Most of the researchers had previous experience collaborating with schools, nevertheless there were occasions where researchers neither participated in CS initiatives nor collaborated with schools.

In case of ethical issues i.e., not posting pictures of children involved in their research; not naming children when acknowledging their participation – without collecting appropriate consent - the participating scientists were very aware of the ethical issues and knew requirements while working with students under 18 years old.

2. **Expectations from Citizen Science activities**

Scientists thought that the main challenge in running Citizen Science activities involving students were making the science understandable to the teachers and students, as well as making it interesting and motivating for them. Secondly, scientists mentioned making an accessible lesson plan; creating a complete project in which the students experience a full learning process as there is a fairly short period in which the students can learn about the context and topic and in which they do their measurements, analysis, interpretation and communication. Very important in scientists' opinion was the fact that involving students in the research must be useful for the teachers as well, i.e., the topics covered by the Citizen Science project have to link to topics that are explicitly mentioned in the curriculum guidelines.

In order to overcome these challenges, the researchers mentioned the importance of the co-creation process in collaboration with the teachers. Scientists also planned to make introductory presentations to the students explaining the context and making the projects interesting for them by actively engaging students and teachers in the research, conducting training on how to use the equipment and filling in questionnaires for data collection, sharing the instructions on data collection in general. Some researchers considered that it is crucial that students knew the significance of the project for society.

While discussing the expectations regarding the quality of data collected by pupils and the steps that could be taken to ensure good data quality, scientists in general did not have high expectations and possible errors were taken into account. Researchers from Spain responsible for Cellspotting pilot had different opinion and they thought that data would be of good quality, because of the software they shared with the students allowed that the same pictures were analyzed by several students and average their results, thus minimizing the possible individual errors. The software also included a tutorial to guide students.

When it comes to the opinion about expected workload in relation to the results, some of the researchers had concerns about the amount of time they would need to devote and what effects it would bring. Others commented that the data collected by pupils would help them since they would not have to be involved in the collection of data and would be able to have access to data that they probably could not have access to otherwise. In general, they thought that if all the activities would be planned thoroughly and would be connected with the curriculum, the workload should not be very high.

One of the researchers in Belgium participated in the project to test the concept, and to bring awareness and teach people about what is technically possible in terms of noise/sound science and give this topic more visibility. In this way, he wanted to trigger (or create a common ground for) new projects. In that sense, he decided to use a standardized survey, as it would enable researchers to add the results from this survey to those performed within the framework of other projects.

3. Expectations from BRITEC activities

When asked about the reasons for choosing specific initiative, researchers indicated that they wanted to get to the classrooms with their science and to immerse the students in the full process of scientific research, as it may be a big educational added value. Also, they believed that the activities they chose for the students could be of their interest and benefit their everyday life, since it concerned socially important topics. In some cases, researchers stated that information provided by the students could be very useful for their research, since data collected by the students would have been difficult to acquire by researchers themselves. Moreover, young people have greater opportunities to reach places inaccessible to the researcher. In Spain, the researcher in charge of the phlebotomine sand flies project, decide to start working with phlebotomine sand-flies in CS projects due to the great outcome of the Mosquito alert app.

4. Working with schools

Participating scientists foresaw that the main challenges were fitting their topic/research into the school curricula and making the science understandable for students. Researchers were motivated to contribute to making young people enthusiastic about science and they were willing to provide guidance to schools how to use specific platforms, collect or interpret the data, co-create the lessons with teachers, if needed.

Throughout this process, some of the researchers wanted to learn about teachers' pedagogical methods, understand better the way pupils perceived the scientific terms, to know the level of proficiency the students had (e.g., researchers wanted to know how long it would take to explain some specific concepts to the students). They also aimed to develop possibly new methodologies and processes on how to conduct Citizen Science projects. Researchers believed that collaboration with schools would be beneficial for them, pupils and the teachers, and the research would raise awareness on topics that were not generally known before.

On the other side, researchers expected teachers to provide feedback on whether the pupils have understood the methodology for conducting their research and data collection and also to check that they were collecting and analyzing their data correctly. They also expected teachers to help pupils with the use of the equipment (when necessary) and communicate to the researchers any problems that might arise. Last but not least, researchers hoped that teachers would inspire the pupils in order to stay engaged in the project. Some of the researchers also stated that they would like to have available guides/toolkits on how to conduct Citizen Science projects and activities. Other tools or support that researchers mentioned as useful to prepare for the project or initiative in the future were: help in finding interested schools and teachers, help in communicating with schools, provide assistance with the school visit, help in co-creation of lesson modules.

Focused Group Interview with Researchers after the implementation of the pilots

1. **Experience about Citizen Science activities**

For researchers the main challenges in running Citizen Science activities involving pupils were the lack of personal interaction with students and teachers due to the coronavirus pandemic as well as teachers' involvement in implementing the pilots and motivating and engaging students. This caused problems with communication and understanding properly the process of data collection. In some cases, teachers and students were well motivated, in other cases, unfortunately not. In some cases, the COVID-19 crisis affected the data and the way it was transferred to researchers. Researchers pointed out that a challenge was to try to raise the awareness among students about the importance of the research and the utility of their results. For some of them - using different platforms to deliver the online classes was a challenge. Being able to explain the pilot project to students clearly, so they could understand and problems with receiving appropriate equipment were also a challenge for some scientists.

Even though the Covid19 pandemic made teachers and researchers change some aspects of the implementation, in researchers' opinion, CS activities have been run out satisfactorily, in some cases even the results have been better than they thought at the beginning. The challenges were overcome and, in researchers' opinion, they could be prevented in the future. This can be done with several ways. For example, by connecting the experiment actions with the curriculum or by introducing Citizen Science methodologies and approaches in the curriculum in an interdisciplinary way connected mainly with practical problems of everyday life as well as with essential big problems that concern humanity in order to increase the interest and engagement of the students. Researchers had to run informative webinars for the needs of the experiments/ongoing data collection and in some cases be in frequent communication and contact with the teachers. Researchers emphasized that the attitude of teachers was very important and it helped a lot during the implementation of pilots.

Other measures that could support overcoming the challenges were: development of teacher training activities in Citizen Science approaches and motivation for teachers; internal incentives and motivation for participating students by conducting internal competitions within the school, participation in local/national/international competitions; actions that will develop the institutional contact of Research Centers, teachers, schools and local educational authorities, targeting the implementation of pilot Citizen Science actions and teacher training.

2. Experience about BRITEC activities

Generally, the pilot initiatives were suitable for cooperation with schools and allowed to gather large amount of data. The pilots were very enriching as they gave sense to students about an actual scientific issue, which concerned a wide range of the population. Hence, students were more motivated and interested in science. At the same time, new teaching methodologies were introduced in the classroom.

In Greece, initially students were not particularly interested in the activities and the effect that the results of the experiments could have. There was a need to stimulate students to think better and clearer. Especially when they realized the importance of the general problem and the fact that it concerns everyone: their family, their city, the whole planet. The age of the students was an important factor. Older students showed greater consistency in their obligations, in all phases of the experiment. Collection, processing, fixation of results, presentation. Easy to use and fun digital applications, gadgets and motivation helped a lot in the implementation of the experiments and the completion of the process, making the activities suitable for cooperation with schools, teachers and students.

The data collected by the students were generally of good quality. Researchers highlighted that they “never got so many data in such a short time span” and the data would be very useful for them, but quality check must be performed.

Generally, the workload was not that high, but in some cases (in Belgium) the workload was higher because the hardware was not entirely ready to be of ideal use in schools. Regarding Flebocollect project, the workload was particularly heavy as well, nonetheless, it has been worthy as the results were very good.

The pilots were useful for all researchers, they assessed the cooperation very positively. In some cases, the concept and experience would also be translated in a publication and an application for a funded Citizen Science project.

In National Observatory of Athens (NOA) researchers considered their participation in BRITEC as very important for the organization. Due to the participation in BRITEC, new ideas have arisen for further development of the organization's collaboration with schools. Researchers believed that by developing their relationship with schools they would find support in collecting and analyzing data related to the organization's research on the environment and climate.

With respect to Flebocollect project, it has been incredibly interesting and enriching in the field of general teaching methodology for the researcher in charge of it. However, in its particular research it has not been relevant as no data could be collected.

3. Working with schools

Researchers assessed the collaboration and interaction with teachers and schools as very good. Even though there have been some difficulties during the implementation because of the coronavirus restrictions, most of the teachers were involved in the project and made students participate in pilots with enthusiasm. The researchers emphasized that teachers' involvement was crucial in the whole process. If teachers had not been enthusiastic, the implementation of pilots would have been more difficult.

In Belgium, speaking to the younger pupils of 12-14 years old, was challenging and required a different preparation to make the matter (meteorites) understandable.

By implementing pilots, researchers gained new ideas for further developing the particular or similar Citizen Science projects, as well as some experience in modifying and adapting experiments at school level according to the age of the students. Researcher in charge of Flebocollect project appreciated the fact of being able to connect education with science. Researcher in charge of Cellspotting had also find this experience genuinely beneficial. Scientist involved in UV radiation pilot obtained very valuable data that would enrich her research.

In some cases, scientists got feedback from pupils concerning the assignment and the aspects they found more "boring" (in the classification process that was part of the Citizen Science project), and this would be taken into account and would influence the setup of the classification tool to make it more fun and attractive in the future.

To implement other initiatives involving schools in the future, scientists highlighted that it would be useful:

- to have a dedicated central platform where the information gathered in Citizen Science platforms can be submitted, stored and shared;
- to have one very good platform to deliver online classes;
- to practice filling in the form (together with students and teachers); going out together in the field; preparing instructional videos;
- to systematically remind teachers about the project, e.g. the Facebook group, contact once a month or online duty;
- if teachers were rewarded.

Besides, local institutions, such as the city council or the environment councillorship (in the case of Flebocollect project), could be in charge of implementing such initiatives and could make also a bigger impact, taking into account that both pilot projects deal with public health issues.

If schools have better digital equipment, the cooperation between research organizations and schools would have been easier and thus the implementation of Citizens' Science programs.

Sometimes special equipment and tools are needed at a relatively high cost that schools cannot afford. It is important that research organizations that collaborate with schools in such programs are able to give access to scientific instruments as well as their digital tools.

Focused Group Interview with Teachers before the implementation of the pilots

1. Knowledge and experience

Knowledge of Citizen Science varied among teachers in all partner countries. In Belgium, majority of teachers heard about CS and even took part in several initiatives in this field either individually or with class. A few teachers collaborated with researchers before.

In Greece, seven out of nine teachers were not familiar with the term before, one teacher was familiar with citizen science, and one participated in a CS project before. Most of them had collaborated with researchers before, mainly during their undergraduate studies, Masters and PhDs.

In Spain, only two teachers who attended the workshop had heard about CS before taking part in BRITEC project, some teachers participated in a CS project without knowing that was CS initiative. All teachers had collaborated with researchers before.

Similar situation was in Poland, where two teachers heard about CS and majority of teachers took part in projects/initiatives that covered Citizen Science field, though it was not called that way. Majority of teachers had collaborated previously with researchers and universities.

2. Motivation

While talking about the reasons that convinced teachers to participate in the BRITEC project, teachers listed:

- The willingness to increase the collaboration between scientists and teachers and development of non-formal education;
- Opportunity to learn a lot of new things from the scientists;
- Support in motivating pupils by linking to real life issues/practice, getting to know best practices from other teachers;
- Obtaining good materials for a research/investigation on a larger scale, learning new methodologies;
- To get European perspective of the project; to get to know what happens in Europe in the context of STEM education;
- To raise students’ interest in science.

Teachers also had some expectations for students learning outcomes. Among the most important ones they mentioned making students’ enthusiastic about science, sparking their interest in STEM subjects and teaching them analytical thinking.

3. Expectations form Citizen Science activities

Teachers thought that the main challenges in running Citizen Science activities in their schools would be:

- Students' involvement, motivation and their willingness to participate;
- Technical realisation – how the measurements would look like in general, how to report the measurements;
- Time constraints;
- New ways of teaching and all the novelty and the unknown which goes with the project.

Other challenges were:

- Getting enough ICT-support from the school (e.g., enough available computers);
- Breaking down the scientific information up to the level of the students;
- Not enough know-how: not having enough knowledge on the subject or project ourselves as teachers;
- The need to align the project with the curriculum requirements;
- Observation of students' interaction with teachers outside the classroom;
- Linguistic issues;
- The fact that students should work on their own, may cause delays during implementation depending on their level of self-motivation and commitment;
- Commute to school/ transportations problems (in case of one school in Poland there were students that commuted 80 km);
- In some cases - lack of parental support;
- In some cases – lack of other teachers' engagement;
- Excessive access to information (not reliable sources).

These challenges can be overcome or prevented with proper research guidance, by linking to the social and environmental problems addressed by research and by further raising students' awareness. Clear planning also would be meaningful in this process. Also it could be useful trying to establish some deadlines for students, so that they could organise themselves and avoid having long-term objectives which may be difficult to achieve. Additionally, trying to simplify things for these students as much as possible can prevent them from giving up. Having an incentive attached to the work would be valuable as well: e.g., evaluate students' work as part of a schoolwork duty (i.e., they get marks on it, just like when they have to make any type of school assessment). According to teachers, it could also be helpful to introduce a prize for the 'best class'; include an element of a contest in the work (competition/gamification); make it a cross-disciplinary project in which the students have to present their results, as part of their final exam, accounting for several course subjects at a time.

Teachers did not have a clear idea on what expected workload in relation to the results could be. Their general answer was that this was an extremely difficult question to answer because they did not have any idea how much work it would be. In Spain, as the pilot was part of the curriculum, teachers did not think that the workload could be very high. However, the planning of how to implement the initiative and the establishment of the steps that should be followed during the implementation was something they thought would take more time.

4. Expectations from BRITEC activities

In Greece, teachers expected that through BRITEC activities, students would:

- Show consistency in collecting scientific data;
- Believe that such activities will improve their quality of life;
- Realize that knowledge exists outside the classroom;
- Be convinced that the more involved they were, the better the results would be.

In Spain, teachers thought that CS initiatives were highly useful to connect what is written in the textbooks with the outside world, seeing that students are going to work with researchers and, consequently, they are going to have the opportunity to know first-hand what does the work of a researcher look like, what they do in their everyday routine, etc.

5. Working with researchers

While working with researchers, teachers in general expected scientists to share some good ideas and methods that would be helpful for implementation of pilots. Teachers wanted to invite scientists to schools, so they could conduct introductory lessons for students, as well as they wanted scientists to conduct webinars, when needed, and provide necessary didactic materials. Teachers also expected that scientists would be able to connect students with specific research problems and get them acquainted with modern research on contemporary problems, as well as make students interested in these subjects.

When asked about what kind of support and feedback from scientists teachers expected, they mentioned support in giving accurate instructions on how to take measurements and how to perform the tasks; mentoring; providing an explanation of phenomena and the purpose of data collection.

Among tools or support that would be useful to prepare for CS initiatives teachers listed specific instructions step by step; contact with persons responsible for specific topics/areas; scientific support line (phone); assistance in data analysis. Some teachers mentioned that they would like to have detailed protocols on how to implement the pilot/roadmap about how much time to invest in the project, and how to get started with the project.

Additionally, teachers mentioned that students need to feel that they are part of the research, and the teacher is not the only one in charge of it while they are observers of the process. Teachers also highlighted the fact that CS should be something that everyone could do and have easy access to.

Usually, the main problem to “do science” in classrooms is the lack of money and technological tools. Most of the school labs do not have the resources needed. Hence, in teachers’ opinion, it is significantly important to make cheaper scientific equipment to give students the tools needed to work properly.

Focused Group Interview with Teachers after the implementation of the pilots

1. Expectations

Generally, teachers’ expectations for the professional development have been met in the project. Most of them achieved all goals set at the beginning. Teachers in Belgium said that “it was a pity it was not live (because of pandemic), because there would have been much more interaction between scientist and pupils/teacher”. Part of the professional development for the teachers was to make the projects that often linked to multiple school subjects work in a multidisciplinary/STEM-context. Since the projects were new to all of them, this involved a lot of problem solving for all parties involved. Teachers in Greece commented that overall students and teachers learned and practiced many things related to Citizen Science, but the event of the coronavirus and the closure of schools lowered their expectations. In Poland teachers were happy that their students were enthusiastic and eager to learn new things and they performed the measurements independently.

Also, teachers’ expectations for student learning outcomes have been met. Many teachers indicated that it has been an enriching experience for the students and it increased their enthusiasm about science. It was very encouraging and interesting for the students to perform professional measurements. It considerably raised their motivation for being involved in science. Of course, there were cases where some students were less interested in the project, but they were few.

2. Experience about Citizen Science activities

Teachers in different partner countries had different challenges in running CS activities in schools.

In Belgium, teachers mentioned some problems with measuring devices; stress associated with organization of work, especially when measuring material was involved; translating the knowledge of the researcher to the teachers/students - on some aspects of the project the teacher had to rephrase at a more "superficial" level, not to make the matter too complex; the issue how to adapt the CS initiative to the right course and lesson plan and to gather teachers to work together in a multidisciplinary project. All in all, the challenges were overcome. Teachers said that if measuring instruments are involved it is important to have them in the school as early as possible so the teacher can get acquainted with them. Communication between teachers on how the project links to their subject(s) was very useful. The teachers’ suggested that solution to the problem of not fitting into the whole package of educational requirements of one single year would be to focus on the aspects the students need to learn in that particular year and go over the other aspects in a more superficial manner, or even omit them, if that is appropriate. Eventually, teachers could ask their colleagues who teach about the other aspects in the grade above, that they would refer to this project, once they are teaching about that aspect.

In Spain, the main challenge was to keep students constantly focused during a repetitive activity for a relatively long period of time without getting a mark. In case of Flebocollect project, the challenge was to implement it without any experimental activity. In both pilot projects the challenges were not overcome. Students began to feel tired and not conscious of the relevance of the pilot project. In Flebocollect, the coronavirus restrictions did not allow any experimental activity, so students had to analyse data collected by researchers, which was not as motivating. In the case of Cellspotting, maybe these challenges could have been prevented if teachers have seen the app before the implementation. Besides, a tutorial could have also been useful to avoid losing time in class finding out how the app works. On top of that, the presentation given to younger students was very long, so it would be interesting to summarize it for them.

In Poland, teachers informed that students had problems with filling in the questionnaires to report the measurements. Some students had problems understanding the research – the course of research and how to conduct it. In these cases, the challenges were overcome - instructional videos prepared by scientists were used and proved to be very helpful.

3. Experience about BRITEC activities

Generally, teachers had an opinion that all BRITEC initiatives were suitable for cooperation between schools and scientists. Teachers highlighted the importance of that kind of collaboration even though coronavirus crisis made that collaboration more difficult at first, because there was a need to reorganize the work.

For teachers in Belgium the workload was quite heavy, but the added value of the projects was to have more direct contact with the researchers. According to the teachers, the networking with other teachers and researchers made it worth it.

Teachers in Greece also said that there was a heavy workload as the program was outside the standard tasks and duties and the school environment was not yet suitable to easily incorporate such actions. But the load is proportional to the desired results. If you want to achieve good results you have to make an effort, “We entered the process and managed to have remarkable results”, Greek teachers said.

For teachers in Spain and Poland the workload was less heavy. Teachers in Poland said that pilot dedicated to rivers was “a developing and learning project that shows that a smartphone can be a measuring tool, not a waste of time. Parents looked completely different at their children phones after the project”.

4. Working with researchers

All teachers assessed the collaboration with researchers and the insitutions very positively. They said that researchers were very motivated and tried to motivate students as well.

In Belgium some teachers commented that e-mail is the easiest way to communicate and decide on things between researchers and teachers. Any other platform that requires getting used to it (especially in the coronavirus crisis) was less effective for them. Presentations given by researchers were more helpful than a theoretical lecutre.

Greek teachers expressed the opinion that the choice of the research subject and the researcher is very important. The subjects were very close to everyday problems that concern the students, and researchers were young people with great communication skills.

In Poland, teachers assessed all the materials and webinars very helpful, cooperation as excellent and said that they were looking forward to further collaboration. Students were enthusiastic and praised their participation in the BRITEC project. Participation in the UV pilot translated into everyday awareness and functioning – teachers said that their students were checking UV index and started using sunscreens.

Teachers gained from BRITEC a new experience and knowledge. Taking part in BRITEC made teachers and students more open and interested in participating in other CS projects. Teachers and students were persuaded that Citizens' Science programs could help and support scientific research. The project also helped to increase students' awareness about Citizen Science initiatives.

Teachers also mentioned some tools/support that they thought would be useful in future initiatives for CS, among them were:

- Access to special equipment needed to implement science programs and training on how to use it;
- General training for teachers;
- Information about using the measuring tools linked to the instruments, e.g., how to use Excel or perform certain operation for which the researcher would use another tool, like MATLAB, Software-tools;
- Support from the school environment, less bureaucratic conditions, team of teachers to support such programs, school must have a clear strategy to support such initiatives. Schools need support from the local and national educational authorities;
- Clear institutional framework, flexibility in the curriculum, less time restrictions;
- Bring research, researchers and universities and research centers closer to schools;
- Contact with other teachers to discuss the implementation process;
- An educational trip or visiting scientists at workplaces would be very motivating for the students, since students were fascinated by the work of scientists.

Teachers from Poland highlighted that being able to listen to the webinar recordings asynchronously was very useful; the list of articles and materials were great. Also, they found a dedicated group on Facebook very helpful. They were very happy with the project's outcome, collaboration and involvement of students.

Finally, teachers in Belgium added that for STEM education in Belgium there are only curriculum guidelines for the first two years of secondary school (at the moment of preparing this document) so it would be good if the CS projects had a modular structure so a teacher can carry out parts of them. A big motivation for the teachers to take part was to "show real life stuff inside of the school walls".

Teachers form Spain mentioned that it could be interesting if institutions in charge of CS projects could get in contact with teachers to know the necessities of schools in order to be capable of implementing them. It is essential to talk to teachers and have a previous collaboration with them to know the pros and cons of the pilot project, get advice, discover possible strengths and weaknesses, etc.

Greek teachers concluded that in order to conduct CS projects at schools, there is a need for:

- Support to teachers and schools;
- Increase students' motivation;
- Involvement of the wider school community (parents, municipalities, industry, local educational;
- Clear institutional framework, flexibility in the curriculum;
- Structured framework to enable students to work out of school;
- Modernization and extroversion of the education system;
- All of the above to become the daily routine of the school.

Annex A – research protocols from BRITEC CS pilots

Protocol 1 Urban Climate and Human Bioclimate

Methodology / Protocol "Urban Climate and Human Bioclimate"

Introduction(speech):

(a) Climate change: An introduction to the new terminology ("climate crisis"), which more accurate-lydescribes the catastrophe that the planet is experiencing and emphasizes the seriousness of the issue.

(b) Urban climate: Description of structural, environmental, etc. characteristics of an urban area. The-problem of widespread urbanization.

(c) Urban Thermal Island (UTI): The UTI as the most representative environmental problem due to theclimate crisis, which is due to abusive human interventions in the local climate.

(d) Urban population: The combined effects of UTI and the most frequent, intense and longer - due tothe climate crisis - heatwaves on city residents.

(e) Human biometeorology: Thermal comfort as one of the basic conditions for a good quality of life. Thefactors of the urban climate and the ways in which they affect the thermal balance of the human body and consequently the thermal sensation of a human being.

(f) Research work at school: (i) What are the characteristics of the local climate and thermal sensation inthe school and the surrounding areas? (ii) Are there differences in thermal sensation between two people? (iii) What are the most crucial factors in creating these potential differences? (iv) There are areas that could be described as "hot / cold spots" (areas of increased hot / cold stress). (v) What are the characteristics of these areas that make them "hot / cold spots"? (vi) What measures could lead to the alleviation of hot / cold stress in these areas?

Students' research work:

The above research questions will be answered by the students themselves through the execution of the following research work:

(a) Recording of meteorological conditions in seven (7) selected points of the school and the surround-ing areas (Annex 1).
(b) Recording of the subjective thermal sensation by each student at each of the seven (7) selected measuring points (Appendix 2).
(c) Calculation of the objective temperature index PET (physiologically equivalent temperature) at the seven (7) selected measurement points according to the meteorological records using specialized software (RayMan).
(d) Processing the data that will be generated using Microsoft Excel. Analysis and discussion of results. Drawing final conclusions.

The recordings (data collection) will be done by students for at least one (1) day within three months (eg No-vember, January, April) during the school year, in order to take into account the seasonality during the anal-ysis of the results. The students of the high school will be given additional meteorological data for the meas-urement periods, coming from three automatic meteorological stations of the National Observatory of Ath-ens (EAA) / meteo.gr: (i) Athens center (Gazi) - urban station, (ii) Vrilissia - suburban station, (iii) Pallini

(Schools of Greek-German Education) - rural station. The purpose is to study the differences between the meteorological conditions of the three areas and in particular to examine the phenomenon of UTI. The calculation of the PET index (c) for each measurement period will take place by the responsible researcher. The processing of the data (d) will take place by the students in groups of 57 people. At the end of the school year each group will present their research work. The presentation will include the group's conclusions on the thermal sensation conditions in the school environment, as well as proposals for adaptation measures of the local climate in the context of a sustainable development plan and response to the climate crisis.

Annex 1 to the protocol.

Recording of meteorological conditions

Date:

Measurin g Area	Description	Local Time	Air Temperature (º C)	Relative hu-midity (%)	Wind Speed (m/s)	Cloud cover [1]
1	School class					
2	School yard (in the shade)					
3	School yard (in the sun)					
4	Street (in the shade)					
5	Street (in the sun)					
6	Park (in the shade)					
7	Park (in the sun)					

[1]

Scale	Conditions
0	*Completely clear sky*
1	1/8 of the sky is clouded
2	2/8 of the sky is clouded
3	3/8 of the sky is clouded
4	*Half* of the sky is clouded
5	5/8 of the sky is clouded
6	6/8 of the sky is clouded
7	7/8 of the sky is clouded
8	*Completely cloudy sky*

Institute of Geophysics Polish Academy of Sciences · UAM Universidad Autónoma de Madrid · GFOSS · ibercivis · European Schoolnet · KU LEUVEN

Erasmus+

BRITEC
BRINGING RESEARCH INTO THE CLASSROOM

Annex 2

Recording of the subjective thermal sensation

Personal Code:

Day of birth (e.g. 26)
First 2 letters of your favorite color (e.g. re)e.g. -> 26re01
Floor Number of the apartment you live in (e.g. 01)

Sex: M / F Age: Body Structure: Small / Medium / Big

Skin tone: Very light / light / dark / very dark

Ημερομηνία:

Measuring Area	Activity [21]	Conditions of location [2]	Clothing [3]	Hat [4]	Thermal sensation [5]
1					
2					
3					
4					
5					
6					
7					

[3]

Scale	Description	Colour
0.3	Very light summer clothes (shorts + short-sleeved blouse)	Bright / Dark
0.5	Light summer clothes (long light pants + short-sleeved blouse)	Bright / Dark
0.8	Light clothes (long light pants + long-sleeved blouse)	Bright / Dark
1.0	Average autumn clothes (long thick pants + long-sleeved blouse) or long-sleeved tracksuit	Bright / Dark
1.5	Average autumn clothes (long thick pants + long-sleeved blouse) with cardigan or long-sleeved tracksuit with sweatshirt	Bright / Dark
2.0	Average winter clothes (long thick pants + sweater)	Bright / Dark
2.5	Average winter clothes (long thick pants + sweater) + heavy jacket or coat	Bright / Dark

[21] Sitting / Standing up / Walking

[2] Sun / Shadow / Partial Shadow

3.0	Average winter clothes (long thick pants + sweater) + heavy jacket or coat + gloves + hat + scarf	Bright / Dark

[4] Yes / No

[5]

Scale	Sensation
− 4	Extreme Cold
− 3	Very Cold
− 2	Cold
− 1	Chill
0	Comfortable
+ 1	Little Hot
+ 2	Hot
+ 3	Very Hot
+ 4	Extreme Hot

Example of Completion:

I am in the 1st measuring area (school class), standing up[1], in the shadow [2], wearing light dark clothes [3], without a hat [4] and feeling chill [5]

Measuring Area	Activity [1]	Conditions of location [2]	Clothing [3]	Hat [4]	Thermal Senasation [5]
1	Standing Up	Shadow	0.8 dark	No	− 1

Protocol 2 Dietary habits

Data collection process

The data collection for this phase will take 1 week and includes the following steps:

1. Measuring students' weight and height by the school's physical education teachers.
2. Installation of the data collection app on a mobile phone (parents') or tablet provided by the school. Once student activate the app, they will be asked to complete a small number of questions about their most common eating, physical activity, and sleeping habits. Approval for conducting the research has been gained by the Ministry of Education and the Research Ethics Committee of the Aristotle University of Thessaloniki.
3. Students use the app to take meal and drink pictures. During the week students take pictures of meals, focusing mainly on breakfast and the main meal after school. Once such an image is captured, the application will ask the user to record their mood at this particular time, through a multiple choice question.
4. Use the app to take food advertisement photos in the everyday environment (outside of school),regardless of the medium of advertisement (brochure, billboard, bus poster, digital, online or on television). Making sure again that faces of the people around are not included while taking the photos.
5. The use of the smart watch records GPS data, physical activity and sleep data and transfers it automatically to the phone. If students are comfortable, they are asked to wear the 'smart watch' for a weekend. They are also asked to wear it while sleeping for at least 3 nights during the week. *This part of the research is not integrated in the data analysis performed by the students; students are presented with the outcomes provided by the dedicated portal and a discussion takes place in class.*
6. At the end of the week students are asked to answer some questions (assess) about their experience using the mobile application and the "smart" watch.

Data analysis, Results presentation and class discussion

For a period of one-week students take pictures of their breakfast, lunch, dinner, snacks and drinks. They take as many pictures as they can. The students annotate their pictures with the use of the mobile app.

At any point of time, the teacher can use the relevant portal and show in class meal graphs and pictures taken by the students.

At the end of the week (data collection period), the AUTH researchers send us a csv file with all meal photos and photo annotations per class/group. The file includes information on the type and time of each meal (e.g. breakfast, lunch, dinner, snack, drink), the meal content (e.g. fruit, vegetable, home-cooked, retail packaged) and drink content (e.g. water, juice, sugary, energy, coffee, dairy).

The students, work in groups, extract statistical measurements from the csv file on the contents of the pictures in order to present important dietary habits of the whole class, such as the following recorded per week:

- no. of breakfasts;
- no. of snacks;
- no. of meals;
- no. of sugary drinks;
- the time meals are consumed.

The groups of students present the results to their classmates, stirring discussion about the analysis methodology and the health-related implications of the findings.

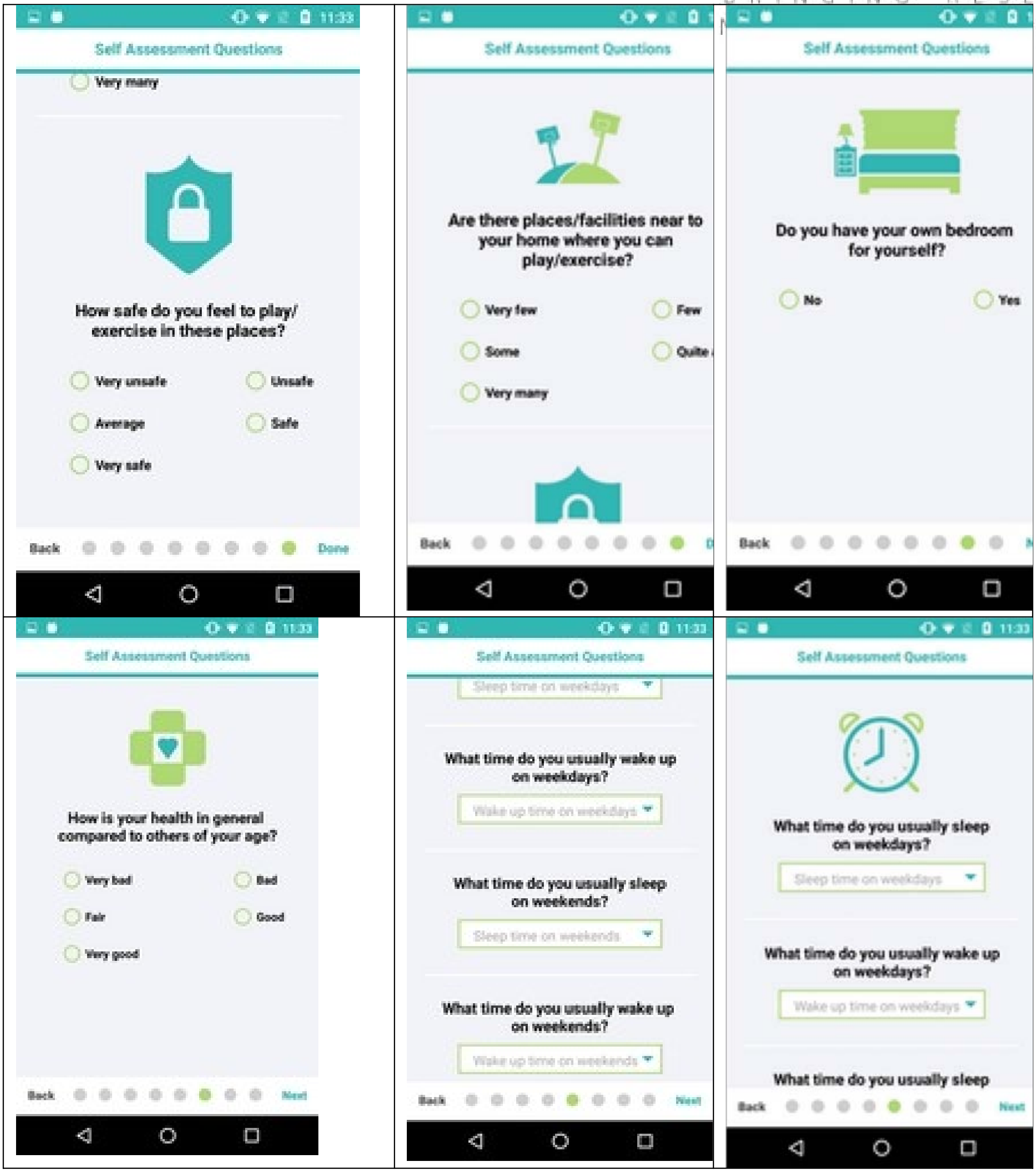
All photos and data collected are anonymised and stored in the cloud. Only researchers have access.

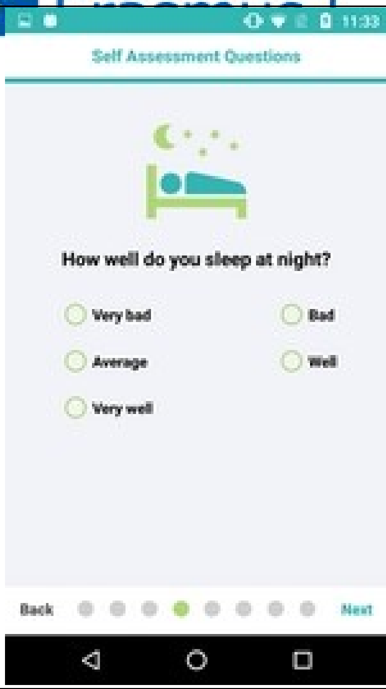
Furthermore, students will present outcomes of their research in the end of the school year to a dedicated event; to their parents and wider audience attending the event.

Equipment

Smart phones and smart watches as well as a mobile application to record the necessary data i.e daily dietary routine, lunches, photos, food advertisements etc.

Self-Assessment Question screens




Self Assessment Questions
How well do you sleep at night?
Very bad
Bad
Average
Well
Very well
Back
Next


Self Assessment Questions
How active do you think you usually are compared to others of your age?
Mostly lying/ sitting
Mostly sitting
Sitting/standing/ walking
Exercising a lot
Back


Self Assessment Questions
How quickly do you think you eat compared to others of your age?
Not quickly at all
Average
Quite quickly
Very quickly
Back


Self Assessment Questions
How much do you think you eat compared to others of your age?
Not much at all
Not very much
Average
Quite much
Very much

UV radiation – questionnaire

Data for calculating the dose of vitamin D3

*mandatory

*the form is available in Polish via google form: https://docs.google.com/forms/d/e/1FAIpQLSfBwDeHR-VnFQmX3z8Pin_gW8kQXgpQcAtBLzRDQcUBySUVe0g/viewform

1. School and class*

………

2. Age*

………

3. Weight*

………

4. Height*

………

5. Date*

………

6. Maximum daytime temperature (degrees Celsius) *

………

7. Select the category that best describes your clothing. If your clothing does not fit any of the categories, please describe it under "Other" *

- o Long blouse, long pants / skirt
- o T-shirt (shoulders covered), long pants / skirt
- o Sleeveless shirt (exposed shoulders), long pants / skirt
- o Long blouse, short pants / skirt (knee-length)
- o T-shirt (shoulders covered), short pants / skirt (knee-length)
- o Sleeveless shirt (bare shoulders), short pants / skirt (knee length)
- o Long blouse, short pants / skirt (mid-thigh)
- o T-shirt (shoulders covered), short pants / skirt (mid-thigh)
- o Sleeveless shirt (bare shoulders), short pants / skirt (mid-thigh)
- o Other: ……..

8. Are you wearing a hat? If yes, please specify:

- o Baseball hat
- o Hat
- o Bandana

9. Which skin phototype is closest to yours?*

- o I Pale white skin, often freckles, blue / green / hazel eyes, blonde / red hair. Always gets burned, difficult to tan.
- o II Pale skin, blue / green eyes. Gets burn easily, does not tan easily.
- o III Darker white skin. Tans after the initial burn.
- o IV Light brown skin. Burns minimal, tans easily.
- o V Brown skin. Rarely gets burn, tans easily and strongly.
- o VI Dark brown / black skin. Never gets burned, always tans heavily.

10. Have you used sunscreen? If so, write what SPF filter you used.

……….

11. Are you supplementing with vitamin D? If so, how many units (I.U.)?

……….

12. Tick the type of activity that you do most often while outside.

- o Walking
- o Running
- o Standing
- o Seating
- o Lying
- o Active sunbathing
- o Other: ……….

13. The content of ozone in a vertical column of air and the projected value of the maximum UV index in your location (from: http://temis.nl/uvradiation/nrt/uvindex.php): *

……….

14. Your location (longitude and latitude): *

……….

Observations

Please enter the UV index values from the website (http://meteoweb.pl/nowcasting) or from the application available on Android (http://meteoweb.pl/sun). If you have your own handheld meter, you can use it. You can record 12 observations in the form. If there are fewer observations, please complete the survey earlier by selecting "end for today". Please do not exceed 12 observations per day. The most important observations are between 11:00 and 14:00.

1.The source of the UV index data you are using: *

- website (http://meteoweb.pl/nowcasting)
- application (http://meteoweb.pl/sun)
- Other:

2. Time (hour)

…….

3. UV index (clear sky)

…….

4. Cloud category

- cloudless sky or single clouds
- diffused clouds (25 to 50% of the sky covered)
- cloudy sky, the sun is shining here and there (up to 75% of the sky is covered)
- Almost completely cloudy sky, with small blue areas (90% of the sky is covered)
- overcast sky

5. UV index (overcast sky)

…….

6. Is this the last measurement for today? *

- End for today
- No

*If the pupil will choose "no" he/she will be filling out more observations for one day (more than one he/she already provided). If he/she clicks "end for today" he/she will be able to send the form.

Protocol 4 - Observing of seasonal change of river riparian vegetation and microclimate of river valleys

Observing of seasonal change of river riparian vegetation and microclimate of river valleys

Project Britec - Rivers - Data transfer questionnaire - ….. (name of school to be filled in)

To send photos and data collected as part of this project, complete the form according to given instructions.

*mandatory questions

1. E-mail address*

………

2. Upload a picture of monitored river/canal/

3. Upload a map with geographical coordinates

4. River/ canal name*

………

5. Date of observation/ measurement*

DD – MM – YYYY, Hour _:_

6. Cloud cover*

Cloud cover - refers to the fraction of the sky obscured by clouds. Okta is the usual unit of measurement of the cloud cover, ranging from 0 to 8 (8 means full cloud cover, 0 – sky completely clear, 9 – sky obstructed from view). See details https://en.wikipedia.org/wiki/Cloud_cover

Clear sky 1 2 3 4 5 6 7 8 9 sky obstructed from view

7. Rainfall*

o no rainfall
o fog
o drizzle
o rain
o sleet
o snow
o Other: ……..

8. Rain in the last 48 hours*

o small
o intense

o no rain

9. Water level *

Approximate change from the reference point [cm]

....

10. Water temperature [C degrees]

Average of several measurements

....

11. Air humidity [%]

From the local weather station

....

12. Atmospheric pressure [hPa]

From the local weather station

....

13. Air temperature [C degrees]

According to some meteorological service

....

14. Air humidity [%]

According to some meteorological service

....

15. Atmospheric pressure [hPa]

According to some meteorological service

....

16. Average water speed from several measurements [m /s]

....

17. Point A, photo number 1*

Upload a picture

18. Point B, photo number 2*

Upload a picture

19. Photo of the bridge pillars (optional)

Upload a picture

20. Comment, additional information about pictures, observations

....

Consent to use data and photos *

- I consent to the processing, free use and sharing by IG PAS as part of the project and for other scientific purposes, of data, photos and graphic materials sent by me during the BRITEC project and related to its implementation.

RESEARCH PROTOCOL OF FLEBOCOLLECT PROJECT

Flebocollect is a Citizen Science project related to sand fly phlebotomines and leishmaniosis. We start from a real problem: for researchers, CDC Light traps for phlebotomine sand flies are very expensive. So, in the initial proposal, students were expected to manufacture different prototypes of light traps made from recycled materials and to test their effectiveness in the playground of the school. The research question was: Are hand-made traps so effective as commercial ones?

Due to the delay in the implementation of this project because of the current pandemia, students were proposed an alternative: to solve a problem based on real non-analysed data collected by researchers.

1. A ***researcher notebook for students*** was designed with sand fly pictures representing captures from traps, commercial and hand-made. The objective was to distinguish morphologically sandflies from other insects, males from females, and finally to answer the research question analysing the pictures.

2. Students were asked to identify sand fly phlebotomines, which have been captured by each light trap, and if they were male or female.
To distinguish between males and females, the researcher showed them these photographs representing the sexual dimorphism related to the anatomy of the final part of the insect abdomen:

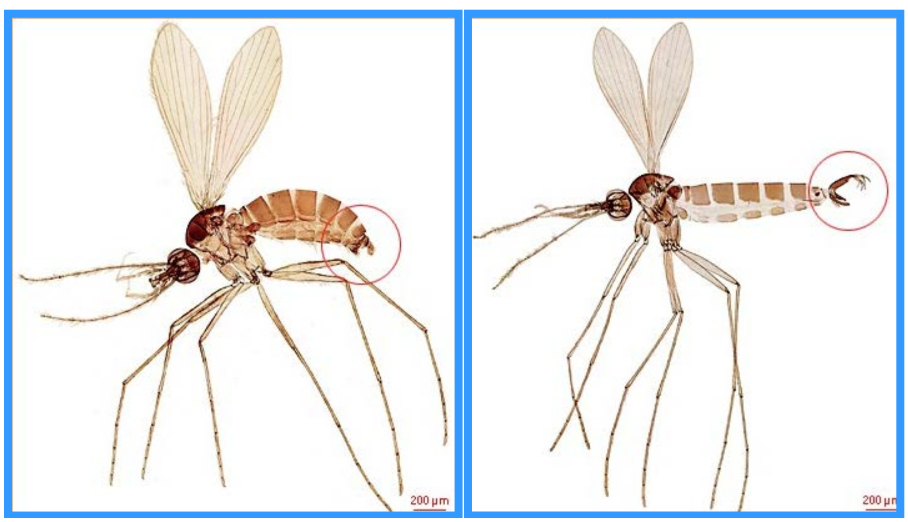
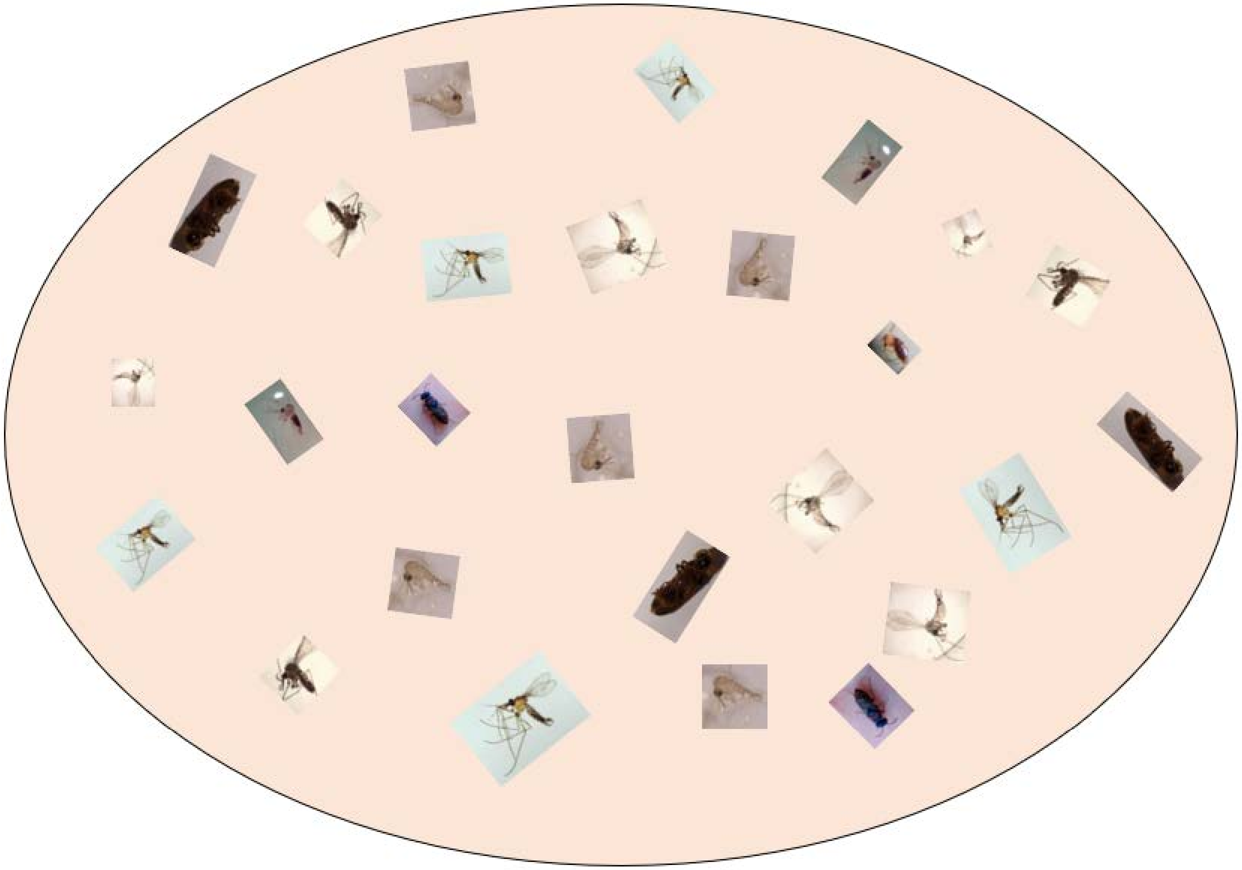


Figure 1: On the left photo of a female phlebotomine sandfly and on the right photo of a male phlebotomine sandfly.

Figure 2: Examples of captures made by a sand fly phlebotomine light trap

A6C3



3. Students were asked to make their own charts showing number of male and female phlebotomine sandflies.

Commercial trap code	Number of male phlebotomine sandflies	Number of female phlebotomine sandflies	Total phlebotom-ine sandflies
C1			
C2			
C3			
…			
Total			

Hand-made trap code	Number of male phlebotomine sandflies	Number of female phlebotomine sandflies	Total phlebotomine sandflies
H1			
H2			
H3			
…			
Total			

Co-funded by the Erasmus+ Programme of the European Union

The work presented in this document is supported by the European Commission's Erasmus + programme – project BRITEC, coordinated by the Institute of Geophysics, PAS. The content of the document is the sole responsibility of the organizer and it does not represent the opinion of the European Commission (EC), and the EC is not responsible for any use that might be made of information contained.

4. Students were asked to make a graph which helps them to know which light trap is more effective.

5. Students were asked to answer the research question giving an explanation.

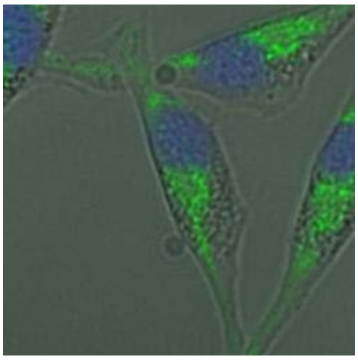
Protocol 6 Cellspotting

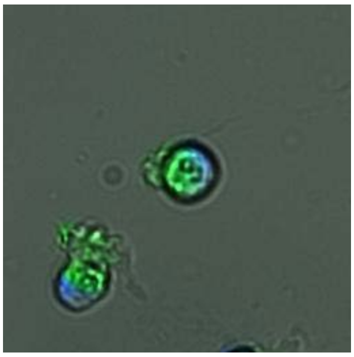
CELLSPOTTING

Providing training data for a ML platform

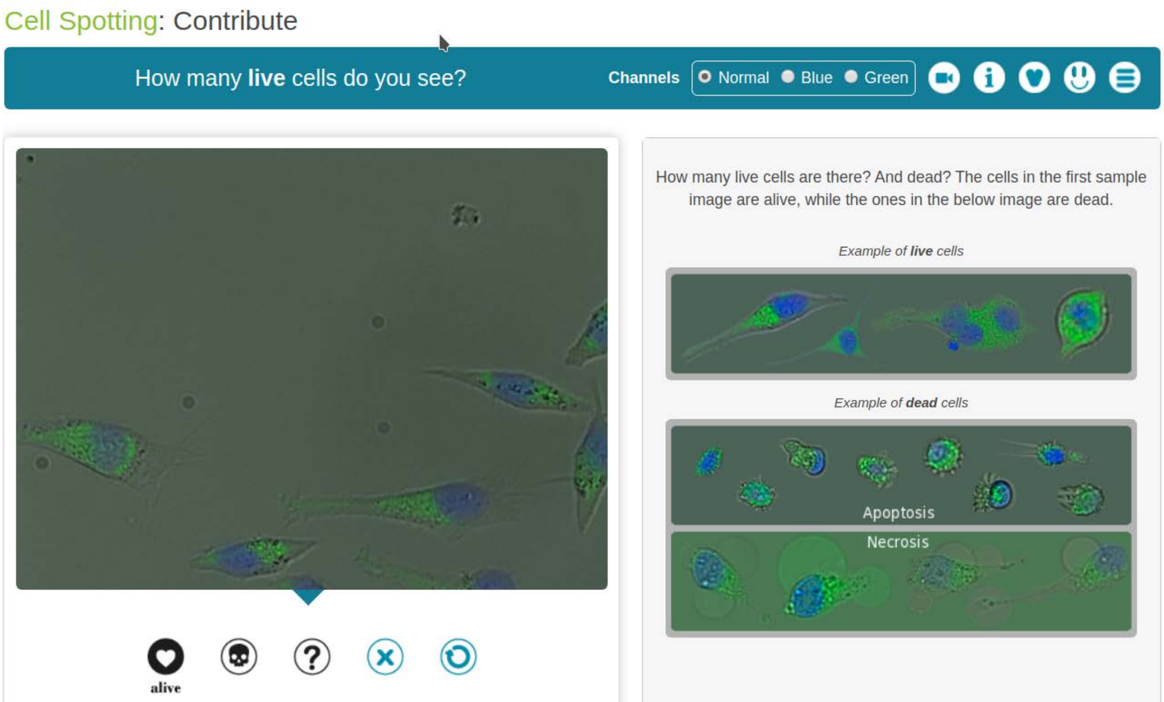
The aim of the project is to create a database of analysis of microscopy images which will be used to train a machine learning platform. This is a purely theoretical project and therefore the design of a research protocol is not necessary as there is no experiment as such. Nonetheless, we present the closest analog we can consider: the sequence of steps followed in the implementation to achieve maximum efficiency.

1. Introduction of the structure of a cell and the different mechanisms of cellular death (Teacher). It is necessary that the students understand the different processes of cellular death to recognize the different images. They must understand the process leading from alive cells which appear in the microscope as into death cells which look like these



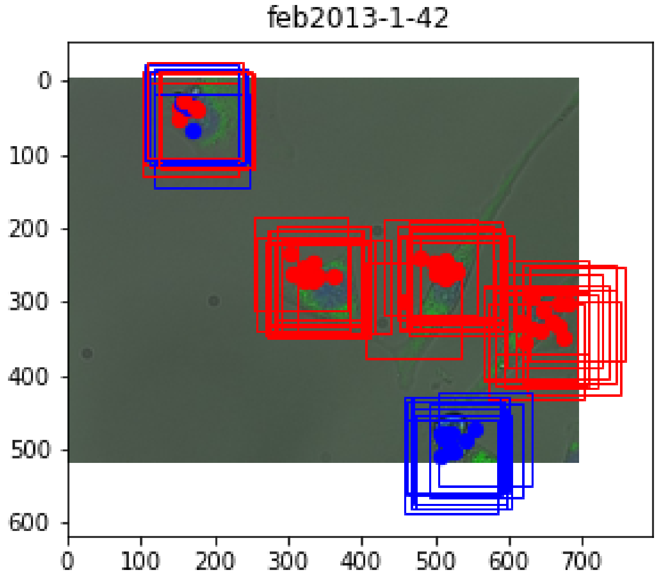


2. Presentation of the online platform created to perform the analysis (http://pybossa.socientize.eu/pybossa/app/cellspotting/)- done by the researcher in the first (online in our case) visit. In particular, the students must be familar with the description of cell status on the right hand side of the window:



The students are supposed to mark with a heart the position of the center of the alive cells in the picture (on the left of the platform) and with a skull the position of the center of the dead cells. These coordinates in the picture will be used to define small squares containing the cells, which are the information which used in the machine learning platform. Thus, the computer will be trained to recognized the small squares containing the alive cells as „alive" and those containing the dead cells as „dead".

3. Sessions in the computer room of the School to practice the analysis supervised by the teacher. The teacher should verify that all students are doing the analysis correctly.
4. As it is done often in CS projects with analysis done by volunteers, several students will be working on the same picture. Then, the system will consider the average of their answers to be used to feed the ML platform. In this way, potential errors of one student will be reduced.



Thus, the final position will be the average of the different points provided by the students and the state (alive/death) will be converted in a probability (a number between 0 and 1), and also averaged.

Protocol 7 Meteors

Gemeentelijk Technisch Instituut Londerzeel
Daalkouter 30 1840 LONDERZEEL
www.gtil.be **info@gtil.be**

The magnificent world of meteors

(Credits: https://www.ibizavandaag.nl/ibiza-nieuws/voor-in-je-agenda-meteorenregen-op-13-december/)

Acknowledgements to Engineer Stijn Calders, Space Physics - Space Weather division @ BIRA-IASB, Belgium & the Erasmus+ BRITEC-project.

Educational pack developed by Wim Van Buggenhout (GTIL school Londerzeel, Belgium), in collaboration with Eng. Stijn Calders (BIRA-IASB, Belgium), facilitated by Dr. Mieke Sterken & Prof. Katrien Kolenberg (KULeuven university, Belgium) in the framework of the Erasmus+ project BRITEC ('Bringing Research Into the Classroom'). Translated by Mieke Sterken.

[.October 2020.]
[.Londerzeel.]

Your name ....

Your course major & class name

School year / Academic year

1 METEORS AND THE BRITEC PROJECT

WHO?

Eng. Stijn Calders
Dr. Eng. Hervé Lamy

Royal Belgian Institute for Space Aeronomy (BIRA-IASB)

THE RESEARCH

Every day some six billion intruders enter the Earth's atmosphere: meteoroids. Most often these are smaller than a pinhead, but when they enter our atmosphere, they 'evaporate' and cause a short-lived stripe of light in the air: a meteor. There's many more meteors than we can observe by the naked eye, and even during the day or when the weather's cloudy, meteoroids continue to enter our atmosphere.

Yet the RBISA can detect these 'invisible' meteors: a meteoroid leaves a trace of ions in the atmosphere's highest layer, the ionosphere. These traces reflect radio waves, and hence if you send out a radio signal from one place, and detect that signal later on with a receiver at another place, you can reconstruct where the signal must have bounced back, and thus where the meteor was at a given moment!

In order to study meteors, the Belgian BRAMS*-network of radio stations was built: a radio emitter in Dourbes sends signals that subsequently reflect upon the ionised trace of the meteor. These reflected signals are then caught by a network of c. 25 radio receivers, which are spread across Belgium. Those data are being analysed by a community of enthousiastic citizen scientists, in the online project Radio Meteor Zoo (http://www.radiometeorzoo.eu) on the Zooniverse-platform.

Will you and your class join us?

This theme fits well in your courses of physics (waves, radar), chemistry (evaporation vs. burning processes vs. ionisation), geography (cosmology & atmospheric sciences, GIS) as well as mathematics (waves, functions, goniometry, speed & acceleration).

** Belgian Radio Meteor Stations (http://brams.aeronomie.be).*

Erasmus+ KU LEUVEN

2 PREPARATORY ASSIGNMENT

2.1 Comets

2.1.1 What

	4

Task 2.1: Succinctly describe, in your own words, what a comet is?
…………………………
…………………………

2.1.2 A comets composition

	9

Task 2.2: A comet is composed of three/four components.

- Search for an image (online or offline) that shows these three/four components.
- Briefly describe these components in your own words.

2.1.3 The orbit of a comet

	6

Task 2.3: Comets originate from two comet reservoirs, what are their names and characteristics, and what are the characteristics of their associated comets? Describe this in a clear way.

2.1.4 From comets to meteoroids

	8

Task 2.4:

- What is the link between meteoroids and comets? Explain this.
- What are meteors and meteorites?

	2

Task 2.5: Some meteoroids don't originate from a comet. They are called sporadic meteoroids. Where do these meteoroids originate from?

2.2 Characteristics of comets

Task 2.6:

- In the table below we enlisted a few well-known comets. Fill in their characteristics in the empty table cells.
- Check the web for two other comets and add their characteristics to this table too.

Table 1 Characteristics of some well-known comets

Name of the comet	When was it observed for the last time on Earth?	When will it be observed again on Earth?	What's the orbital period of the comet?	What's the diameter of the comets core?
Halley				
Hyakutake 2				
Hale-Bopp				
Mc Naught				
Neowise				

2.3 Meteor showers

Task 2.7: Which quantity and unit are being used to indicate the amount of meteors one can effectively observe with the naked eye in a certain area? Write those down in Table 2, in the last column of the first row.

Task 2.8: What are the three meteor showers providing the greatest chances to observe meteors with the naked eye? Write them down in Table 2, and rank them in the order from 'highest chance' to 'lower chance'.

Table 2: Meteor showers in 2020

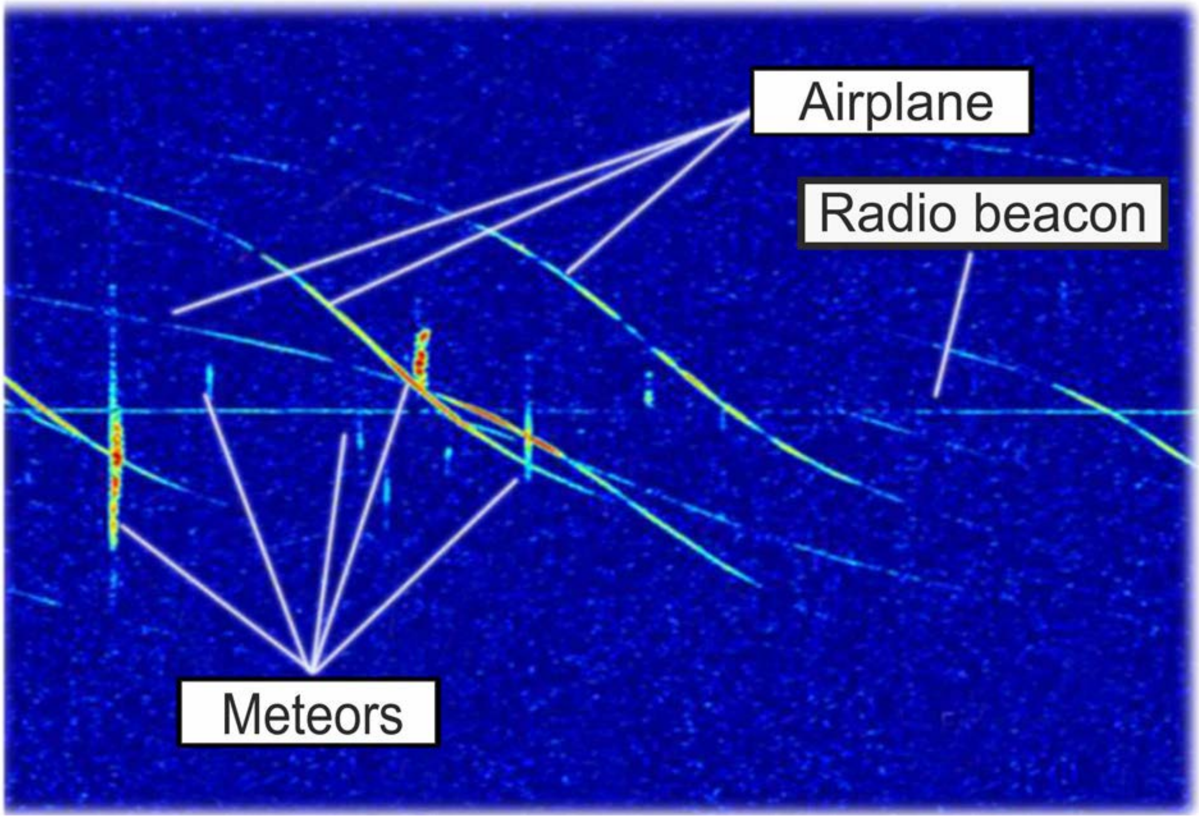
Meteor shower	Time (in the year)	Zodiac sign name	

6

3 COUNTING METEORS

3.1 Spectrogram

Ir. Calders explained in one of his videos that this course contains a citizen science module in which you are going to search for meteors on a spectrogram. The figure below shows such a spectrogram. Go to the website https://www.zooniverse.org/projects/zooniverse/radio-meteor-zoo and follow the instructions. Draw the red rectangular boxes around each meteor signal.



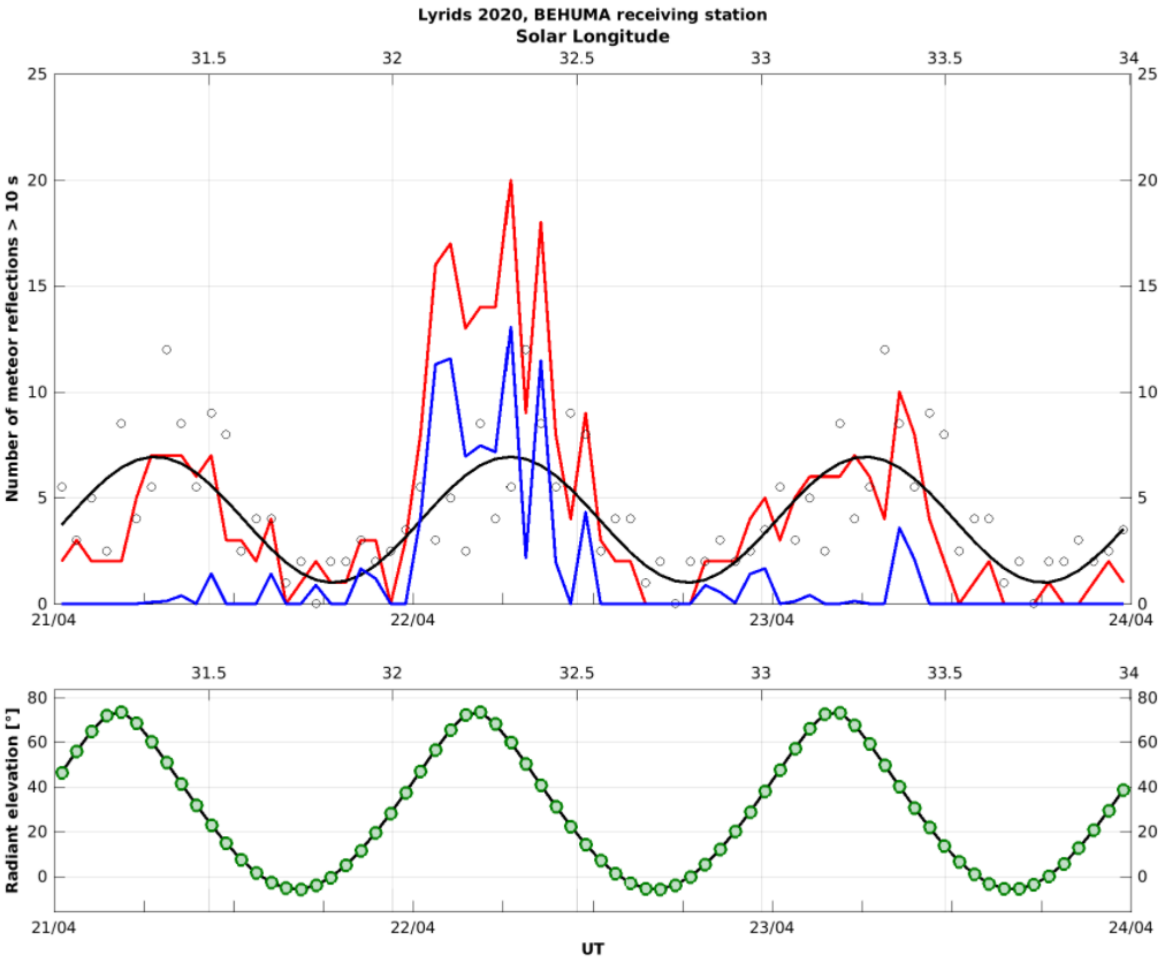
(Source: Stijn Calders, BIRA-IASB)

Task 3.1: What are the X-axis and the Y-axis representing in these spectrograms? And what are the units used?

3.2 Profiles: the results of the countings

	2

The figure below shows the amount of long-standing (> 10 s) radio-meteor-echos that were present between april 21st to april 24th, 2020, belonging to the meteor shower "Lyrids".



(Source: https://www.zooniverse.org/projects/zooniverse/radio-meteor-zoo/about/results)

Task 3.2: Mr. Stijn Calders explained in his online course about the significance of the curves in the abovementioned figure. What do the different colors stand for? (fill in the box below).

	3

Red	
Black	
Blue	

3.3 And now: start searching!

Before you start 'drawing' the rectangles around the meteor signals, please read the full explanations about the background and process here.

Task 3.3: You are going to analyse meteors from a meteor shower now. Which one?

	1

Task 3.4:

- Please draw red rectangular boxes around each signal that signifies the presence of a meteor.
- Do this for at least eight spectrograms per day, during five consecutive days. You can do more if you want.
- Take a screenshot of each of these eight spectrograms and paste it in this document (see tables below).
- Fill in the date on which you are doing the analyses (change the green dates on the pages below).

	25

3.3.1 Day 1: Monday, Oct 19th, 2020

3.3.2 Day 2: Tuesday, Oct 20st, 2020

3.3.3 Day 3: Wednesday, Oct 22nd, 2020

3.3.4 Day 4: Monday, Oct 26th, 2020

3.3.5 Day 5: Tuesday, Oct 27th, 2020

4 CONCLUSIONS

Task 4:

Note down your thoughts, questions or remarks concerning this series of tasks.

How did you feel about them?

What did you learn?

What could be done in a better way?

...

Licence

About the BRITEC project

BRITEC – Bringing Research into the Classroom project (https://britec.igf.edu.pl/) aims to introduce the Citizen Science (CS) approach in schools as a way of engaging pupils in research practices. This project has been funded with support from the European Commission within ERASMUS+ Programme and is coordinated by the Institute of Geophysics, Polish Academy of Sciences.

Online: https://britec.igf.edu.pl/

Social: #BRITECproject

Co-funded by the Erasmus+ Programme of the European Union

The work presented in this document is supported by the European Commission's Erasmus + programme – project BRITEC, coordinated by the Institute of Geophysics, PAS. The content of the document is the sole responsibility of the organizer and it does not represent the opinion of the European Commission (EC), and the EC is not responsible for any use that might be made of information contained.