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STEAM MANIFESTATION MODELS ACROSS EUROPE

Funded by the
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sySTEAM

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FRANCE

Project: solving real life problems

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The project *Classroom brightness and two variable statistics* provided a new approach in the mathematics curriculum.

The main **objectives** were:

- To conduct a study of the brightness inside the classroom to understand if the light points implementation was necessary or not.
- To perform related tasks, modifications to the electrical supply and distribution systems, rewiring buildings, replacing lamps/LEDs – tasks integrated into the students' curriculum.
- To teach about two variables – statistics and photometry & light measurement – through a project; both topics included in the students' Maths and Sciences curriculum.

References:

Nistor, A., Gras-Velazquez, A., Billon, N. & Mihai, G. (2018). Science, Technology, Engineering and Mathematics Education Practices in Europe. Scientix Observatory report. December 2018, European Schoolnet, Brussels.

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TURKEY

“Make Tomorrow for Turkey”

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The project comprises different steps:

1. Training and guidance on applied electronics and programming for teachers;
2. Students work on developing technology-based solutions to real-life problems/needs related to Health, Environment, Energy, and Smart Cities. The student teams are provided with technology kits and are guided by the trained teachers;
3. Evaluation and presentation of the projects implemented by students.

References:

Nistor, A., Gras-Velazquez, A., Billon, N. & Mihai, G. (2018). Science, Technology, Engineering and Mathematics Education Practices in Europe. Scientix Observatory report. December 2018, European Schoolnet, Brussels.

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ITALY

Attracting more girls into STEM: summer camp

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ASTROFINO IN SPACE is a summer camp for girls aged 9 to 12, organised over five days. Main activities were:

- Girl participants designed, constructed and launched rocket models in the school garden;
- they entered the simulated ISS through a tunnel and wore blue shirts and identification badges.
- An ASTRO PI kit was located in the Columbus Lab and supported the different types of space communication.
- Girls made robotic arms with Lego EV3 robotic kits to develop skills in space robotics and solved gravity questions through fun experiments such as egg drops.

References:

Nistor, A., Gras-Velazquez, A., Billon, N. & Mihai, G. (2018). Science, Technology, Engineering and Mathematics Education Practices in Europe. Scientix Observatory report. December 2018, European Schoolnet, Brussels.

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AUSTRIA

“Open matchbox!”: how to increase students’ interest in computer science

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The project was implemented in the “computer science and natural science” class during which students are required to go through a number of steps:

- Think out a plan for how to reach the goal.
- Make a project plan.
- Test the ultrasonic sensor with respect to the Arduino platform; do the same for the stepper motor
- Develop the algorithm and implement it.
- Design an opening mechanism for the box.
- Get used to a 3D construction program.
- Construct needed parts.
- Print the parts with a 3D printer.
- Learn to solder, so that the electronic links are robust.
- Assemble all parts.
- Test the mechanism.
- Present the project and its development to an interested audience.

References:

Nistor, A., Gras-Velazquez, A., Billon, N. & Mihai, G. (2018). Science, Technology, Engineering and Mathematics Education Practices in Europe. Scientix Observatory report. December 2018, European Schoolnet, Brussels.

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SPAIN

Nanotechnology

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Project's *Room at the bottom: from the smallest, to the conquest of the universe* main activities were:

- Working in teams with the topic chosen after brainstorm, related to nanothechnologies.
- Sessions in which the teacher meets with the teams to analyse the degree of progress, difficulties, possible ramifications of the project, new ideas, etc.
- Appointing a project coordinator (the student responsible for organising the team and who will be a spokesperson in communication with the teacher) and a project secretary (student in charge of taking notes of the meetings, the agreements made, the tasks that arise and the students in charge of these tasks).
- After a documentation phase, students acquire the ability to seek contacts in the scientific community, make experiments, contact companies and institutions, etc. Students begin to become "experts" and can make an initial sketch of how the research will be conducted.

References:

Nistor, A., Gras-Velazquez, A., Billon, N. & Mihai, G. (2018). Science, Technology, Engineering and Mathematics Education Practices in Europe. Scientix Observatory report. December 2018, European Schoolnet, Brussels.

ROBOT THEATRE

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- Robots, ready for simulate human expressions as Aisoy allow students to organize small theatre plays involving robotic actors.
- This is designed to work with multiple skills such as the robot's programming, plastic expressions (clothing and props), performing arts, literature and human relationships.

References:

https://www.aisoy.es/

The NanoEduca

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The NanoEduca drivers have designed a program based on three main lines of action:

- **NanoKit** Discover nanoscience and nanotechnology in the classroom with this kit designed to link nano concepts and applications with different curricular areas. The experience combines an experimental methodology, for students to try in first person, and an online platform, to deepen and discover related current research.
- **Teacher training.** Interact with active scientists, know first hand the most advanced facilities and participate in interactive sessions to share pedagogical resources.
- **Poster contest.** The participating centers, which will have discussed concepts related to nanoscience and nanotechnology in the classroom, will present a scientific poster with their conclusions.

References:

http://nanoeduca.cat/es/inicio/

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THE NETHERLANDS

Instructional videos on STEM-projects

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- Instructional videos on TItechnology concerning TI-84 Plus CE-T & TI-Nspire CX handhelds.

- With WIL-de STEM, still under the name of WILde Wiskunde (‘wiskunde’ in Dutch means Mathematics) developers provide “Path to STEM projects”, enabling teachers and students to work with sensors, TI-Innovator HUB and TIInnovator aROVER and more.

References:

Nistor, A., Gras-Velazquez, A., Billon, N. & Mihai, G. (2018). Science, Technology, Engineering and Mathematics Education Practices in Europe. Scientix Observatory report. December 2018, European Schoolnet, Brussels.

Virtual labs

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- The Go-Lab Sharing Platform provides a large collection of quality-proven remote and virtual laboratories (“Labs”), shared by renowned research institutions and technology providers from all over the world.
- These online labs allow students conducing scientific experiments in a virtual environment.
- Multiple web-applications (“Apps”) are offered, supporting students in their inquiry learning activities and teachers in the preparation, implementation, and monitoring of these activities.
- Teachers have a possibility to share Inquiry Learning Spaces (“Spaces”) they create for their students with other teachers, so they can benefit from ready-to-use scenarios available for different subject domains and in different languages.

References:

Go-Lab Project, https://www.golabz.eu/

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GREECE

The Space Awareness kit: “Earth’s climate and global warming”

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Students learn about the climate and the global warming of the Earth through experiments and demonstrations:

- Discussions around the conditions that have to be fulfilled on Earth in order to have life.
- The different climates in the different regions of Earth are explored. Students are encouraged to monitor various problems and to give possible solutions.
- In the process, students learn about satellites and how the data from satellites helps us understand complex phenomena that occur related to climate change (using space awareness kit).
- In a special event with their parents, other students and teachers students present their findings and demonstrate simple experiments they have learnt.

References:

Nistor, A., Gras-Velazquez, A., Billon, N. & Mihai, G. (2018). Science, Technology, Engineering and Mathematics Education Practices in Europe. Scientix Observatory report. December 2018, European Schoolnet, Brussels.

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SLOVENIA

Real-world applications in Maths classes

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The objective was to start adding practical activities to the existing teaching methods, and increase the practical use of Mathematics.

Examples of the activities:

- Estimating how long it takes for the candles to burn. Do the tea cool down to zero degrees? Does it cool evenly?
- Modelling the trajectories of the shuttlecock and the volleyball and the light reflection from a table, using the parabola.
- Approximating the sound level of different devices (phones, our school bell, home alarm) and making a sound scale.
- Iinvestigateing earthquakes using data available on the Internet.

References:

Nistor, A., Gras-Velazquez, A., Billon, N. & Mihai, G. (2018). Science, Technology, Engineering and Mathematics Education Practices in Europe. Scientix Observatory report. December 2018, European Schoolnet, Brussels.

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PORTUGAL

Biotechnology in biology and english

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Different topics from two subjects are connected in activities covering different areas:

- Genetics: students use hands on activities about the organisation and the regulating of genetic material (lac operon, PCR, DNA finger prints, etc.) and use virtual labs and among other more complex techniques.
- Biotechnology in Food Production: students carry out hands-on activities about lactase persistence, enzymatic immobilisation, fermentation, produced in ginger beer and some food conservation techniques such as pickles.
- Immunity: students work on the effects of phytoactive compounds, produced by onions (Allium cepa) and ginger (Zingiber officinale) on bacteria.
- Environment: the actions of micro-organisms in the biological treatment of waste waters will be investigated.

References:

Nistor, A., Gras-Velazquez, A., Billon, N. & Mihai, G. (2018). Science, Technology, Engineering and Mathematics Education Practices in Europe. Scientix Observatory report. December 2018, European Schoolnet, Brussels.

Plant Growth Project

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- Students observe the growing of the plants, from the seed to flowering. They register data related to the plants on a monthly basis including height and width, number of leaves, signs of disease parasites, slug/snail damage that affected the plants during the investigation process.
- Using a data recorder, students monitor temperature and moisture levels.
- Also, students visit a research center for contact with researchers in different STEM areas.

References:

Nistor, A., Gras-Velazquez, A., Billon, N. & Mihai, G. (2018). Science, Technology, Engineering and Mathematics Education Practices in Europe. Scientix Observatory report. December 2018, European Schoolnet, Brussels.

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SERBIA

Gamification

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HEMBIZIKA - a quiz game with questions on Chemistry, Biology and Physics:

- Pupils are asked during class to create one question from a physics lesson taught that day and ask another student to solve it.
- For homework students are asked to create a list of questions for a next class during which HEMBIZIKA would be played. Rules when creating questions were that the student who asks the question must know how to solve it and that it has to be from the 6th grade physics curriculum.
- Students were shown examples of good questions from final exams at the end of elementary school, PISA testing and others.

References:

Nistor, A., Gras-Velazquez, A., Billon, N. & Mihai, G. (2018). Science, Technology, Engineering and Mathematics Education Practices in Europe. Scientix Observatory report. December 2018, European Schoolnet, Brussels.

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UNITED KINGDOM

Using resources in the classroom

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- The Thinking Science resources come in the form of questions designed to provoke thinking and discussion, to consolidate and extend core curriculum knowledge and understanding.
- The resources can be used as a stand-alone activity and require no preparation. Also, questions can be used in different ways in the classroom: as a starter, plenary, introduction to a new topic, for consolidation at the end of a topic, or as revision.
- There are resources for: physics, chemistry, biology, working scientifically.

References:
http://www.bristol.ac.uk/philosophy/thinking-science/

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BELGIUM

Raising awareness of environmental issues

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- The Bioplastic project builds new lab activities where students aged 16- 17 are asked to work on specific topics (e.g. catabolism of polysaccharides by chemical, physical or enzymatic actions, numeration under microscope of microplastics after extraction).
- Links to various initiatives, universities and organisations are sought to increase the contextualisation of teaching.
- Class activities leads students to read scientific papers, face scientific issues, develop strategies to offer solutions, and, finally, to fulfil pedagogical expectations.

References:

Nistor, A., Gras-Velazquez, A., Billon, N. & Mihai, G. (2018). Science, Technology, Engineering and Mathematics Education Practices in Europe. Scientix Observatory report. December 2018, European Schoolnet, Brussels.

Entrepreneurship

Quantum Spin-Off shows the applications of Quantum Physics and gives students a taste of entrepreneurship for the high-tech sector:

- The high school students are brought into contact with a world-leading research institution in nano-electronics, high tech companies.
- Spin-off valorisation process: For several weeks the students work as in a high-tech company. They contact the supervisors of the participating high-tech companies or research groups and create a technical and a business plan. There are at least three working days in the company and / or research institution where representatives of the class can discuss the detailed plans.
- Spin-off day: The groups of students present their technical and business plans to a jury.

References:

Bogner, F,. Boudalis, A.K., & Sotiriou, S., (Eds) (2012) Pathway D3.1 Best Practices of Inquiry-Based Science Education Methods and Activities

Peer teaching

ŽINIŲ EKONOMIKOS FORUMAS

- The project “Capital Digital” successfully trained youngsters aged 15 to 18 from disadvantaged backgrounds, migrants and asylum seekers, in how they can teach coding and programming to their 10 to 12-year-old peers in Brussels.
- The young “e-facilitators” learned how to engage children in STEM and coding activities in a playful way.
- The project effectively supports young people to develop critical thinking, creativity, digital and collaborative skills, and science capital.
- Most importantly, the Capital Digital pedagogical method for peer learning has a strong inclusive potential and fosters the STEM education and inclusion of disadvantaged students both inside and outside the classroom.

References:

“Capital Digital” project, www.capitaldigital.be

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ROMANIA

Scientific and technical workshop

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- Groups of students organise their work, identify the resources (strategies, knowledge, experience, equipment, software, materials), and decide how the resources will be used for building and maintaining a shared understanding of the task and its solutions.
- The Inquiry-Based Learning (IBL) approach is fundamental to this course. IBL is used in a collaborative and interactive context. It is not the solution which is the most important in the context of this elective course, but the process. The students' activity is facilitated by the teacher.
- Then, students share their research results at different scientific events, and write and publish a scientific article about their research findings.

References:

Nistor, A., Gras-Velazquez, A., Billon, N. & Mihai, G. (2018). Science, Technology, Engineering and Mathematics Education Practices in Europe. Scientix Observatory report. December 2018, European Schoolnet, Brussels.

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DENMARK

Integration of coding

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In **Grade 7-10** coding is integrated in the binding national Common Objectives for Physics and chemistry.

- Knowledge about simple programming and transmission of data.
- Programming languages and skills of programming simple digital solutions (Physics and chemistry).
- In Math to enhance systematic and abstract thinking with specific guidance.

In **Grade 11-13** coding is intergraded in the optional subject Information Technology.

- Using programming technologies for the development of IT products and adaptation of existing IT systems (Data structures such as nested conditions; different types of loops; functions coupling different programming technologies; approaches to programming such as Stepwise Improvement, Object-oriented Programming etc.)

References:

http://uvm.dk/Uddannelser/Gymnasiale-uddannelser/Fag-oglaereplaner/Forsoegsfag-i-de-gymnasiale-uddannelser/Informationsteknologi-C-og-B

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IRELAND

The BT Young Scientist and Technology Exhibition (BTYSTE)

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- Enables second level students to develop their STEM skills by devising and carrying out projects. The annual showcase attracts major public attention and several winners have gone on to represent Ireland internationally and to forge careers in STEM areas.
- Since its inception, the cumulative impact of the BTYSTE has been immense and it is a striking model of the value of inquiry-based learning

References:

A Report on Science, Technology, Engineering and Mathematics (STEM)Education: Analysis and Recommendations

https://www.education.ie/en/Publications/Education-Reports/STEM-Education-in-the-Irish-School-System.pdf

SciFest

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- Hosts one-day science fairs for second-level students at local, regional, and national levels that encourage students to prepare and showcase inquiry-based projects.
- At the regional level, SciFest@College takes place at Institutes of Technology (and DCU) and winning projects move on to a national SciFest science fair supported by Science Foundation Ireland.
- Overall winners represent Ireland in an international competition.

References:

A Report on Science, Technology, Engineering and Mathematics (STEM)Education: Analysis and Recommendations https://www.education.ie/en/Publications/Education-Reports/STEM-Education-in-the-Irish-School-System.pdf

Smart Futures

ŽINIŲ EKONOMIKOS FORUMAS

- Promotes STEM careers to second-level students, parents, guidance counsellors, and teachers in Ireland, highlighting opportunities in sectors such as pharma chemical, medical devices, information and communications technology (ICT) and energy.
- Events and initiatives in this government-industry partnership include school visits by science researchers and engineers, a Transition Year Work Experience programme, a Video Series and a blog that profiles people working in STEM to give an insight about their work and experience.

References:

A Report on Science, Technology, Engineering and Mathematics (STEM)Education: Analysis and Recommendations
https://www.education.ie/en/Publications/Education-Reports/STEM-Education-in-the-Irish-School-System.pdf

CoderDojo

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- A global volunteer-led community of free programming clubs for young people aged between 7 and 17.
- Young people attending a Dojo (typically weekly) learn how to code and create with software and hardware.
- The emphasis is on peer learning, mentor-led and self-led learning and having fun with technology in a social environment.
- Within the CoderDojo community, some dedicated CoderDojo sessions have been established to encourage the participation of girls.

References:

A Report on Science, Technology, Engineering and Mathematics (STEM)Education: Analysis and Recommendations
https://www.education.ie/en/Publications/Education-Reports/STEM-Education-in-the-Irish-School-System.pdf

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BULGARIA

Mathematics classes using inquiry-based learning methods

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- The Virtual Mathematics Laboratory, is developed in support of inquiry-based mathematics education and in broader contexts within the fields of Science, Technology, Engineering, Arts and Mathematics (STEAM).
- Most of the VirMathLab resources can support the independent (re)discovery of properties of mathematical objects and create conditions for applying them to solve problems.
- There are several types of VirMathLab resources, including: files with dynamic constructions, didactic scenarios on various topics, video files and publications. There are separate sections dealing with subjects such as functions, geometric transformation, applications, games, puzzles and art.
- In addition, there are resources for evaluation and self-evaluation.

References:

Project coordinators - Institute of Mathematics and Informatics at the Bulgarian Academy of Sciences, more information: http://cabinet.bg

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LITHUANIA

Science experiments

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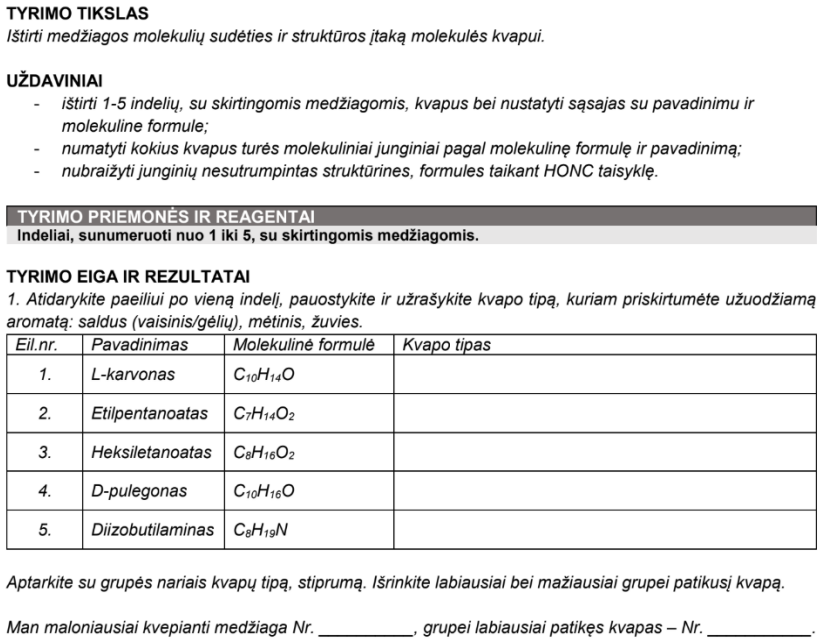
Examples and templates of science experiments

http://www.gamtosmokslai.lt/

- Does the smell have a shape?
- Diffusion test in gels
- Hydrophobic surfaces
- Production of (non) Conductive Plasticine
- Production and testing of spectrophotometer



TYRIMO TIKSLAS

Ištirti medžiagos molekulių sudėties ir struktūros įtaką molekulės kvapui.

UŽDAVINIAI

- *ištirti 1-5 indelių, su skirtingomis medžiagomis, kvapus bei nustatyti sąsajas su pavadinimu ir molekuline formule;*
- *numatyti kokius kvapus turės molekuliniai junginiai pagal molekulinę formulę ir pavadinimą;*
- *nubraižyti junginių nesutrumpintas struktūrines, formules taikant HONC taisyklę.*

TYRIMO PRIEMONĖS IR REAGENTAI

Indeliai, sunumeruoti nuo 1 iki 5, su skirtingomis medžiagomis.

TYRIMO EIGA IR REZULTATAI

1. Atidarykite paeiliui po vieną indelį, pauostykite ir užrašykite kvapo tipą, kuriam priskirtumėte užuodžiamą aromatą: saldus (vaisinis/gėlių), mėtinis, žuvies.

Eil.nr.	*Pavadinimas*	*Molekulinė formulė*	*Kvapo tipas*
1.	*L-karvonas*	$C_{10}H_{14}O$	
2.	*Etilpentanoatas*	$C_7H_{14}O_2$	
3.	*Heksiletanoatas*	$C_8H_{16}O_2$	
4.	*D-pulegonas*	$C_{10}H_{16}O$	
5.	*Diizobutilaminas*	$C_8H_{19}N$	

Aptarkite su grupės nariais kvapų tipą, stiprumą. Išrinkite labiausiai bei mažiausiai grupei patikusį kvapą.

Man maloniausiai kvepianti medžiaga Nr. _____, grupei labiausiai patikęs kvapas – Nr. _____.

"Mission - Mars" is a virtual journey to the red planet.

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Cycle of lessons include:

- The scientific analysis of Martian;
- Development of 3D glasses and using them to analyze 3D real Mars surface photos;
- Picking a place for permission and construction of a habo (residential station).
- Building unmanned spacecraft (students dropped the self-made engineering constructions with the egg from the third school floor),
- Programming the tools to measure the temperature in Mars, the pedometer and so on; Using the electronics kit LittleBits to build an alarm system, cooling system, etc.
- Discussing the difference in the time of day, the difference between the circle of the sun and the consequences of it;
- And solving other challenges!

References:

Innovative Teachers Awards, winner of nommination

Innovative math, IT teacher Eglė Bukienė

Integrated project "The Epoch Circle"

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During the project students give an insight into selected epoch‘s philosophy, literature, music, art and architecture. For two days, all teachers and students of the gymnasium work in different groups. The third, the last day of the project, presentations and reviews of the works performed.

Also all teachers take classes in one way or another related to the selected epoch; Later the students of all classes will divide into groups according to the planned activities, they have chosen teachers-consultants.

Past topics of the project: Ancient Ancient Period, the Middle Ages of the Middle Ages, Renaissance.

References:

www.epochuratu.wordpress.com

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ESTONIA

Technological literacy

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- HITSA´s (Information Technology Foundation for Education) ProgeTiger programme is aimed at preschool, primary and vocational education in effort to integrate technology education into curriculum.
- In preschool, teachers teach and use LEGO WeDo, Kodu Game Lab, tablets (apps), programmes to make animations etc. In primary school, teachers teach and use Kodu Game Lab, Logo MSW, Scratch, LEGO Mindstorms EV3, mobile app making programmes and environments, many different programmes and environments which are used for teaching various subjects (music, mathematic, physics, biology), e-labs etc.
- In high school and vocational education, teachers teach and use different programming languages (Python, JavaScript etc), Codecademy.com courses, 3D graphics, robotics, programmes to make games, web-pages and apps etc.

References:

https://www.hitsa.ee/it-education/educational-programmes/progetiger

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SWITZERLAND

Evidence based experimental activities

Building a Cloud Chamber- is designed to enable students to gain inquiry knowledge and skills through observation, collection and interpretation of experimental data, and reflection on experimental outcomes.

- The Building a Cloud Chamber activity may commence with a discussion initiated by the teacher on the natural phenomenon of cosmic rays and their detection, particle physics, CERN and the LHC, and a brief history of particle detectors' evolution from Wilson's original cloud chamber to the large detectors presently used at CERN's LHC.
- This is followed by a step-by-step construction of cloud chambers by the students themselves whose work is guided and facilitated by the teacher.
- Then students reflects on the construction of their cloud chambers, on their observations of cosmic particle tracks, their considerations of alternative explanations. The activity may conclude with a discussion on various technological applications of particle physics detectors to everyday life.

References:

Bogner, F,. Boudalis, A.K., & Sotiriou, S., (Eds) (2012) Pathway D3.1 Best Practices of Inquiry-Based Science Education Methods and Activities