MAke science Real in sCHools (MA.R.CH.)

MARCH Pilots – Teachers' guide

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Contents

A warm welcome

Dear teachers,

Thank you for your interest in MARCH (**MA**ke science **R**eal in s**CH**ools)!

MARCH is a Comenius network that brings together institutions, NGOs and educational establishments in a co-operative learning environment so as to share innovative content and best practices in Science Education for secondary schools (ages 11-16) and to highlight and promote the important contribution of science to sustainable cities. It consists of nine partners that come from seven European countries: the UK, Greece, Germany, Serbia, Lithuania, Bulgaria and Portugal.

Recent studies[1] have shown that students believe that willpower and enthusiasm are more important factors to build a successful STEM career than academic achievement. These are the elements the MARCH project wishes to nurture: inspire passion about science, promote scientists as role models and unveil the wealth and depth of science that surrounds us.

Our key objectives are:

- To make science teaching more attractive to the students
- To help young people to actively contribute to the learning process
- To argue in favour of the relevance of science to everyday life
- To promote science as a force that can build up active citizens
- To highlight the relationship between science skills and future employability

So far the MARCH network has implemented an empirical study on the state of the art of science education, a series of national and international swap innovation workshops and two international conferences presenting these results. More than **1200 teachers** and **1400 students** have been directly involved in these activities.

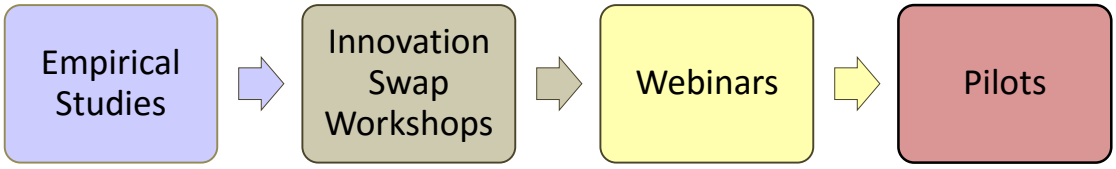
We use a collaborative learning environment to share innovative content and best practices in Science Education for secondary schools under the theme of "Sustainable Cities". We have collected 21 good practices from schools in our partner countries and we would like to invite you to browse them, get inspired and apply them in your classroom, taking part in the **MARCH pilots** and spreading innovation and excellence in science teaching across Europe!

Looking forward to working together,
The MARCH partners

[1] "Is science a land of equal opportunities?" Fourth Royal Institution unconference for young people, London, October 2015

Building the Pilots

The pilots will be based on the outcomes of the previous stages of the MARCH programme. The pilots' design will build on the Results of MARCH empirical studies[2], will take into consideration the good practices and methodologies presented in the local and international swap innovation workshops[3] and will use the new tools and techniques that will be developed through the webinars[4].



Work flow Chart

How are the good practices going to travel across Europe?

In this toolkit you will find 21 good practices that have been successfully applied to schools in the partner countries of MARCH and beyond. The school pilots' period is the time for all interested teachers across Europe to try them in their own classes, incorporate them in their lessons and open up to new learning paths aiming to make science teaching more attractive and enjoyable for the students.

However, do not feel obliged to copy and paste one of the examples and good practices you will find bellow. Feel free to adopt and adjust, making sure the practice you will be applying will serve your local needs in the classroom.

An example that came up during the ISW in Sofia, is the following: a group of teachers worked together in a round table to create a lesson plan on water. The result was focusing on water preservation and raising awareness on water shortage. A group of teachers and students from a different table expressed their concern that in their area, which suffers from seasonal floods, this project would have not been appropriate. The answer on how to face this situation lies on **flexibility** and **localisation**, two of the main pillars of the MARCH pilots. Each school is encouraged to choose a good practice/ scenario and apply it according to their own needs and educational goals.

In order to assist educators in bringing the pilots in their classrooms, MARCH partners will organise **a series of trainings** in each participating country to provide the local

[2] Galev T. (2015) "The State of the Art in Science Education: Results of MA.R.CH. Empirical studies", Sofia: Bulgarian Academy of Sciences.

[3] Statauskiene L., Mazgelyte R. (2015) "Defining a good practice in STEM education within a framework of MARCH Project", Vilnius: Education Development Centre

[4] Papadimitriou S., Karatsiori M., (2016) MARCH webinars report (TBC)

educational community with resources, insights, mentoring and helpful tips that will make the pilots' stage smooth and enjoyable for teachers and students alike.

How to bring a pilot in your classroom

In order to participate in the MARCH pilots, you only need to follow the next steps:

1. Get inspired by the good practices collection and identify the one(s) fitting in your classroom
2. Decide on the time and resources you have available and adjust accordingly
3. Visit MARCH website and let us know of your plans
4. Apply the pilot in your classroom
5. Evaluate your results using before and after questionnaires
6. Present your work with photos/ ppt presentation/ video
7. Browse other teachers' work around Europe and vote your favourite!

In the end of this toolkit, you will find lesson plan templates, questionnaires, resources and guidelines on how to present your results in the end (Appendix).

When: The pilots are going to take place from **February 2016 until October 2016**. You can choose to implement them on a time scale that serves your teaching needs, as far as they span from two school hours to a school semester.
Where: The pilots should take place in your school; MARCH local partners will offer their help and guidance.
After the pilots: During the pilots' period, teachers from all over Europe will upload their work and results on MARCH website. After the end of this period (end of October 2016), a 10 days online voting will open, where teachers from each participating country will be able to vote their favourite pilot. Two teachers from each participating country (UK, Portugal, Germany, Lithuania, Serbia, Bulgaria and Greece will be invited to present their pilot in the 3rd International Conference of MARCH in London, in November 2016. A judging committee will make the decision based on the impact and quality of the pilots (consistency with MARCH goals, actual good practice spreading, students' views, etc.) of the pilot and the results of the online voting will be taken into consideration and make 40% of the final decision. MARCH consortium and evaluators keep the right to also invite some more participants in the conference, depending on their pilot results and impact.

Collection of good practices in science education

The following categorisation emerged from the good practices that have been collected during local and international Swap Innovation Workshops, as well as the MARCH international conferences and webinars. However, the following categories are not exclusive; some practices might fit more than one fields, some others might be broader than the narrow title of the category. We have chosen to present them this way, to enhance better understanding and easy navigation among the numerous examples.

The general theme of MARCH, "Sustainable Cities" is linked with all of them, either directly or indirectly.

The axes around which the good practices, methodologies and pilots are concentrated.

In the following pages, you will find a short description of each category and the accompanying good practices and examples that have emerged from the MARCH project.

Learning Outside the Classroom

Under this category projects and practices that take the student outside the classroom to the nature are gathered. Outdoor education is linked with many different educational approaches like experiential and explorative learning and takes place mainly in the outdoors. It is based on interdisciplinarity and uses relationships among people and natural resources[5].
During the MARCH programme, the following practices have emerged, under this axis:

- **Learning outside the classroom: Field trips to local ecosystems (Portugal)**

Students from Portuguese schools got involved in a project that invited them to carry out field visits to local woodland ecosystems with the support of scientists. The groups were offered advice on the choice of woodlands, help in the identification of species and worksheets to be filled in during the field trips. Local science centres, environmental groups and local authorities offered support to the groups of students. The work of the groups has been compiled in a book (paper and online version). The project has run in Portugal for four years.

[5] Redefining Outdoor Education: A Matter of Many Relationships, Simon Priest, Journal of Environmental Education, July 2010

Learning Goals	Learning Activities
To create conditions for students to get interested in learning about the local forest ecosystems of their region. To engage students in activities that promote autonomy and collective decision-making. To involve students in activities that create situations for problem solving, experimentation and observation. To involve students in dissemination activities.	Students identify local forest ecosystem in their region. Students get involved in observation activities (field trips and school) Students interact with local authorities and get their support for the project activities Students go on field trips and fill in an observation worksheet Scientists and other experts give support for students in the project (design the worksheets, help identify species, give advice on contents for the book) Students communicate information about their work (book) and sites Teacher Development Sessions run by scientists and education experts

(Author: Ciencia Viva)

- **The Magical Village, Spa Vrujci (Serbia)**

Students are taught in ambiental classrooms, under the clear blue sky, where they are surrounded by plants and animals, developing their critical thinking. Students face real life situations in which they spontaneously, through games, adopt new knowledge applicable in every-day life. It is innovative because children finally have the opportunity to get out of the classroom and learn new contents in different ambients where they can observe relations between things, living beings and natural phenomena and understand them much more easily than from the books in their classrooms.

Learning Goals	Learning Activities
To integrate different curricula and showing students on the examples of real life problems that different disciplines and different approaches can be used on the same problem and not only separately in different subjects.	This project includes integrated educational and entertaining activities like: Orientation in time and space, by using human sundial on the field of The Magical Village

To active learning through independent exploratory work. To encourage children to develop critical thinking and curiosity and use their imagination when resolving a problem. To encourage students to develop the ability to come to conclusions based on evidence they see around them.	Orientation by compass and by The Northern Star, learning about cardinal points, looking for planets in the sky through telescope, Collecting healing herbs, drying them in solar dryer and making tea bags for them, Making dough and learning about the wheat's journey from the field to people's homes Learning about tradition through handcrafts and old forgotten games

(Author: Zeljana Radojicic Lukic)

- **Physics Winter Camp in Sokobanja (Serbia)**

The Physics Camp includes various types of activities like physics classes; short trips; popular lectures on physics and astronomy; spare time activities. Students are given the opportunity to gain knowledge and develop the ability for its application through camp activities. The Camp proves that the scientific lectures are not always boring, provides hands-on experience evidencing that physics is all around us, disproves students' understanding that physics problems are quite difficult.

Learning Goals	Learning Activities
To empower students so they can analyze, explain and solve physics problems. To have students experience the process of creative thinking and to be able to explain their conclusions to the fellow students. To help students develop communication skills by presenting their work and gain self-confidence.	Students actively participate in the lectures and discussions (by asking questions). Students conduct experiments which are related to everyday life (there is no need for expensive materials to conduct them, only the capacity for intensive thoughts and quick understanding), Students make presentations based on what they learned and share their knowledge with other students. Creation of Powerpoint and Prezi presentations, films and computer applications and programs in Scratch environment.

(Author: Vladan Mladenovic - Physicists Association "Omega")

Other examples in outdoor learning include the cultivation of gardens by the students and the creation of aquaponic systems. Find out more in the resources section!

Interacting with researchers

Initiatives to promote mentoring relationships in the lives of young people have become immensely popular in recent years. Programs with this aim now number well into the thousands and benefit from significant levels of governmental, corporate, and philanthropic support[6]. In science education, established researchers are serving in programmes as mentors and young scientists featuring an enthusiasm for their subject are serving as role models.

In the following good practices, interaction among scientists, students and teachers is sought, to create interactivity and inspire students to consider a career in science.

- **Research Placements for Students (Portugal)**

Secondary education students work alongside scientists, engineers and mathematicians for a limited period of time (during a two-week period during the summer holidays). This programme has been running in Portuguese research institutions for 19 years.

Learning Goals	Learning Activities
To offer students the opportunity to experience the reality of research work. To allow students to learn about areas not included in the school curriculum. To offer students the opportunity to do real science. To give students the possibility to learn about recent advances in science To promote students interest in STEM topics and influence their careers' choices	For a two-week period, students carry out research activities in scientific institutions' laboratories. Students carry out an investigation integrated in teams of scientists. Students carry out experiments, collect data, define variables, discuss and present results. Students evaluate their two-week period in the laboratory

[6] David L. DuBois, Jean E. Rhodes: "Youth mentoring: Bridging science with practice", Journal of Community Psychology (2006)

To help students develop communication skills (do a final presentation).	

(Author: Ciencia Viva)

- **Junior Science Café (Germany)**

A group of students (it could be a class or a project group) chooses a science topic that interests them. The students do research, find an expert, invite him to their school and organize the event "Junior Science Café" with him which other students, teachers, parents are invited to. The student group is responsible for every step of the organization, including marketing and communication, moderation of the event, etc.

Learning Goals	Learning Activities
To meet real-life scientists and learning about professional possibilities To think about real-life problems (that students chose themselves) with expert help To introduce role-models To encourage teamwork	Research Communication with external experts Organization of an event Preparing questions for the discussion with an expert

(Author: Jungvornweg)

- **STEM Ambassadors (UK)**

The STEM Ambassadors network enables scientists and engineers to volunteer as role models for young people, visiting their schools to provide a personal insight into science and engineering to enthuse young people about the opportunities that exist. Though a broad initiative, it can link to the sustainable cities in that many STEM Ambassadors will talk about the future and importance of science in enabling sustainable solutions.

Learning Goals	Learning Activities
To understand the careers and applications of science by speaking with real role models working in science To develop an understanding of the breadth of science through role model examples To enable young people to advance their knowledge of science through	Giving careers talks or helping at careers fairs Providing technical advice or practical support to STEM projects in the classroom Supporting projects in after-school STEM Clubs

practically applying knowledge to career related examples To enthuse young people through them directly working with adults working in science	Judging school STEM competitions Speed networking with pupils, parents and teachers Devising or delivering practical STEM experiments or demonstrations Helping students with mock job interviews

(Author: British Science Association)

Other examples in learning by interacting with researchers include "apprentice" schemes where students are hosted in real laboratories to get involved in a science project under the guidance of a researcher and interacting through social media, campaigns, like the "I'm a scientist, get me out of here!" in the UK. Find out more in the resources section!

Creating New Media

New media in youth communities, projects and schools are reshaping traditional education, opening up to more creative approaches and re-defining aspects of the educational procedure like assignments and evaluation[7]. In this section the practices presented are under the umbrella of the new media, with an emphasis on student creation.

- **Flip the classroom (Serbia and Germany)**

Instead of getting information input from the teacher and then doing homework all alone, students watch learning videos at home in their own pace and then do exercises together at school. This way they come to class with the basic concept of what they are going to learn. In class they learn, experiment, gain new experience, make mistakes, and create. They no longer get the information, they handle the information. The teacher is no longer deliverer of information, but a guide on the side of the students.
This has been a powerful good practice, highlighted in both Serbia and Germany for its efficiency and excellence.

Learning Goals	Learning Activities
To let students learn in their own pace at home To create a good basis for effective in-school teaching	Choosing fun, well explained video about the science topic that will be taught. Make it interactive for learning. Teach students how to use it. (teachers can make their own video)

[7] D. Buckingham, R. Willet "Children, Young People and New Media" projects collection, Institute of Education, University of London (2006)

To discuss and test new knowledge together in class To motivate learning To control own learning	Watching videos at home by the students Discussion and teamwork in class through creative activities and learning exercises

(Author: Irina Damnjanovic and Jungvornweg)

- **E –learning platform for science education in secondary schools (Bulgaria)**

E-learning platforms provide attractive interactive presentations and movies, which allow students to take their time to prepare for school classes, to catch-up with the scientific material, to acquire new knowledge and to test it whenever they want. The electronic system for science education is based on the open-source Moodle learning platform. The platform provides much different functionality, easy to be used by both teachers and students. The scientific content of each lesson and each section of the textbook is represented in the platform in an attractive and understandable interactive way. Each interactive lesson is followed by a test of the knowledge acquired by the students. There are also questions appearing during the presentation of the lesson.

Learning Goals	Learning Activities
To make learning more personalized and create a new classroom culture To provide flexible online environments for problem-based learning, To bridge the gap between old and new information literacy To motivate students, increase students' knowledge and interest in science	E- learning – for preparation and self-studies Teaching through objectives Learning by reasoning Visual memory and Video lessons Teaching by application

(Author: Desislava Tsokova)

- **Use of on-line virtual and remote labs in science education (Bulgaria)**

On-line laboratories are aimed at supporting education based on research and provide opportunity to conduct scientific experiments in virtual environments. For optimal learning results it is important that the study process is well-structured. Software tools help students in different tasks – for example to create hypotheses, experiments, to interpret data etc. Virtual labs simulate real equipment. Remote labs enable students to collect data from real laboratory with real equipment.

This practice helps teachers to use the available free on-line resources in order to present specific scientific content and to encourage student's interest. Students can get familiar with installations and Labs far from their country which they may never have a chance to visit personally. They can make their own real-time explorations.

Learning Goals	Learning Activities
To provide opportunity for a large number of students to acquire new skills and obtain live data using Remote labs. To provide students with the opportunity to make “their own” experiments whenever they want Virtual labs. To explore cost-effective solutions for improvement of science education in each school and in any scientific topic.	E- learning Real-time explorations and data collection Live experiments

(Author: Ivo Jokin)

- **School Lab (Greece)**

School Lab is an innovative programme for communicating science in schools. Students who take part in School Lab are expected to form teams with their friends, choose a scientific topic they’re interested in, present their chosen topic in an inventive and comprehensible way, record their presentation on video and upload it to the School Lab website. Their video should be addressed to the general public and it should be both scientifically accurate and entertaining.

There are no limitations on how they can present their topic, they can choose to make a theatrical show, a series of experiments, a funny gag, a hip hop song, a cartoon using computer graphics, etc. The video can be between 3 and 5 minutes. The young students are guided throughout the programme by a group of scientists, called the programme’s mentors. The videos produced are judged by a panel of judges that will include experts in science and in communication. The 10 best teams compete in the School Lab finals where the best videos are awarded.

Learning Goals	Learning Activities
To support students to comprehend science’s fascinating challenges. To help students develop a critical mindset through innovative and creative activities. To promote scientists as role models. To enhance confidence and skills so they can present their ideas to a wide audience	Researching on a science topic Creating a presentation for the topic using creative ideas Filming the presentation Uploading it at school lab website and participate in the online community

Other new media in education include social networks such as Facebook, twitter and YouTube, online games and quizzes, students using software especially developed for learning activities like Stellarium in Astronomy, etc. Find out more in the resources section!

Mixing Science and Art

Combining science and art provides under a specific thematic instruction provides an interdisciplinary focus to help meet both arts and science goals and objectives. Students are learning how to think creatively, how to express themselves and their ideas and use abstract thought and inductive reasoning to make arguments and find solutions[8].

The following practices are presenting interesting mixes of science and art and have emerged from the MARCH swap innovation workshops.

- **Theatre Sports (Lithuania)**

Theatre sports are a branch of improvisation in the theatre. It aims to create groups' narrative "here and now" without any preparations and to contemplate and prepare for activities in the theatre. Improvisation encourages competitiveness. Humour is essential in theatre sports. Activities in theatre sports require to be courageous, use humor to express feelings, emotions and to have no prejudice. It encourages participants to combine different experiences and transfer them to new situations.

Theatre sports aims to release creative forces, relax, "switch-off" brain control and surrender to creativity. Professional actors use sports to relax, build a team and activate sub-consciousness. The same objectives can be achieved in education process.

Learning Goals	Learning Activities
To foster creative approach towards scientific hypothesis formulation; To build a team in science To bridge the "gap", where students involve in improvisation on sustainability related topics: - 11-12 grade students: sustainability - 10 and lower grade students: city; safe and healthy human; me and others; me and the world; me and my environment.	Students together with parents or other students identify a problem in local environment (before the class). Students and teacher discuss the concept of sustainable city in the class. Mind-mapping ideas on sustainable city in relation to sustainable development goals. Research activities.

[8] Eisner, E. W. (2004, October 14). What can education learn from the arts about the practice of education? *International Journal of Education & the Arts,* (2004).

	Creation of sustainable city models. Presentation of sustainable city models and dissemination of sustainable city model to wider audience (local community).

(Author: Education Development Centre)

- **Big Bang Theory (Germany)**

Physics teachers make use of the TV series "The Big Bang Theory" in order to enthuse students for physics and explain physics problems. As the series is very popular and entertaining, it is a perfect way to get students' attention, show them the fascination of physics, and fight against prejudice of physics being boring.

Learning Goals	Learning Activities
To get students interested in physics in general To improve the subject's reputation To spark students' ambition to solve a problem	Watching a film sequence on video and discussing it (possibly copying an experiment)

(Author: Jungvornweg)

More ideas on blending science and art include mixing dancing, singing and crafting with science, making comics and storytelling, using architecture and perspective, etc. Find out more in the resources!

Hands-on Activities

By getting hands-on the point is that learning is done by doing, by integrating theory (educational goals) into practice. In science education, hands-on has to do with direct involvement with specific projects, conducting experiments and crafts, but also a broad range of experiential learning activities.

- **Sustainable Cities – IBSE activities (Portugal)**

Students from Portuguese schools carried out activities that involved identifying problems in their cities and looking for solutions based on Science and technology. Activities were designed according to IBSE (Inquiry Based Science Education) principles.

Learning Goals	Learning Activities
To get students involved in STEM activities according to IBSE (Inquiry Based Science Education) methodology	Identifying a problem in the local community Planning the investigations

To create the conditions for students to get involved in activities in an autonomous way To get students involved in decision-making To provide opportunities for students to get actively involved in diagnosing problems, debating with peers and presenting coherent arguments To promote the development of inquiry skills (working collaboratively, forming arguments, planning investigations) To promote the development of students' scientific reasoning competences	Studying the problem (focus on Science & Technology) with the support of experts Searching for information Interaction with the local government Carrying out field work in the city Doing (lab) experiments (testing hypotheses, controlling variables, discussing results,…) Exchanging ideas with peers (group work) Constructing models (solutions)

(Author: Ciencia Viva)

- **Nature inspires – Bionics (Germany)**

The Institute of Chemistry Didactics of the University of Bremen has developed a website with interesting experiments and material for students and teachers on the topic of Bionics (e.g. lotus effect, what airplanes learned from birds, etc.) in order to get students interested in what technology can learn from nature

Learning Goals	Learning Activities
Thinking interdisciplinary Learning from nature (using the fascination of nature) Learning about how science and engineering work	Experiments

(Author: Jungvornweg)

- **CREST Awards (UK)**

CREST is a way of recognising quality Project work in STEM. The idea is that many different project scenarios can be done using a framework of: Planning, Doing, Communicating and Evaluating.

Over 30000 students in the UK do CREST projects each year and it is equally attractive to both boys and girls. Ideally students do projects that match their passions in STEM and they should be related to real life.

Learning Goals	Learning Activities
To Plan the project *A clear aim is broken down into realistic objectives, evident in the work done. The link between aim, objectives and work done is clearly communicated. The project has a wider purpose that is communicated by the student(s). The project is framed by its wider purpose, stated from the outset as a rationale for the project. A range of approaches is considered using stated reasoning and a realistic strategy is used to complete the project. The project is well planned, with work and people organised coherently organised work justified through reporting* To Do the project *The student(s) make some use of resources available and can explain when and why this was necessary. Relevant aspects of the project are researched from a range of sources* To Finalise the project *Logical conclusions are drawn, and their wider implications stated. The student(s) can explain the effects of some of their actions on the project outcome. The student(s) can explain what they have learnt, how and when this will be useful, and also further learning that would be helpful.*	Lots of learning activities can lead to a CREST Award- however whatever activity is chosen it must allow students to: Demonstrate adequate understanding of the core topic(s) appropriate to the level Initiate and take some decisions to direct the project, taking some account of safety and ethical issues, and acting on them Think laterally in executing some elements of the project ideally producing an original outcome Identify and overcome some problems successfully, ideally with innovative solutions Explain/communicate their project clearly in writing and in conversation, using appropriate visual media proficiently

(Author: British Science Association)

- **Light Pollution: A historical study on a modern threat... (Greece)**

Studying Ancient Astronomers especially in Greece, Egypt, and Middle East we are astonished by the detailed descriptions of the Constellations and Stars. Eratosthenes is describing in full detail the Hydra constellation, while Aratus described the constellations of Orion, Ursa Minor and Major, Draco and Cepheus. Their ability to observe a wide number of stars was mainly due to low “light pollution”. Nowadays,

stars are almost out of sight especially in cities due to high levels of “light pollution”. We will compare the number of stars observed by ancient astronomers to the number of stars we can observe nowadays, revealing information about “light pollution” through centuries. We will use hands-on experimentation, measurements, the Stellarium application and a Google plug-in to detect light pollution for each place.

Learning Goals	Learning Activities
To get hands on learning To include ICT in education To use of Open Science Resources To help students to cooperate and act as researchers	Search in Open Resources (Digital Libraries) Work under a specific theme using software Research

(Authors: X. Theodosiou, S. Malamou, N. Metaxas, G. Mihalopoulou, Y. Mihas, C. Mouratidis, C. Nakos, M. Sourgiadaki, S. Spanos, A. Tsamouris, I. Chiotelis)

- **Science Day – Become an expert for my city for a day (Greece)**

The practice concerns the institutionalization of Science Day at secondary education. Schools may participate in Science Day if they wish and organize plenty of learning, experiential and other activities. Its institutionalization will motivate the school community. A certificate of participation will be provided as a reward to all students and teachers that were involved. Especially on this day students will implement the experiential activity “Become an expert for my city for a day” in cooperation with local authorities, local organizations or professionals, as a part of a school project or subject.

The methodology applied in the practice is authentic learning. It is real life learning that motivates students to learn by doing in real life tasks and so to create a meaningful learning outcome. The suggested techniques are six thinking hats and jigsaw. Six thinking hats engage students in a productive thinking process. Jigsaw promotes creative cooperation in learning groups.

Learning Goals	Learning Activities
To motivate students To engage students in authentic activities To cultivate skills and values of active citizens for a sustainable city To cooperate in structured teamwork	Work on a real life community problem Do experiments, crafts, presentations Collaborate and create with local communities

(Authors: A. Apostolakakis, A. Kitsou, A. Kylafi)

- **Make Energy Real @ Education (M.E.R.E.) (Greece)**

This project is highly innovative because it combines education with real-life problems and situations. It promotes students' initiative and self-acting (fading scaffolding), is inter-disciplinary and highly interactive. Through it, students can "discover" knowledge on their own, scatter the data they find and reform it in a new-fresh way. This project is highly attractive because it combines playing/constructing with the educational process. Students take up multiple duties, use advanced technology in school and express their creativity and imagination through acting and doing.

Students working on this project are able to express all of their concerns, consideration, as well as their creativity regarding their surrounding environment, while producing something original and benefiting to their direct environment (rise of their environmental awareness).

Learning Goals	Learning Activities
To Understand the concept of "energy" (in every form that it can be found) To Work in groups while taking up multiple duties (role playing). To Develop communicative abilities (constructed dialogue, productive dialogue forming the right questions and answers, information diffusion among groups, corporative decision, identification and expression of feelings, etc.) To Develop cooperative abilities (achievement of a common goal, helping one another, productive feedback, taking initiative, decision making though dialogue, etc.) To Develop skills (data research, engineering, presenting results, etc.)	Students work in groups and are asked to focus on the concept of energy, distinguishing it in every aspect of every-day life, starting from their most direct environment, their school. Students design and build their own models (experimental or full scale), in order to truly conceive the meaning of "energy". Students make a project presentation supported with all the necessary data (audio, video, PP presentation, animation, etc.)

(Author: I. Tourlos et al.)

Find out more about getting hands-on in science education in the resources!

Using ICT

In a constantly evolving technological world, traditional school has to evolve too and follow the information explosion[9]. By creating a specific ICT category in the good practices presented in this guide, all practices that include coding, handling new technologies and working inside software are gathered together.

- **Learning by doing in science education using ICT (Bulgaria)**

Students in this practice are preparing interactive presentations to preset scientific topics by themselves. In order to complete the task, students learn how to use different software programs and how to prepare presentations, movies etc. For more complicated tasks they need to find additional information which leads to new knowledge in different areas. This approach stimulates students' imagination on how to present something purely scientific in ways that are creative, understandable and attractive for their classmates. On the other hand, this cultivates new skills and knowledge. All the presentations are published in an open platform and are available for other students to learn.

Learning Goals	Learning Activities
To use, user friendly web-based educational site To encourage individual expression, providing quick, easy and exciting opportunity for real time learning To use ICT and to explore different free on-line resources To acquire new knowledge and skills while preparing their presentations	E- learning Learning by doing - Preparation of video presentation on a specific topic Exploration of different free on-line resources, applications and platforms Collection and selection of proper educational content presenting the selected topic Creating animated videos, interactive presentations, etc.

(Author: Dimka Shivacheva)

- **3D printers (Lithuania)**

This is an attractive practice, because students have an opportunity to work with modern equipment, which is being used in industry. It is a hands-on activity, which is connected with technologies' application in real life. The practice is connected to sustainable cities, because the technology allows a wide and sustainable application to solve various city-related problems

[9] https://ec.europa.eu/digital-agenda/en/pillar-6-enhancing-digital-literacy-skills-and-inclusion

Learning Goals	Learning Activities
To test fast modern technologies of new industrial product creation – from the concept to prototype.	Creating a product design. 3D modelling and projecting of the product. 3D scanning and virtual modelling of objects and premises. Fast production of the product (or a product prototype) with 3D printers and 2D cutting technologies.

(Author: Education Development Centre)

- **Robotics (Lithuania)**

Activities with robots allow pupils to understand main principles and logic of technologies, electronics, and mathematics. Robotics encourages creativity, independence, persistence and curiosity in innovations. It develops communication and collaborative work skills.

Learning Goals	Learning Activities
To learn to operate with various programming algorithms for rectilinear robot movement.	Create and execute programs for rectilinear robot movement. Measure the distance robot travelled during the fixed time and calculate approximate speed of the robot (m/s). Present measurement results in graph to reveal the dynamics of speed according to time. Create and execute the program for rectilinear robot movement in ellipse shaped path.

(Author: Education Development Centre)

Other activities under the ICT category include coding in various computer languages and pseudo-languages, using hardware, etc. Find out more in the resources section!

Learning Resources

Going Outdoors:
www.cienciaviva.pt/bosque/materiais.asp
www.kreativnoobrazovanje.edu.com
http://omegafizika.rs

Interacting with researchers:
http://www.cienciaviva.pt/ocjf/?accao=changelang&lang=en
www.cienciaviva.pt/img/upload/LSWE_IJSS.pdf
www.golabz.eu
www.scienceinschool.org/content/beat-flood
www.compass-project.eu/resources.php?ug_preselfl=sdtnvqddt-qgq
http://www.juniorsciencecafe.de
http://training.stemnet.org.uk/

New media:
https://youtu.be/QbZM4Dg_ZjY
http://www.fliptheclassroom.de
http://moodle.nitbg.com
http://it-5ou.weebly.com/
http://www.go-lab-project.eu/
http://icodl.openet.gr/index.php/icodl/2013/paper/view/273
www.school-lab.org
http://www.nasa.gov/mission_pages/station/research/experiments/90.html
http://www.slideshare.net/sofipapadi/march-making-science-real-in-schools
http://www.slideshare.net/sofipapadi/march-workshop-flipping-classrooms

Science and Art:
https://www.youtube.com/watch?v=DRFv9miQFew
http://www.leifiphysik.de/themenbereiche/physik-und-film

Getting hands-on:
http://www.sails-project.eu/
http://www.inquirebotany.org/en/
www.establish-fp7.eu/resources/units
http://www.chemiedidaktik.uni-bremen.de/multimedia/bionik/
www.britishscienceassociation.org/crest
http://www.wilbourhall.org/pdfs/Eratosthenica.pdf
http://www.stellarium.org/
http://www.globeatnight.org/
http://physcool.web.auth.gr/images/teyxos_5/5%CE%BF%20%CE%A4%CE%95%CE%A5%CE%A7%CE%9F%CE%A3.pdf
http://authenticlearning.weebly.com/
http://apostolakakis.blogspot.gr/p/blog-page_3.html
http://www.debonoforschools.com/asp/six_hats.asp
https://www.jigsaw.org/

http://www.teachinquiry.com/index/Introduction.html
http://www.unesco.org/education/tlsf/mods/theme_d/mod20.html
http://study.com/academy/lesson/cooperative-and-collaborative-learning-in-the-classroom.htm
Richard G. Stevens, Yong Zhu, Electric light, particularly at night, disrupts human circadian rhythmicity: is that a problem? Philosophical Transactions B, The Royal Society. DOI: 10.1098/rstb.2014.0120, 16 March 2015.

Spanos S. and Xenakis, C. (2013). Learning Astronomy through Inquiry and by means of Self-Constructions. Published by Astronomy and Space Society & Ellinogermaniki Agogi, Athens pp 191

Using ICT:

http://padlet.com
http://it-5ou.weebly.com/
http://medziaga.puslapiai.lt/Paprastos%20robot%C5%B3%20valdymo%20programos.pdf

Other Resources:

http://www.scientix.eu
http://www.consumerclassroom.eu/
http://www.inspiringscience.eu/

FAQs

Q: Who can participate in the pilots?

A: Secondary and high school teachers serving in a school in one of the project countries, namely: UK, Portugal, Germany, Lithuania, Serbia, Bulgaria and Greece.

Q: I live in a country other than the consortium countries. Can I participate in the pilots?

A: We are very glad for your interest in MARCH. Please contact us directly and we will try to include your school in the pilots.

Q: What theme should my pilot have?

A: The main objective of the pilots is to spread good practices in science teaching under the theme of sustainable cities. However, this theme is not exclusive. If your theme is a scientific one your pilot is eligible.

Q: How much time should I devote to the pilots?

A: This depends on your own timeline. Pilots need to be implemented between February and October 2016 and their time span can be from 2 school hours to a full semester.

Q: Can I join the international conference in London?

A: You are very welcome to join us at the 3rd MARCH International Conference in London. Find out more here. Please note that your participation will be under your own expenses, unless you are the winner of the national online voting competitions. Organisers also maintain the right to support financially participants who stand out for the quality of their work and the impact they offer to the project

Q: How should I present my final results?

A: There is a deliverable template for teachers participating in the pilots. You can find it here or contact MARCH pilots national contact point.

Q: How do I post my results online?

A: You sent the template to your MARCH national contact point and they will take it from there.

Q: Do I have to do the evaluation with the questionnaires?

A: We are doing the evaluation questionnaires to measure the pilots' success and take into consideration your opinion on the project. Replying to them will help us understand your needs better and improve. However, filling the questionnaires is not obligatory for your participation in the pilots, so you can skip them if you wish.

Q: Where can I find more info about MARCH?

A: In the MARCH website and Facebook page.

Q: What language should I use for MARCH deliverables and pilots?

You can do the pilots in your local language. The deliverable template (one page) would be preferably submitted in English, but if this is not possible, it is ok to submit it in your local language, letting your national contact point know.

Q: How can I participate in MARCH after the pilot ends?

A: You can stay tuned in our website and social media, contact us to get a copy of the publications we have made, present your work in pilots in conferences and science events and share your ideas with your national contact point.

Q: I am working on a relevant project with the ones you are presenting in MARCH. Can I adjust it and participate in the pilots?

A: We want to encourage as much flexibility as possible in the pilots' stage, to serve educators and students' needs. If your project is inside the pilots' timeline, aligned with the good practices and relevant with the theme, you are welcome to participate.

Q: Can I choose to apply as a pilot a good practice tested in another country?

A: Yes, absolutely. Our aim is to share and spread the good practices and the ideal scenario is to inspire teachers apply something developed in a different context and measure its success. So please feel free to browse all the good practices in the toolkit and choose the one that suits you best.

Q: How can I participate in the coaching sessions?

A: Contact your national contact point or visit our website to find out about the sessions schedule and make a registration.

Q: Will the coaching sessions be streamed online?

A: The presentations and information material will be uploaded in the website. Live streaming announcements will be made in the local pages if available.

APPENDIX

Questionnaires template

➢ *Students before*

Identification Code:

Create your own code by putting the following elements together: initial of mother, initial of father, street number, day of birthday. E.g. MJ7019 for Mary (mother), Jake (father), 70 (street number), 19 (day of birthday).

	About You				
1	Gender	F ☐	M ☐	Other ☐	
2	Age				
3	Grade				
4	City/ Country				

	About Science	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
5	I am interested in science	☐	☐	☐	☐	☐	☐
6	Knowing science will help my career in the future	☐	☐	☐	☐	☐	☐
7	Getting high grades in science is important for me	☐	☐	☐	☐	☐	☐
8	What I learn in science is often practically useful	☐	☐	☐	☐	☐	☐
9	I usually feel confident during science classes	☐	☐	☐	☐	☐	☐

	About the activity you will do in class	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
10	I like the idea of participating in the activity	☐	☐	☐	☐	☐	☐
11	I like the idea of learning about science by working in a team	☐	☐	☐	☐	☐	☐

12	I like the idea of learning about science by using technology (software and hardware)	☐	☐	☐	☐	☐	☐
13	I like the idea of learning about science by interacting with real life researchers	☐	☐	☐	☐	☐	☐
14	I like the idea of learning about science by using new media (video, social media, etc.)	☐	☐	☐	☐	☐	☐
15	I like the idea of learning about science by mixing science and art (e.g. on a theatre play about science)	☐	☐	☐	☐	☐	☐
16	I like the idea of learning about science by doing outdoor activities	☐	☐	☐	☐	☐	☐
17	I like the idea of learning about science by doing experiments and crafts	☐	☐	☐	☐	☐	☐
18	I like the idea of learning about science by using new methods to learn science	☐	☐	☐	☐	☐	☐
19	I think the activity will be fun	☐	☐	☐	☐	☐	☐
20	I think the activity will be useful	☐	☐	☐	☐	☐	☐
21	I think the activity will help me understand a science topic better	☐	☐	☐	☐	☐	☐

Dissemination		
22	How did you find out about the activity?	

Comments *Please let us know of any comments you would like to share on MARCH pilots and activities*

- ***Students after***

Identification Code:

Create your own code by putting the following elements together: initial of mother, initial of father, street number, day of birthday. E.g. MJ7019 for Mary (mother), Jake (father), 70 (street number), 19 (day of birthday).

	About the activity you did in the class	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
1	I liked participating in the activity	☐	☐	☐	☐	☐	☐
2	I liked working in a team	☐	☐	☐	☐	☐	☐
3	I liked using technology (software and hardware)	☐	☐	☐	☐	☐	☐
4	I liked interacting with real life researchers	☐	☐	☐	☐	☐	☐
5	I liked using new media (video, social media, etc.)	☐	☐	☐	☐	☐	☐
6	I liked mixing science and art	☐	☐	☐	☐	☐	☐
7	I liked going outdoors	☐	☐	☐	☐	☐	☐
8	I liked doing experiments and crafts	☐	☐	☐	☐	☐	☐
9	I liked using new and innovative methods to learn science	☐	☐	☐	☐	☐	☐
10	The activity was fun	☐	☐	☐	☐	☐	☐
11	The activity was useful	☐	☐	☐	☐	☐	☐
12	The pilot helped me understand a science topic better	☐	☐	☐	☐	☐	☐
13	I would like to participate in similar activities again	☐	☐	☐	☐	☐	☐
14	I feel this activity has increased my interest in science	☐	☐	☐	☐	☐	☐
15	I believe this was a high quality activity	☐	☐	☐	☐	☐	☐

Comments *Please let us know of any comments you would like to share on MARCH pilots and activities*

➢ *Teachers before*

Identification Code:

Create your own code by putting the following elements together: initial of mother, initial of father, street number, day of birthday. E.g. MJ7019 for Mary (mother), Jake (father), 70 (street number), 19 (day of birthday).

	About You						
1	Gender	F ☐	M ☐	Other ☐			
2	Age						
3	Years of teaching experience						
4	Expertise (what subject do you teach?)						
5	Grade (where the activity took place)						
6	City/ Country						

	About Science	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
7	I am looking up new ways of science teaching	☐	☐	☐	☐	☐	☐
8	I have been involved in innovative science projects before	☐	☐	☐	☐	☐	☐

	About the pilot: I believe the pilot will	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
9	Raise my students' interest for my subject	☐	☐	☐	☐	☐	☐
10	Develop my students' social skills	☐	☐	☐	☐	☐	☐
11	Develop my students' co-operative skills	☐	☐	☐	☐	☐	☐
12	Develop my students' creativity skills	☐	☐	☐	☐	☐	☐
13	Develop my students' communication skills	☐	☐	☐	☐	☐	☐

14	Develop my students' STEM competences	☐	☐	☐	☐	☐	☐
15	Inform students on job options associated with my subject	☐	☐	☐	☐	☐	☐
16	Help me find out about innovative practices from all over Europe	☐	☐	☐	☐	☐	☐
17	Help my own professional development	☐	☐	☐	☐	☐	☐
18	Help me collaborate constructively with colleagues	☐	☐	☐	☐	☐	☐

Dissemination		
19	How did you find out about MARCH?	

Comments *Please let us know of any comments you would like to share on MARCH pilots and activities*

- ***Teachers after***

Identification Code:

Create your own code by putting the following elements together: initial of mother, initial of father, street number, day of birthday. E.g. MJ7019 for Mary (mother), Jake (father), 70 (street number), 19 (day of birthday).

	About the pilot: I believe the pilot has	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
1	Inform students on job options associated with my subject	☐	☐	☐	☐	☐	☐
2	Helped me find out innovative practices from all over Europe	☐	☐	☐	☐	☐	☐
3	Helped my own professional development	☐	☐	☐	☐	☐	☐
4	Helped me collaborate constructively with colleagues	☐	☐	☐	☐	☐	☐
5	Inspired me to use new practices in my teaching	☐	☐	☐	☐	☐	☐
6	I believe this was a high quality pilot	☐	☐	☐	☐	☐	☐

Comments *Please let us know of any comments you would like to share on MARCH pilots and activities*

Deliverable template for the teachers

Pilots Deliverables

Field	Description
Title	Brief title (10 words max)
Chosen practice	Which practice did you apply in your classroom? (dropdown menu)
Teacher's name	
Teacher's expertise	(dropdown menu)
Number of students	(number of students participating in the activity)
School	
Grade (where the activity took place)	
Connection with the curriculum	
Timeline	
Description	Brief description (100 words)
Activities	List of educational activities performed (200 words)
Photo	
Contact Info (email)	
Contact Info (phone)	

Number of students

Additional material (optional): **Photos (up to 10), video (up to 2 minutes), presentation (up to 15 slides)**

Lesson Plan

To be used as a resource for teachers in a voluntary basis.

Goals: by the end of the lesson, learners will be able to:

- (write the 1st generic goal)
- (write the 2nd generic goal)

Location (classroom, school labs, research labs, outdoor activity etc.)

Material needed (blackboard, PC, interactive board, pen and pencil, realia, cds, technical equipment etc.)

Length (ie.1 hour, 2 hours etc.)

Lesson Stage and timing	**Aim**	**Procedure**	**Interaction**
Lead in (i.e. 5 mins)	To create interest in the topic		(Whole class, pairs, groups, individuals etc.)
Feedback (i.e.10 mins)			