EXPLORE+

Toolkit for
Curiosity - and Creativity-driven Learning

It's all about STEAM

Erasmus+

cēsis

SPACE EDUCATION CENTER

DACVG

AGRUPAMENTO DE ESCOLAS PINHEIRO E ROSA

solaris
Förderzentrum für Jugend & Umwelt gGmbH Sachsen

Primăria Municipiului Timișoara

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IMPRESSUM

TITLE

"EXPLORE+ Toolkit for
Curiosity- and Creativity-driven Learning"

This Toolkit is an intellectual output of cooperation within the project: "EXPLORE+ creative explorations of curiosity for innovative transdisciplinary, STEAM and social learning"

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Timișoara Municipality

PROJECT COORDINATOR

solaris Foerderzentrum fuer Jugend und Umwelt gGmbH Sachsen

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PREFACE

Schools, as a fundamental component of educational systems, are increasingly needing to prepare new methodologies and pedagogical instruments, which allow them to improve the levels of education.

The challenges the education faces today, external and internal as well, need prompt, but, above all, appropriate solutions.

Learning is no longer reduced to a single, self-contained subject, but the approach must be multidimensional, involving components adapted to the realities and needs of the environment we come from and live in.

Considering this perspective, six various entities from 4 European countries (3 municipalities, 2 schools and one youth welfare provider) understood that their own experience should be shared, exchanged, and validated by other educational institutions and providers.

They contributed to create this Toolkit as a learning open-source for teachers, youth workers, pedagogues working at the intersection of education and cultural pedagogy. The purpose of the toolkit is to share learning outcomes and methods of the EXPLORE+ project with other schools, cultural institutions, youth organisations and other relevant stakeholders. Its core goal is to experiment and share innovative pedagogic practices, which stimulate curiosity, creativity, STEAM skills, scientific literacy and critical thinking as part of the learning experience, and provide pupils and citizens with tools, in order to explore their own capacity and interest as well as the and relevance for the local community.

This Toolkit is open to be completed by **"new Explorers"** by developing a new version of the EXPLORE+ project.

CHAPTER I
THE PARTNERS

Space Education Center (Cēsis municipality)

Professional fields where this organization is working?

1) School children (primary and secondary school) and students

2) Teachers as a cornerstone of every educational process who can inspire children to pursue specific careers

3) Preschool children (kindergarten and elementary early education) and their parents.

Whom is whom

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Jānis Urtāns, Workshop expert on Natural Science

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Friendly Appeal Cēsis State Gymnasium

Photo: Ainārs Vītols

Professional fields where this organization is working?

Primary and secondary education for students from age 13 till age 19; professional development for teachers and school leadership teams in different educational fields.

Whom is whom

Oskars Kaulēns,
principal and history teacher

Contacts

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Escola Secundária Pinheiro e Rosa

Escola Secundária Pinheiro e Rosa – Agrupamento Pinheiro e Rosa whose mission is to offer the community a quality educational service, ensuring a participative and cooperative, open and integrative environment, in a school committed to the challenges presented by current legislation.

Professional fields where this organization is working

Our offer consists of pre-school education, basic education and secondary education. In primary education, besides the regular classes, there are classes of alternative training offers. In secondary education, besides the scientific and humanistic courses, the training offer extends to vocational courses covering several areas.

All the offers aim in general, to make a contribution towards individual qualification and democratic citizenship, which translates into the effective appropriation of knowledge, abilities and attitudes, developing the skills that allow the students of this school grouping to successfully pursue their academic training, whether at a higher level or not, or to enter the employment market.

Whom is whom

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Projects coordinator – André Lara Ramos

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Museu Zer0
Instituto Lusíada de Cultura - ILC

Based on an initiative proposed by the **Instituto Lusíada de Cultura -ILC** (Lusíada Institute of Culture), a Museum dedicated to digital arts is now being created, already implementing initiatives that provide an introduction to and raise awareness for digital art, through a training programme and communication initiatives held in schools, in particular, where we have already provided presentations (by artists, creatives and other professionals linked to digital art, and the techniques and technologies used to produce it) in schools across the Algarve, working with hedteachers, teachers and students across the full range of subjects.

Our presentation programme ranges from lectures by artists, multimedia professionals and video programming and production experts to electronic music, including sessions held in classrooms, and labs/workshops being worked into the curricula of several subject areas.

Professional fields where this organization is working?

Museu Zer0 aims to implement several features: a space for art residencies and a creative studio for cutting edge projects, an exhibition space for both Portuguese and foreign artists within which to debut works, and a research and training centre dedicated exclusively to digital art, to which academic entities and professionals in the field will contribute.

With no permanent collection, but structured around museological principles, **Museu Zer0** will create a collection of metadata based on its operations, specialising in classifying, managing and conserving digital art.

Whom is whom

João Correia Vargues, head of the board of Direction

Joana Carmo, responsible for public mediation service, artistic and exhibitions programme

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Partner name

ILC-Museu Zer0

Why it is important to teach and learn STEAM subjects

Cultivar e estimular atividades interdisciplinaridades são cruciais para o desenvolvimento solido de aprendizagens, sendo que os desafios hoje existentes para a criação artística, suportadas pelas tecnologias computacionais, são oportunidades que importa estimular tanto pelo lado das engenharias como das estéticas artísticas.

What is special on this organization according to the teaching and learning STEAM subjects

Museu Zer0 support new talents for artistic creation, giving knowledge, instruments and a curatorial programme that, from the beginning at schools encourage technological experts to cross arms for culture and arts, combining them skills with aesthetics inspiration from creative young people.

The professional experience on teaching and learning STEAM subjects

Museu Zer0 had already reach 6.000 students in the last 4 scholar years, all over Algarve's region, dealing with more than 80 teachers, on 30 different disciplines.

The organization

Solaris

solaris Foerderzentrum fuer Jugend und Umwelt gGmbH Sachsen (**solaris** FZU) is a reference point in the local non-profit organisation landscape in Chemnitz, Saxony. With 30 years of activity behind it, **solaris** is a major player in the field of extracurricular educational activities, having been awarded in 1993 as a carrier of the free youth welfare of the city of Chemnitz.

The specificity of **solaris** FZU is given by the complexity of the themes addressed, by the portfolio of activities carried out and not least by the own mission: developing innovative answers of how we all want to live together. Now and tomorrow.

Professional fields where this organization is working.

solaris FZU works nationally and internationally either headquarters or within its own five operators such as: **solaris** Facilities for Youth and Environment, **solaris** Multigenerational House, **solaris** Experiential Educational Center, Chemnitz Art-Factory, and Ikarus Neiberghood Center in the field of education, child and youth welfare, social work, integration and inclusion, environmental protection, and research.

Looking back **solaris** understands that what it has accomplished is a unique vision of what a community can achieve - employees, partners and customers.

Looking forward, **solaris** understands that its mission based on trust, tolerance and openness continues.

Whom is whom

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The organization

Timişoara Municipality

Professional fields where this organization is working.

Main fields of activity:

- education,
- health,
- culture,
- sport,
- public order,
- civil protection,
- environment protection,
- water supply and sewage,
- waste management,
- sanitation,
- heating,
- public lighting,
- public transport,
- social assistance
- local development.

Whom is whom

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Primăria Municipiului Timişoara

CHAPTER II

THE PARTNERS ENGAGEMENTS ON STEAM

Space Education Center (Cēsis municipality)

Why it is important to teach and learn STEAM subjects

Using STEAM education results in students who take thoughtful risks, engage in experiential learning, persist in problem-solving, embrace collaboration, and work through the creative process. These are the innovators, educators, leaders, and learners of the 21st century society.

What is special on this organization according to the teaching and learning STEAM subjects

The topic of space and space exploration has a wide and deep coverage across many industries and economic sectors and learning areas, including healthcare, food production and processing, material sciences, electronics, communication, design, architecture, computer programming, economics, law, arts; not to mention that space exploration covers a wide range of natural sciences of physics, astronomy, mathematics, chemistry, biology, and more.

The professional experience on teaching and learning STEAM subjects

Cēsis municipality has announced - Cēsis - an excellent place to live! Behind this slogan stands municipality priority's - education and business development. Cēsis already holds offices for two biggest HI schools in Latvia as well as offices of biggest IT companies in Latvia. Starting from 2010 Cēsis has invested in STEM education. By creating Space Education Center Cēsis promote development of knowledge and career choices in STEM on a bilateral cooperation, where educational programs, workshops, co-working place, maker-labs, and other interactive activities in STEM area are developed for school children and students, teachers and preschool children and their parents.

How we see the linkage between STEM subjects and Arts

A very important similarity between the arts and STEM disciplines is the inquiry-based learning and problem-solving at the core. Artistic processes fostering learning skills are also built-in components of the STEM disciplines.

Motivation and expected benefits from participation in this Erasmus+ project

It is an opportunity to generate new ideas and create a material that help teachers at school and students learn STEAM subjects in an exciting way.

Photos by Sandra Lielmeza

Opportunities for schools and other organizations, using this Toolkit

The materials of the created toolkit can be used in the teaching content by connecting them with topics that need to be taught to students at school. They show how space exploration topics relate to STEAM subjects.

Friendly Appeal Cēsis State Gymnasium

Why is it important to teach and learn STEAM subjects

Global economy is requiring graduates who can create and innovate. Learning STEAM subjects is a way how we can integrate creative arts with sciences to develop important skills for students, for example, skills of critical and analytical thinking, creativity, problem solving etc.

What is special on this organization according to the teaching and learning STEAM subjects

In the secondary school students can choose a program where they can study natural sciences – chemistry, physics, biology etc. It means that they are studying these subjects for much longer time than students from other programs. During the secondary school students at our school can choose to study also cultural studies and arts according to their preferred career perspectives.

Photo: Oskars Kaulēns

The professional experience on teaching and learning STEAM subjects

Our school have been a part of several Erasmus+ projects which have been related to learning about environmental issues and climate changes. Also, students of our school have practicums in different fields, for example, environment and ecology where they are visiting different environmental institutions and study in the real environment.

How we see the linkage between STEM subjects and Arts

We see it with the use of technologies where students can use different ICT tools for learning STEAM curriculum at the same time creating different learning projects, for example, infographics, animations, podcasts etc.

Motivation and expected benefits from participation in this Erasmus+ project

Our school wanted to get to know new experience and best examples of other educational institutions on how they are creating linkages between STEM and Arts subjects. We also wanted to know new approaches which our teachers could use to teach STEAM subjects in a more creative, technologies based way. During the study visits our students have participated in several workshops and developed new skills in a field of STEAM and modern technologies, for example, planning, problem solving, critical and analytical thinking, creativity etc.

Photo: Edgars Pletiēns

Opportunities for schools and other organizations, using this Toolkit

It is a practical tool for teachers which can be used in every classroom where students are studying STEM and Arts curriculum. We suggest that teachers are cooperating together to use some of the tasks which are included in this toolkit and then have some reflection about the experience their students and themselves have got during these learning activities.

Escola Secundária Pinheiro e Rosa

Why is important to teach and learn STEAM subjects

It is a challenging and attractive learning model that provides a learning environment based on collaborative practices that will allow inclusion and cooperation among all students, without exception, in which teachers play the role of mediators in the learning process.

Learning through STEAM helps the development of communication, creativity, collaboration and critical thinking. If, on the one hand, this methodology allows students to experience and acquire new essential skills for solving day-to--day problems, on the other hand, this model, which provides for the integration of knowledge from Arts, Sciences, Technology, Engineering and Mathematics also enables them to prepare for increasingly demanding challenges in terms of flexibility at work, innovation and responsibility.

What is special on this organization according to the teaching and learning STEAM subjects

AEPROSA is concerned about all types of learning styles (visual, auditory, kinaesthetic, reading/writing) and the various needs and interests of the students, i.e. the personalization of learning. Teachers use Project Based Learning (PBL) and Inquiry-Based Science Education (IBSE), encouraging students to ask questions, link what they are observing/learning to their prior knowledge, and test their solutions to problems, with an emphasis on STEM topics and competencies.

The professional experience on teaching and learning STEAM subjects

Providing learning activities/ learning scenarios of an interdisciplinary nature, involving the areas of Science with other disciplinary areas, in a STEAM approach, in order to contribute to the scientific and technological literacy of students and the educational community.

How we see the linkage between STEM subjects and Arts

The connection is made whenever activities are designed that facilitate meaningful learning to develop the areas of competence provided for in the Profile of Students Leaving Compulsory Schooling, such as reasoning and problem solving, critical thinking and creative thinking, information and communication, scientific knowledge , technical and technological; and whenever a lesson plan uses methodologies such as PBL, Problem Solving projects, investigations, in an authentic context or close to reality.

Motivation and expected benefits from participation in this Erasmus+ project

We expect to raise the interest and understanding of all the teachers, independently from their background and technical expertise and appetence, regarding the creation of new Learning Scenarios.

Opportunities for schools and other organizations, using this Toolkits

We wish to offer the possibility to use these Toolkit in order to engage students in a participative approach, being then an effective way to motivate students toward scientific and technical learning.
We also aim to address one of the major challenges related to the development of technical and technological activities in schools: the issues of ethics, inclusion and equity.

Museu Zer0
Instituto Lusíada de Cultura - ILC

Why it is important to teach and learn STEAM subjects

To cultivate and stimulate interdisciplinary activities that are crucial to a solid development of learning processes, being that the challenges that exist today to artistic creation, supported by computational technologies, are opportunities that should be stimulated by Enginering side by side with artistic aesthetics.

What is special on this organization according to the teaching and learning STEAM subjects

Museu Zer0 supports new talents for artistic creation, giving knowledge, instruments and a curatorial programme that, from the beginning at schools encourages technological experts to cross arms for culture and arts, combining their skills with aesthetic inspiration from creative young people.

The professional experience on teaching and learning STEAM subjects

Museu Zer0 has already reached 6.000 students in the last 4 school years, all over Algarve's region, dealing with more than 80 teachers, on 30 different disciplines.

Motivation and expected benefits from participation in this Erasmus+ project

We expect to create pilot demonstration projects that will bring creativity and arts near teachers and scholar's, combining media art technologies and scientific programmers.

Opportunities for schools and other organizations, using this Toolkit

Up with these examples, teachers will be given the opportunity to deep combine arts, on their pedagogic and scientific classes, demonstrating that augmented reality can be an excellent instrument to present and better explain some contents that are better "captured" by students trough, as an example, multidimensional figures.

Solaris

"The difference between science and the arts is not that they are different sides of the same coin or even different parts of the same continuum, but rather, they are manifestations of the same thing. **The art and science are avatars of human creativity**"

(Quote by Mae Jemison)

1. In which fields of work is your organization active?

The **solaris** Foerderzentrum fuer Jugend und Umwelt gGmbH Sachsen (Support Center for Youth and the Environment shortly solaris FZU) was founded in Chemnitz in 1993 and was recognized in 1994 as a welfare nonprofit supporting organisation for youth. As a non-profit organization, **solaris** FZU works nationally and internationally in the fields of education, culture, child and youth welfare, social work, integration, environmental protection, and research.

solaris FZU is a division of the Solaris group, which has been mainly active in the areas of planning, building, maintaining, and managing in Stuttgart since 1903 and in Chemnitz since 1990.
The large range of activities at solaris FZU is the starting point for a general and holistic way of working.

In this role, the **solaris** Förderzentrum für Jugend und Umwelt gGmbH offers extracurricular child and youth welfare activities in its own facilities and projects for various interests, from the STEM -subjects to art and experiential education to aerospace. The formats include open meetings, special courses, competitions and organizing competitions, or regular offers such as working groups and cabinets.

In addition, **solaris** FZU sends its own pedagogical specialists, accredited social workers, to Chemnitz educational institutions to provide advice and individual support in schools.

Furthermore to the local and regional activities, many international activities and projects in areas such as youth work, adult education, European mobility or the European Solidarity Corps ensure added value to the range of activities, e.g.: exchange of experiences, implementation of new concepts, intercultural development, and strengthening of European partnerships.

All activities serve to promote social interaction in all age groups and the integration of people of different origins in the sense of mutual peaceful coexistence.

2. Why do you think it is important to teach and learn STEM subjects (STEM = Sciences, Technology, Engineering)?

Natural sciences and technology are important keys to understanding our world and the engines of progress. Currently, socially important topics such as digitalization, environmentally friendly mobility and sustainable industrial production require specialists today and even more so in the future to develop useful solutions for the tasks ahead of us.

Children and young people are naturally curious and equally enjoy playing and experimenting. STEM topics are excellent for serving these interests.

If children are cared for with innovative learning methods, appropriately trained pedagogical specialists, and educational staff, they can develop productive enthusiasm for STEM disciplines with their inexperienced creativity, develop themselves creatively and advance society in the future.

3. + 4. What professional experience does your organization bring to the learning and teaching of STEM subjects (local, national, international) and what approach do you take?

With **solaris** FZU youth and environmental workshops, we have a facility in Chemnitz that focuses on the STEM disciplines and combines a Student Research Center and a Student Laboratory under one roof. For more than 20 years, children and young people have been experimenting and tinkering with wood, metal or paper in open workshops or fixed courses. There are also supplementary courses in the form of project days on a wide variety of topics and working groups, e.g. "Young Researchers", "Students experimenting", "Electronics and Computer Science" and other targeted research on various subjects.

Since 1995, the **solaris** FZU has been in volved in organizing various regional competitions like "Youth researching", "Bridge building" or "Students experimenting" regional and national Germany's most well-known young talent competition. Numerous projects in Chemnitz and the surrounding area owe their success primarily to the support of one of solaris youth facilities "solaris Workshop for Youth and Environment".

With other school competitions (local) or the Solaris CUP (national, and regional competitions), solaris FZU promotes the combination of curiosity, creativity, and spirit of discovery with STEM topics in children as described in question 2.

In the current millennium, these thoughts also evolved into numerous transnational projects that have connected **solaris** FZU to other European countries and even to the Gulf countries.

5. What connection do you see between STEM subjects and art? How can they be united and why is this important?

Scientific solutions are often by themselves useful, but sometimes they are not designed for everyday use or do not have an appealing appearance. One needs a "user-friendly" design.

The arts use creativity and imagination to encourage the development of essential STEM skills and enhance flexibility, adaptability, productivity, accountability, and innovation - all skills required for a successful career in any field.

Let's take the automobile as an example: the basic functional technology engine - power transmission to the axles - wheels for movement on the road is a masterpiece of the STEM disciplines, but numerous ergonomic elements are required to make this "raw technology" user friendly. This includes, for example, practical arrangement of controls on the fittings, understanding of warning lights and efficient arrangement of the required functional elements for optimal use of the available space.

Art, in particular the discipline of "design", is necessary to integrate the results of MINT activities into our everyday life in a practical way. Furthermore, to make them accessible to people with limited educational opportunities. A computer, for example, could technically be operated simply by entering the necessary commands in the form of ones and zeros. Only the design of a user interface (operating system) and input assistance (mouse, keyboard) provide the possibility of use for many people.

Incorporating art into STEM classes has benefits:

Our Top 5!

1. Art makes STEM subjects more exciting and attractive, even for kids who think they don't like science or math.
2. Hands-on projects and experiments that involve art improve a child's understanding of certain concepts.
3. Art teaches children how to find creative solutions to problems and the importance of spotting mistakes.
4. Art reduces the intimidation level of STEM - and helps raise enlightened children.
5. The "marriage" of arts and STEM promotes creativity, improves academic achievement, motor skills, improves visual learning and the overall learning experience.

In summary:

A close connection between art and STEM is key for the next few years as both stimulate and challenge creative thinking. Using art isn't about spending less time on STEM subjects, it's about using art to stimulate students' imaginations.

6. What motivated your organization to take part in the Erasmus+ project and what are the main benefits for your organization and the local society from participating in the project?

Chemnitz has successfully applied for the status of European Capital of Culture and will receive this status in 2025. As a former nationally recognized industrial location, it is the cradle of numerous inventions and famous Chemnitz natives in the fields of STEM disciplines. Chemnitz is still pursuing this claim to this day and only recently received approval for extensive federal funding in the field of hydrogen research.

Through own centers like "solaris Youth and Environmental Workshops", the "Chemnitz art factory" or the "Cosmonaut center Sigmund Jähn as part of the "Adventure Educational Center in Küchwald", **solaris** FZU has the optimal facilities to explore and to bring together two "worlds" STEM and ART. The main target group of **solaris** FZU are children, adolescents, and young adults, so we can always address and reach the next generation and arouse the appropriate curiosity for the disciplines to ensure they become the professionals of tomorrow.

solaris FZU focuses correspondingly own employees, educators, education officers, social workers, pedagogues, who not only pass on the knowledge, but also the passion and interest in ART and STEM. Their participation in EXPLORE+ project brings additional knowledge, skills, and competences, as well as supports them in the development of new ideas and enables the exchange of experiences and ideas at European level.

At this level, the many years of experience in international projects and the resulting contact networks also enable **solaris** FZU to share knowledge and methods beyond national borders and thus maximize the benefits across Europe.

The EXPLORE+ project is a special part of the Chemnitz Bid Book as European Capital of Culture 2025 and aims to promote local cooperation between school and cultural educators to develop and disseminate new interdisciplinary, multimedia, and creative learning methods and participatory approaches. These should include and can be applied practically in the areas of STEM education so that Chemnitz students have better access to and understanding of these important educational disciplines.

Participation in Erasmus+ projects offers excellent networking and cooperation with other former or future Capitals of Culture.

7. What do you think: how can schools and other organizations use the toolkit that we will develop during the Erasmus+ project? Why would you suggest you use it?

In the EXPLORE+ project, various European institutions (educational, children's and youth institutions, schools, museums and municipalities) from the four European countries Germany, Latvia, Portugal and România have decided to work together to found a "community" and build a microsystem, which supports all who want to participate in order to grow and innovate.

We look to this community, which develops new methods and approaches from experience, as role models for the next generation of scientists and experts.

150 learners and 80 specialists from school and cultural education are involved. The resulting toolkit thus draws on an extensive wealth of experience and a wide variety of perspectives when it comes to ideas for new things, with different perspectives being included - all in the interests of maximum possible learning success. How is the learning success achieved? Try it yourself, test it yourself, research it yourself and assign special significance to mistakes. The toolkit shows innovative elements and methods, but also shows how to learn from the mistakes and use them to support learning.

Scientific studies clearly show that people internalize content more when they have tried or experienced things themselves. The frontal teaching that is still typical in many educational institutions today, in which experiments are only described and calculated theoretically, can be optimized in its mode of operation so that the teaching content remains in the memory of the students longer.

Municipality of Timişoara

The City Hall is the local public administration structure, managed by the Mayor, which applies the Local Council's decisions. Its main tasks are to apply measures aimed to ensure the sustainable development of the city and the administration of the city's assets, technical infrastructure and public services.

Even if in România, the local administration does not have specific competences for the educational process, through numerous European projects addressed especially to young people, it has carried out a series of activities dedicated to the young generation.

Photo: Ovidiu Simonetti

Why it is important to teach and learn STEAM subjects

Most of these projects were carried out by combining theoretical and practical aspects in the learning stages.

STEAM is therefore all the more important as it allows combining theory with practice.

At the same time, possible problems can be identified through STEAM, answers to these problems can be sought, possible solutions can be tested, as well as solutions can be sought.

These identified solutions will be tested and put into practice through models and layouts, or experiments.

What is special on this organization according to the teaching and learning STEAM subjects

By supporting educational activities, the local administration contributes to a better understanding of aspects that are often more difficult for young students to understand, from fields such as: chemistry, mathematics, physics, material sciences,, computer programming and so on.

Photo: Ovidiu Simonetti

The professional experience on teaching and learning STEAM subjects

The experience gained in some projects allows the development of new activities, in courses, seminars, educational programs, laboratories, etc.

All these will contribute to the development of students, educators and teachers in the 21st century, as well as to the development of a society based on a new way of learning and experimenting.

How we see the linkage between STEM subjects and Arts

Aspects related to art can be incorporated into STEAM learning. In this case, learning tries to become closer to the student.

Photo: Ovidiu Simonetti

Motivation and expected benefits from participation in this Erasmus+ project

STEAM is an attractive method of learning and experimenting. Due to the combination of theory and practice, teachers have the opportunity to demonstrate the ideas of the course much more clearly, and students can understand much better the process, the way to solve a problem.

Opportunities for schools and other organizations, using this Toolkits

By creating dedicated materials, the learning process is supported within structures with an educational role. A better understanding of the process will contribute to the optimal transmission of knowledge.

Photo: Ovidiu Simonetti

CHAPTER III

TOOLKITS FOR STEAM TEACHING ACTIVITIES

Space Education Center (Cēsis municipality)

ACTIVITY 1 - LUNAR ROVER MODEL

The subject Engineering	**The grade** 4th – 9th (11 – 15 years old students)
The learning activity Creating Lunar rover	
Preparation time 30 min	**Lesson time** 30 min – 1 hr

Overview Students use an Engineering Design Process circle to model their Lunar Rover using paper layout and rubber that can scramble across the room. Then improve parts in the model based on testing results.

1. Build your own lunar rover;
2. Make the rover travel a distance of at least 1m;
3. Answer to yourself the question, did the rover follow the planned path? If it failed to travel the planned route, why?
4. Make improvements;
5. Tell how you did, what improvements you needed to make, why?

The outcomes for students

1. Students will practice a problem solving skill.
2. Students will be able to create their own lunar rover and improve it.

The resources

- Rover layout (Appendix 1);
- Rover assembly (Appendix 2 - 3);
- Scissors;
- Wooden chopsticks (3 pcs.);
- Glue pencil;
- Rubbers (4 pcs.);
- Office lime ("white gum")
- Ruler

TIPS FOR THE LEARNING ACTIVITY

1. **Tell students some of the ways rovers will be used on the Moon:**
   NASA plans to land astronauts on the moon by the year 2025. The astronauts will need moon cars—called rovers—to drive across the moon's surface, carry supplies, help build their outpost, and explore the area. Today you'll build and test a rubber band-powered rover.
2. **Show students your sample rover and tell them:**
   This is a prototype of a rover, just like the one you are going to build. Prototypes are used all the time in engineering. They give you a basic design to build, test, and evaluate. Once you understand a design's strengths and weaknesses, you can then find ways to improve it. Today, for example, as you test your rover prototype, you'll find ways to make it work better. Improving a design based on testing is called the engineering design process.
3. **When we build our model**, of course we want everything to come together right away. This time, more important than immediate success is the process of how we arrive at the result. "Why?" is a question that is important to ask! Why did what happened happen? If we find the answer to the question "Why?", we will be able to find solutions to prevent it. Each new solution will give us an opportunity to learn.
4. **Help students with any of the following issues:**

Example 1:

Challenge: The rover's wheels are "spinning" and it's not moving forward.
Question: Why do the wheels spin on the spot?
Answer: The wheels slide on the floor, they have no traction on the floor.

Question: How can we improve the grip on the floor?
Answer: Make the rover heavier, make wider wheels, put on bigger wheels, tape the wheels so the sticky side is out and the wheel sticks to the floor.

It is important to evaluate after each attempt. Did the improvement idea work? I put extra weight in the rover, but it still didn't go forward, maybe the weight was too little? Maybe this time it is not the most effective solution?

Example 2:

Challenge: The rover's wheels are "spinning" and it's not moving forward.
Question: Why do the wheels spin on the spot?
Answer: The wheels are spinning because they are spinning too fast.

Question: How can we reduce wheel spin?
Answer: With a longer rubber band, or several short rubber bands joined together, cut one round rubber band to make it longer.

Maybe the "engine" itself needs to be changed, instead of rubber we can use a "jet engine" - attach an inflated balloon to the rover, which when released pushes the rover forward. What can make a rover move?

Example 3:

Challenge: The rubber folds rover body.
Question: What is the reason for the body folding? How can this be prevented? Where does the hull need reinforcements? What could you make these reinforcements out of?

Answer: Print the worksheet on thicker paper, stick the worksheet on a cereal box, then cut it out of the box's cardboard, etc. options.

Discuss what happened - Have the students show each other their rovers and talk about how they solved any problems that came up. Emphasize the key ideas in the challenge by asking the questions in the discussion section below.

DISCUSSION

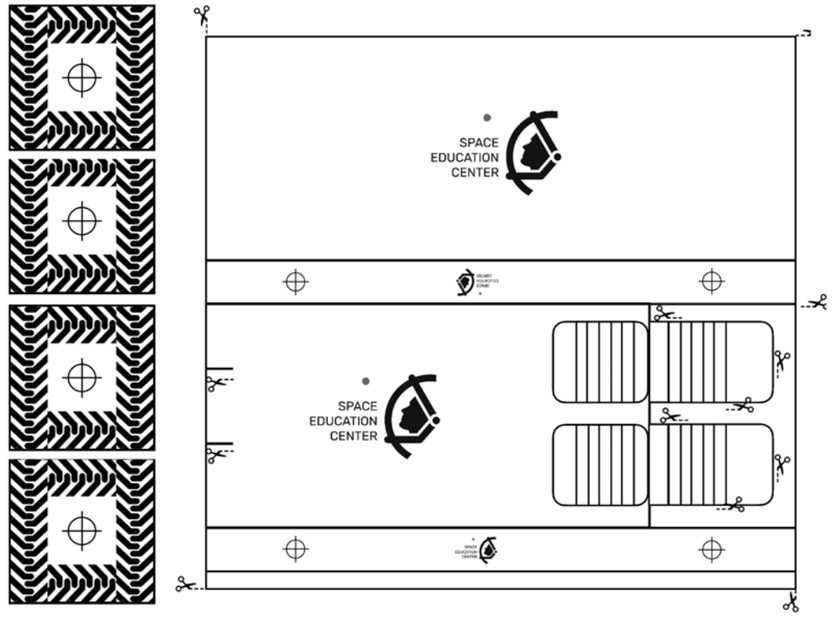
- To learn, it is important to look back, what was the challenge that had to be overcome? What did students do? How did it work? It is essential to encourage the thought process and experimentation.
- The challenge sheet gave you a rover prototype to get started with. How did starting with a prototype help you end up with a rover that worked really well?
- How did friction affect your rover?

USEFUL RESOURCES

Lunar Rover mission: https://www.youtube.com/watch?v=S9Y6n1G5hhc&ab_channel=NASA%27sAmesResearchCenter

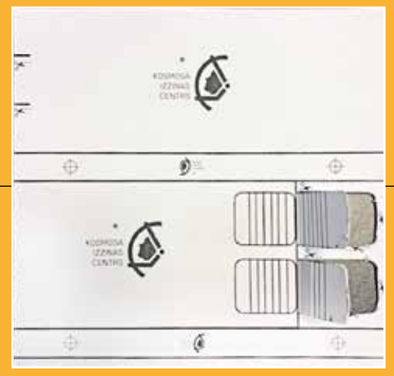
ROVER LAYOUT

Appendix - 1



ROVER ASSEMBLY INSTRUCTIONS

1. Prepare everything necessary for work:
- Rover layout (2-3 prints);
- Scissors;
- Wooden chopsticks (3 pcs.);
- Glue pencil;
- Rubbers (4 pcs.);
- Office lime ("white gum")
- Ruler



2. Follow the scissor symbols, cut out the rover layout

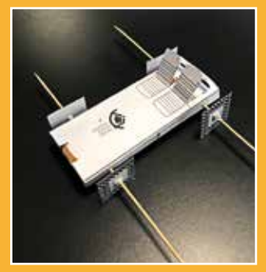
3. Fold the spread and pierce the wheel axles in the marked places

4. Firmly fasten the rubber on the rear axle using the covering knot, put the rubber on the cuts made in front.

*Type and number of rubber mounts may vary depending on available

5. Using stationery glue "white gum", create places for attaching the wheels to the axles.

6. Attach the wheels



7. Shorten the axles of the wheels

8. Rover is ready for the test!
Put on the rubber when turning the rear axle! How did it go? Did everything go as planned? Are there any improvements needed? If something didn't happen, ask yourself the question - why didn't it happen?

ACTIVITY 2
CREATING INFOGRAPHICS USING WWW.INFOGR.AM

The subject Science, Arts, Social studies	**The grade** 7th - 12th (13 - 19 years old students)
The learning activity Creating educational infographic using ICT platform www.infogr.am	
Preparation time 30 min	**Workshop time** 2 to 3 hours

Overview students are using the platform www.infogr.am to create educational infographics on different topics from the curriculum. During this activity students have to:

1. Analyse ready-made examples of infographics.
2. Get to know functional possibilities of the platform www.infogr.am
3. Choose the subject from the curriculum to explore more.
4. Create an infographic about the chosen topic using platform www.infogr.am

The outcomes for students

1. Students will know the content of the concrete topic from the curriculum..
2. Students will know what infographic is and what are the criteria for a good infographic.
3. Students will develop skills of information analysis, skills of structuring and visualising information.
4. Students will be able to create their own educational infographic using platform www.infogr.am

The resources Computers / Internet Access / Literature and information sources about the chosen topic

TIPS FOR THE LEARNING ACTIVITY

1. Try to find a question in your curriculum which is relevant to your students and includes an actual problem which students may explore more.
2. Start with analysing different examples of infographics together with students for them to better understand what infographic is and how it differs from other forms of information presentation.
3. Explore together with students all the technical options which are available in a free version of platform www.infogr.am before they start to create their own infographic. To do this you can use ready-made tutorials which can be found at www.youtube.com
4. Adjust the content criteria of the infographic in accordance with the requirements of the curriculum and learning outcomes students need to achieve in the topic.
5. Use a project-based learning approach where students are self-directing their own learning exploring the topic and then creating their own infographic.
6. If you don't have any access to ICT tools in your classroom, students can create their infographics in a paper format. See some examples from Latvian students here: https://drive.google.com/file/d/1Uvj1JzlDivghy__RN9krNordkf4c-UxR/view?usp=sharing

DISCUSSION

1. What is the difference between infographic and presentation?
2. Are infographics a good way to structure and present information?
3. What were the challenges for students creating infographics?
4. What students learned about the concrete topic creating infographics?
5. How can students use infographics to structure and present information?

USEFUL RESOURCES

What is an Infographic? Examples, Templates & Design Tips. https://venngage.com/blog/what-is-an-infographic/

Platform for creating infographics. www.infogr.am

Tutorial on www.youtube.com "How to use Infogr.am". https://www.youtube.com/watch?v=Wgg0My-rZnc

50+ Infographic Ideas, Examples & Templates. https://venngage.com/blog/infographic-ideas/

7 Essential Rules to Create Infographics. https://venngage.com/blog/7-essential-rules-create-infographics/

ACTIVITY 3
CREATING SOCIAL ISSUE ADS USING WWW.CANVA.COM

The subject Science, Arts, Social studies	**The grade** 7th - 12th grade (13 - 19 years old students)
The learning activity creating social issue ads using ICT platform www.canva.com	
Preparation time 30 min	**Workshop time** 2 to 3hr

Overview students are using the platform www.infogr.am to create educational infographics on different topics from the curriculum. During this activity students have to:

1. Analyse ready-made examples of social issue ads on different topics (issues).
2. Get to know functional possibilities of the platform www.canva.com
3. Choose the topic (issue) from the curriculum to explore more.
4. Create a social issue ad about the chosen topic (issue) using platform www.canva.com

The outcomes for students

1. Students will know the content of the concrete topic (issue) from the curriculum.
2. Students will know what the social issue ads are and how they can be used to attract the attention of society on different topics (issues).
3. Students will develop skills of information analysis, skills of structuring and visualising information.
4. Students will be able to create their own social issue ad using platform www.canva.com

The resources Computers / Internet Access / Literature and information sources about the chosen topic (issue)

TIPS FOR THE LEARNING ACTIVITY

1. Try to find a question in your curriculum which is relevant to your students and includes an actual problem students may explore more. It is important to find a problem (issue) which is relevant for the whole society or a concrete group of people.
2. Start with analysing different examples of social issue ads together with students to better understand what the criteria for a good social issue ad are.
3. Explore together with students all the technical options which are available in a free version of platform www.canva.com before they start to create their own social issue ad. To do this you can use ready-made tutorials which can be found at www.youtube.com
4. Adjust the content criteria of the social issue ad in accordance with the requirements of the curriculum and learning outcomes students need to achieve in the topic.
5. Use a project-based learning approach where students are self-directing their own learning exploring the topic and then creating their own social issue ad.
6. After the lessons students can present their social issue ads in the classroom and discuss the topics (issues) which have been explored during this activity.
7. If you don't have any access to ICT tools in your classroom, students can create their social issues ads in a paper format.

DISCUSSION

1. What is the difference between social issue ads and other types of advertisements?
2. Is advertising a good way to draw public attention to specific topics (issues)?
3. What were the challenges for students creating their social issue ads?
4. What students learned about the concrete topic (issue) creating social issue ads?

USEFUL RESOURCES

Platform for creating social issue ads. www.canva.com
Tutorial on www.youtube.com "How to use Canva". https://www.youtube.com/watch?v=zJSgUx5K6V0
Examples of social issue ads. https://www.boredpanda.com/powerful-social-advertisements/?utm_source=google&utm_medium=organic&utm_campaign=organic
Examples of social issue ads. https://digitalsynopsis.com/inspiration/60-public-service-announcements-social-issue-ads/
11 Simple Tips for Creating an Effective Ad. https://targetpublic.com/11-simple-tips-creating-effective-ad/

ACTIVITY 4
CREATING EDUCATIONAL SOCIAL MEDIA ACCOUNTS USING WWW.INSTAGRAM.COM

The subject Science, Arts, Social studies	**The grade** 8th - 12th grade (14 - 19 years old students)
The learning activity Creating educational social media accounts using www.instagram.com	
Preparation time 30 min	**Workshop time** 3 to 4hr

Overview Students are using the platform www.instagram.com to create educational social media accounts on different topics from the curriculum. During this activity students have to:

1. Analyse ready-made examples of social media accounts which are created on the platform www.instagram.com
2. Get to know functional possibilities of the social media platform www.instagram.com
3. Choose the subject from the curriculum to explore more.
4. Create a social media account about the chosen topic using social media platform www.instagram.com

The outcomes for students

1. Students will know the content of the concrete topic from the curriculum.
2. Students will know what social media are and what are the possibilities of using the platform www.instagram.com for educational purposes.
3. Students will develop skills of information analysis, skills of structuring and visualising information.
4. Students will be able to create their own educational social media account using platform www.instagram.com

The resources Computers / Internet Access / Literature and information sources about the chosen topic

TIPS FOR THE LEARNING ACTIVITY

1. Try to find a question in your curriculum which is relevant to your students and includes an actual problem which students may explore more.
2. Start with analysing different examples of social media accounts which are created on the platform www.instagram.com together with students to better understand what social media are and how they can be used for education purposes.
3. Explore together with students all the technical options which are available on a social media platform www.instagram.com before they start to create their own social media accounts on this platform. To do this you can use ready-made tutorials which can be found at www.youtube.com
4. Adjust the content criteria of the www.instagram.com social media account in accordance with the requirements of the curriculum and learning outcomes students need to achieve in the topic.
5. Use a project-based learning approach where students are self-directing their own learning exploring the topic and then creating their own social media accounts.
6. If you don't have any access to ICT tools in your classroom, students can create their www.instagram.com accounts in a paper format. See the simple example of the worksheet here: https://ej.uz/framework_instagram

DISCUSSION

1. What are social media and what are the differences between social media and traditional media?
2. How can social media be used for educational purposes?
3. What are the benefits and challenges for using social media platforms in education and everyday life?
4. What were the challenges for students creating social media accounts on the platform www.instagram.com?
5. What students learned about the concrete topic while creating social media accounts on the platform www.instagram.com?
6. How can students use social media platforms to educate others and represent themselves?

USEFUL RESOURCES

A beginner's guide to Instagram. https://www.businessinsider.com/guides/tech/what-is-instagram-how-to-use-guide
Tutorial on www.youtube.com "How to use www.instagram.com" https://www.youtube.com/watch?v=_wo5C9qh4xE
Tutorial on www.youtube.com "How to use www.instagram.com" https://www.youtube.com/watch?v=P1vtAZoMMuU
Platform for creating social media accounts www.instagram.com
Steps for Creating Educational Content on Instagram https://instamber.com/steps-for-creating-educational-content-on-instagram/

ACTIVITY 5
CREATING MY FIRST ROCKET MODEL

The subject Engineering	**The grade** 3rd - 7th grade (9 - 13 years old students)	**Students** 15
The learning activity Creating air powered rocket		
Preparation time 20 min		**Workshop time** 45 - 60 min

The outcomes for students

1. Students will learn data-driven decision making process
2. Students will practice problem solving skill

Overview Students build their own rocket. In building process they are discovering how to measure angle, how angle is affecting flight distance, how design is affecting flight characteristics.

1. Build your own rocket;
2. Predict the flight distance, make the test launch;
3. Compare prediction to actual results;
4. Make improvements for the rocket, make 2nd launch and analyse result;
5. Make 3rd launch with attempted landing in defined place;
6. Analyse results regards rocket design and launch angle;
7. Define how to use data-driven decision making process.

The resources

A4 size pepper 90g/m2 and heavier 120-180 g/m2
Scissors;
White masking tape;
Ruler;
Pencil;
Plastic pipes one for each student
Template for cone
Template for stabilisator fins

ACTIVITY

1. **Build your rocket (Appendix - 1)**
   Prepare all the resources for activity. It is advisable to prepare pipe for each kid you can get the pipe in home depot or any other DIY store look for diameter 19 - 25mm. The templates for cone and fin can be used one for pair.
   Follow the steps to create your own rocket! For smaller kids you can allow to colour the page before wrapping around the pipe for better drawing quality.
2. **Predicting the flight distance and making the first launch**
   Prepare the rocket launch field, depending on the launch method (squish bottle up to 25m, compressed air mechanism up to 75m). Place distance markers approximately 1m apart for squish bottle and around 5m apart for compressed air launch.
   Use Appendix-2 worksheet.
   Ask student to write in the angle the rocket will be launched (depends on launch system) and to predict where the rocket will land. After launch attempt draw the line, how the rocket flew (approximate trajectory).
   Teacher must ask a question was everything as expected? Does the prediction came true? It is important to encourage and say that this is process of learning. It is impossible to predict the landing site without data. And you just received the first data about your rocket. Now when you know how the rocket flew the first time what will you change to get the rocket to your expected landing place? Give the time for improvements. It is possible to analyse how the best flying rockets ware made? (weight, fin size, body tube length etc.)
3. **Invite to 2nd launch attempt**
   Write down the angle of the second launch and draw the trajectory of the second launch. Did the rocket landed where it was planned? What further changes need to be made? Always remember not to change a lot of variables, best practice is to change one variable at the time.
4. **Choice for teacher**
   By the time that has spent on the activity teacher needs to make decision, allow to make third attempt to reach the goal - planned landing site or to give the final task.
5. **Final task**
   Teacher is setting the goal, placing the object that is the target for example Moon. How you would need to adjust the launch angle to bring your rocket to the moon? By now students have two attempts with variable angle. Teacher is asking them to look at the data, how their chosen angle is impacting landing site?
6. **Last rocket launch attempt**
7. **Rocket launch debriefing**

DISCUSSION

The activity goal was to learn data-driven decision making process.
Teacher need to ask three questions:

1. What are the variables in our rocket launch?
2. What you need to take in account when changing variables?
3. How ware you using data in setting the launch angle for the last launch attempt?

Now we know that we used the experiments to gather data and to predict the landing site on previous attempts.
Are we using the same process elsewhere?

USEFUL RESOURCES

Link on how to make squish bottle launcher.

ROCKET ASSEMBLY INSTRUCTIONS

Tools and materials

A4 size papper 90g/m2 and heavier 120-180 g/m^2
Scissors;
White masking tape;
Ruler;
Pencil;
Plastic pipe
Template for cone
Template for fin

1. Take the desired weight paper and wrap it around the pipe		**2. Using masking tape fix the loose end of the paper to the paper sheet**	
3. Find the template for the fin, circle the template with the pencil and cut it out of the paper		**4. Create the cone from cut-out hemisphere, tape it together using masking tape** *If it is hard to understand how to create cone, draw the letters ABC in designated places, rotate the corners inward)	
5. Using the masking tape cover the end of the tube, fix the cone upon the covered end		**6. Find the template for the stabiliser fins, draw the desired count of them.** *What is the most effective placement on the sheet for drawing the fins?	
7. Bend the longest side of the fin as showed		**8. Using the masking tape glue on the stabiliser fins. When the work is finished remove your rocket off the tube**	
9. Rocket is ready for the test launch			

Predict the rocket landing place

Task 1

1. Write down the angle and the landing prediction for your rocket launch.

Launch angle	Landing prediction (distance)

2. Mark with X the actual landing spot for first launch attempt.

3. Draw the line how the rocket flew to the landing place.
4. Did rocket landed in planed landing spot? Circle the result.
   Yes / No
5. What will you change in the rocket to land it in the planned landing place? Rocket design, angle etc?

Task 2 Launch attempt 2

Launch angle	Landing prediction (distance)
	(the same that in first try)

Draw the line how the rocket flew to the landing place.

What is the angle to reach the greatest distance?

What is the angle to land closest to launch device?

What characteristics is the most important for best performing rocket?

ACTIVITY 6
BULLSEYE WITH PARACHUTE

The subject Engineering	**The grade** 6th - 9th grade (13 - 16 years old students)	**Students** 20
The learning activity Understanding how the parachute works and the science behind it		
Preparation time 10 min	**Lesson time** 40 - 50 min	

The outcomes for students

1. Students will learn data-driven decision making process;
2. Students will practice problem solving skill;
3. Discover importance of STEM subjects in engineering

Overview Students must build their own parachutes calculate actual descent speed, then adjust it to requirements:

1. Build your own parachute
2. Conduct drop test and calculate descent speed;
3. Calculate and plan changes in parachute design to accommodate requirements;
4. Test the improved parachute design
5. Answer the questions regards parachute design process

The resources

Fabric or polyethylene for parachute canopy
Rope/cord for parachute strings (1mm in diameter)
Scissors;
Tape;
Ruler;
Worksheet 1 for each pair of students
2m long measurement
Phone or Stopwatch
Figure or object to be attached to parachute

ACTIVITY

1. **Build your first parachute**
   The parachute has two main functions to slow down the descent speed and to deliver goods or persons at the desired place. Build your parachute using the given materials (see the instruction). Conduct the drop test. from 2m height.
   What was the descent speed? Did it landed at the desired place? If not What we can do to improve it?
   *Fact: safe landing speed is considered 5m/s. If the speed is faster, we have trauma possibility, if speed is slower possibility to drift away from desired landing spot is raising. Acceptable landing position is within 50cm diameter of marked cross. (Appendix 1)
2. **Adapt the parachute design**
   You calculated the descent speed most likely was way slower then considered safe landing speed and parachute drifted away from landing spot. How you can increase the descend speed? What can you do to control drifting?
   *To increase descend speed we need to decrease the parachute area. You can remove the suspension lines and cut the parachute smaller. Descent speed will decrease but did it solved the problem with drifting? Air beneath the parachute canopy is creating drag. The trapped air needs to escape and it is escaping threw one side of the parachute, the opposite side of the direction parachute is flying. To control the descent direction you can make spill hole on top of the canopy. It will stabilise the descent.
   Now you need to find the right ratio between the parachute area and spill hole size to land the parachute in desired place.
   *It is possible that it will seam that 5m/s is to fast for descent. You can let students to test it let them jump from hight of 1m (approximately hight of table) calculate the speed. approximately 2m/s. (Appendix 2).
3. **Choice for teacher**
   By the students age and grade teacher can chose how deep students will go.
   Options: Landing speed and spot;
   Parachute area in cm2. Total area minus spill hole area.
   Calculate drag coefficient for your created parachute
4. **Debriefing**
   Engineering and parachuting can be fun activities, can you name the subjects from curriculum that you used to create the parachute?.

DISCUSSION

The activity shows importance of STEM subjects in fun and sport activities. In the activity students used data-driven decision making process. (changing the parachute parameters to reach desired goal) Depending by the grade students used knowledge from mathematics, geometry, physics, engineering etc.

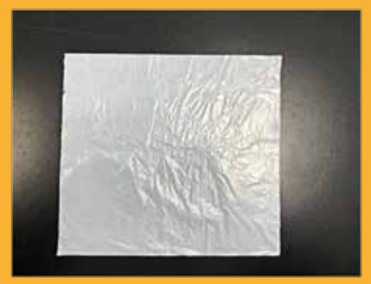
1. Teacher need to ask questions:
1. What are the variables to be changed for safe and precise landing?
1. What curriculum subjects did you use in this activity?

INSTRUCTION TO CREATE PARACHUTE

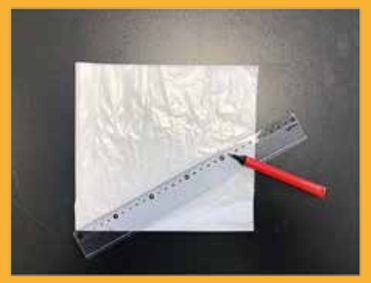
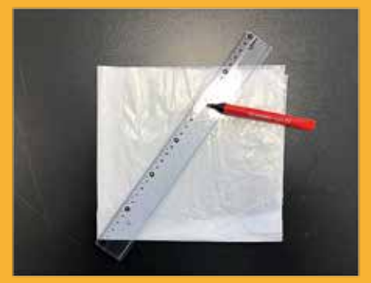
Tools and materials

Fabric or polyethylene
for parachute canopy
Rope/cord for parachute strings
(1mm in diameter)
Scissors;
Tape;
Ruler;
Worksheet 1 for each pair
of students;
2m long measurement;
Phone or Stopwatch;
Figure or object to be
attached to parachute.

1. Cut out square from available material, then fold the square two times in half

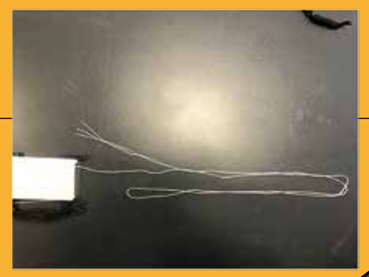


2. Chose middle corner as center for circle. Mark radius with ruler and marker. Place as much points as you need to form a line

3.Connect all the points forming a quarter of the circle


4. Cut the material



5. Prepare at least four suspension lines.
Advisable to chose line count that divides by 4
(4, 8, 16. etc. for easyer placement in step 10.)

6. Tie the knot to form a loop

7. Cut the lines in the same length

8.At the end of the each line tie a overhand knot

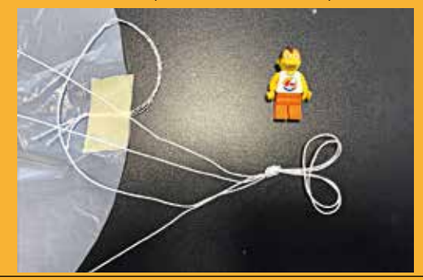
9. Tape the line to the side of the circle

10. Tape the second line on the opposite side

11. Tape all lines

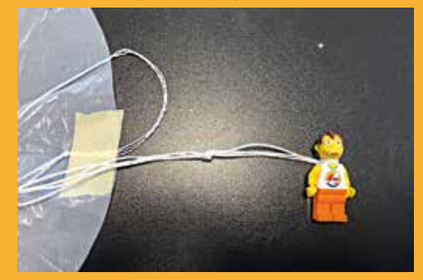
12. Prepare the figure

13. Bend the loop to form double loop



14. Fold the loops together

15. Put the loop on the object



16. Mark the cross 10x10 cm on the ground

Your parachute is ready for drop test!

CREATE YOUR OWN PARACHUTE

1. Follow the instructions to make your parachute;
2. Using tape measure mark 2m over your marking X on the ground (the hight for action figure to be dropped is 2m. The parachute will be higher then 2m);
3. Make drop test ! Did the parachute landed in desired place? Circle answer

Yes / No

4. Use the formula $speed = \frac{distance}{time}$ to calculate parachute descent speed;

My parachute descent speed was _____

5. Make improvements for your parachute to reach desired speed and landing place

Attempt	Distance 2m	Time in seconds	Speed - meters per second	Landing in desired point X
1.	2m			Yes / No
2.	2m			Yes / No
3.	2m			Yes / No
4.	2m			Yes / No

*What is safe landing speed? Find out your descent speed when you jump from height of chair 0,5m or table 1m.

Escola Secundária Pinheiro e Rosa

ACTIVITY 1
LET'S PROTECT OUR PLANET! LET'S PROTECT LIFE!

The learning activity Let´s protect our planet! Let´s protect life!	
Real life questions 1. Do all air pollutants have an impact on our planet´s climate and thus, in our life quality?	2. What is the 2050 European Green Deal?

A brief description of the learning activity

"Climate change is the single greatest threat to a sustainable future but, at the same time, addressing the climate challenge presents a golden opportunity to promote prosperity, security and a brighter future for all."

Ban Ki-Moon, former Secretary General, United Nations

Nature provides the basis for the good health and well-being of world population. Clean air, water and food are essential for sustaining life; natural environments provide space for recreation, relaxation and social interaction; and raw materials feed into our production systems to provide the comforts of contemporary life. At the same time, environmental pollution is unavoidable. We are exposed to pollution in our homes, in our workplaces, in the outdoor environment and when we eat, play, sleep, drive, walk, swim or run (EEA Report N.º 21/2019).

According to Copernicus, the European Union's Earth observation programme, the last seven years were the warmest on record, with 2021 being the fifth to seventh warmest, and only a few regions were more than 2°C above average, including north-eastern Canada and parts of Greenland. Also show us that the atmospheric concentrations of carbon dioxide CO2 (about 2.4 ppm/year or 0.6%/year) and methane CH4 (about 9 ppb/year or 0.5%/year) continue to increase since 2010.

A lot of NGO promoting ecology at local level revealed this problem but not all the people understand the risks. Some laboratories measured the air quality and the data collected revealed that in the air are liberated a lot of types of gases and not only CO2 and CH4. All those gases that are emitted in the atmosphere are responsible for enhancing the greenhouse effect and, affect our health in the long-term as the studies made by competent medical and healthcare institutes demonstrate. The COVID-19 pandemic provides a stark example of the inextricable links between human health and ecosystem health.

Besides that, in many counties with significant industrial activity and with a significant population, are facing a dramatic deforestation due to exploitation of space and the construction of houses and factories. The living standards have increased but also the number of cars and daily consumption of the resources.

We are living in a very friendly planet which looks like paradise. We all know that in our solar system there are some planets and satellites situated almost at the same distance from the sun but on which life is impossible because of the climate conditions determined by their atmosphere and the greenhouse effect. In this STE(A)M integrated learning scenario we will bring greenhouse effect and climate change in the classroom using IBSE (Inquiry Based Science Education).

Outcomes for teachers Learn how to design educational activities that facilitate deep learning to enhance 21st century skills such as critical thinking, collaboration, communication, creativity and divergent thinking, among others.

Aims of the lesson

1. To promote a critical attitude towards environmental impacts and to understand that the alteration of the natural Greenhouse Effect mainly originates from pollution from anthropogenic activities that generate pollutants that increase the concentration of greenhouse gases in the Earth's atmosphere.
2. To promote students' motivation and creativity in learning science and art subjects
3. To implement Inquiry Based Science Education and Project Based Learning approach in teaching and science and art subjects

Outcomes for students

1. Get acquainted with some topics such as: types of radiation, atmosphere, chemical composition of Earth atmosphere, greenhouse effect, greenhouse effect gases, photosynthesis, global warming.
2. Examine the influence of greenhouse effect gases on air temperature; examine the influence of rising temperature, of greenhouse effect gases, of desertification and of the amount of light on plants' growing.
3. Measure the temperature with thermometers, calculate the variation of temperature in different situations.
4. Learn how to process data from a virtual experiment /real experiment.
5. Develop social competences in the prevention of pollution, becoming proactive citizens
6. Express social competences through arts and literature.
7. Understand that "Climate change is the single greatest threat to a sustainable future but, at the same time, addressing the climate challenge presents a golden opportunity to promote prosperity, security and a brighter future for all."

TIPS BEFORE THE LEARNING ACTIVITY

1. Try to find a publication in a newspaper or magazine about a regional/national pollution situation

Or

2. Promote a movie session where students see one of the following films:
   "Before the flood", a documentary presented by National Geographic or the popular satire-comedy movie "Don't look up".
3. Ask students to brain storm the main ideas from the movie
4. Ask students to make some group research about these topics
   Climate change:
   What is a planet atmosphere and why is so important the composition of a planet atmosphere?
   What is the composition of Earth atmosphere?
   How it works the atmosphere on Earth and how it affects the weather conditions?
   What is greenhouse effect?
   Is it useful the greenhouse effect on Earth?
   Which are greenhouse effect gases and how they are produced during the ages and nowadays?
   What effects could have a higher concentration of greenhouse effect gases on plants, animals and human beings?
   What can we do for prevent the climate change?
   Pollution:
   The pollution in our town and in the county will conduct to an increasement of greenhouse effect gases. What will be the con sequences and what do we have to do?
5. Create infographics with the main results of the research
6. Communicate the results to the main group

USEFUL RESOURCES

Online white board www.miro.com
Platform for creating infographics www.infogr.am
Copernicus, European eyes on Earth https://bit.ly/3RRmlsQ
https://phet.colorado.edu/en/simulations/greenhouse-effect/about

LESSON PLAN

The subject(s) Biology, Physics and Chemistry, Geography	**The grade** 10th grade (15 years old students)

Topic

Reflection on the causes of climate change, protection of biodiversity and protection of the territory and landscape.
Composition of the terrestrial troposphere, identifying the polluting gases and their sources, namely the gases that cause green-house effects and alternatives to reduce the sources of pollution, communicating the conclusions.
Sustainability entails associated with intergenerational responsibility and citizenship.

Resources

Documentary "Before the flood" presented by National Geographic or the popular satire-comedy movie "Don't look up".

Preparation time 2 hours

Lesson time 6 hours

Lesson 1 - Physics (2 hours)

Students will start exploring the online simulator https://phet.colorado.edu/en/simulations/greenhouse-effect/about They will be asked to formulate a hypothesis about the causes (the planet atmosphere, the composition of atmosphere, the presence of the greenhouse effect gases in planet's atmosphere etc). After that, they will investigate this hypothesis using a simulation - *building a greenhouse**.

They will simulate:

a) a greenhouse and the role of glass layers in increasing the temperature inside
b) the greenhouse effect on different ages of the Earth (ice age, before industrialization and today) and they will observe that the increasing of temperature on Earth is due to it
c) the interaction of light and infrared radiation emitted by Earth land with almost all types of molecules existing in Earth atmosphere

They will understand how are working the greenhouse effect gases on a planet atmosphere and how they interact with light and infrared radiations.

They will understand that greenhouse effect had a positive role during the ages (heating the atmosphere and creating the proper conditions for life).

Lesson 2 - Chemistry (2 hours)

Students will explore https://www.edumedia-sciences.com/en/media/378-atmosphere about how did the atmosphere form and its chemical composition.

The students will understand that:

without atmosphere did not appear the greenhouse effect
without the greenhouse effect the earth would not have warmed enough
without the atmosphere and the heat there would have been no life, as we know it today.
the atmosphere is indispensable
the greenhouse effect is not harmful, on the contrary

After that a greenhouse will be built and some simple experiments will be conducted in order to produce greenhouse effect gases and observe the heating effect they are producing. Measuring the temperature in an environmental space in which there are produced greenhouse effect gases, more than the atmospheric air can handle, they will understand that human activity pollutes the environment, with major effects on climate changes.

THE GREENHOUSE

Part 1

Each group (3-4 students) needs:

6 acrylic or Plexiglas squares, approximately 25 to 30 cm/ per side (or you could provide the pieces previously cut)
hot glue gun and glue sticks (Attention: no not attach the roof!)
soil and plant – wheat and corn (the plant is used for the Biology class experiment, only)
thermometer
clear, wide strapping tape
Greenhouse Design & Testing Worksheet (optional) structural frame made of wood, metal or plastic
For the entire class to share: saws, to cut acrylic or Plexiglas (be carefull!!)

Ask/direct students to:

Make a sketch and build their model greenhouses.
Fill the bottom of the greenhouse with soil and a plant
Insert a thermometer inside and try to maintain the structure sealed using tape for one of the roof pieces (to allow access inside)
List and register on the sketch the different types of heat transfer that occur within and around the structure.

Part 2

Recording inside and outside temperature (make these measurements on a sunny day!)

Determine the ambient (initial) temperature of the outdoor air. Place the greenhouse under direct sunlight with the thermometer inside. At each specified time interval, take a temperature reading inside the greenhouse. Also keep a record of the ambient outdoor temperature at the same time intervals.

Make a chart with the results and a graph. Make a comparison between the results of different groups.
Discuss results and make an oral communication

Part 3

(Experiments to produce greenhouse effect gases- water vapor and carbon dioxide) Do it on a sunny day!

A – randomly, chose the first half of the total number of model greenhouses made by the students

Put a Berzelius beaker with a lid inside the greenhouses
Use the thermometer to measure the inside temperature
Repeat the experiment but using a Berzelius beaker without lid
Use the same water quantity – 75ml (the water will evaporate and produce water vapor)

B – now you are going to make the experiments with the other half

Use a graduated cylinder to put 75 ml of water in one Berzelius beaker (100ml or 150ml) inside the greenhouse
Do the same procedure but using a spatula add sodium bicarbonate and vinegar (which will be used to produce carbon dioxide)
Measure initial temperature and then measure it every 5 minutes, for 1 hour. Collect data (chart and graph)

Data interpretation:

Outside air temperature in open space: Initial temperature ….
Final temperature .....
Air temperature in a closed space: Initial temperature…..
Final temperature .....
Air and water vapors temperature inside the greenhouse (Berzelius beaker with water):
Initial temperature ….. Final temperature .....
Air and CO2 temperature in a closed space/greenhouse:

The student will compare the results with the hypothesis they formulated in the conceptualization phase answering the question: **What do you think it will be the consequences of increasing the amounts of greenhouse effect gases due to industrial development, related to the values of air temperature, to the soil humidity, etc?** using Concept-Mapper Application https://www.golabz.eu/app/concept-mapper

Lesson 3 - Biology (2 hours)

Students will repeat some information about photosynthesis (definition, the explanation of this process), how, under sun radiation, water and carbon dioxide are transformed into glucose, with release of oxygen into the atmosphere. The plants are seen as 'oxygen factories', but can they grow in any climate conditions?

In this lesson we will investigate how the amount of light, the rising of carbon dioxide amount, the rising of temperature and the decreasing of soil humidity, due to greenhouse effect, are influencing the plants growing. We will use two types of plants.

The students will conclude that most of the plants (cereals, vegetables, fruit trees) which represent the basis for food for humans and animals are dramatically influenced by these factors. After that they will discuss about what humans can do in order to prevent pollution and global warming.

Part 1

In this lesson the students will repeat some information about photosynthesis (definition, the explanation of this process), how, under sun radiation, water and carbon dioxide are transformed into glucose, with release of oxygen into the atmosphere. Yes, the plants are seen as 'oxygen factories', but can they grow in any climate conditions?
In this lesson we will investigate how the rising of carbon dioxide amount, the rising of temperature and the increasing of soil humidity, due to greenhouse effect, are influencing the plants growing (wheat and corn)

Part 2

Its purpose is to check how the growing of plants is influenced by:
The increase of soil humidity; the rise of carbon dioxide concentration and temperature; the amount of light.
We will follow the growing, in controlled conditions, of the wheat (prefers temperate climate, with reduced temperatures, mild humidity and light) and corn (prefers a warm and sunny climate).
In each greenhouse, use cards to identify in which you will study the growth of plants according to variations in H2O, CO2, temperature and light
You will need a ruler for measure the height of the plants.
The experiment will last for 7 days.

In half the number of greenhouses, plant 2 seeds of wheat, and in the other half, plant 2 seeds of corn. After that, water the soil using a spray (repeat this procedure every day). The greenhouses should be kept near a window (not in full light of the sun) and in few days, the plants will sprout.
After the plants sprout, separate the greenhouses, keeping one close to the window and other, far.
Use the thermometer to measure the temperature.
Cover one of the greenhouses with a black plastic bag.
During all experiment, read the temperatures and measure the height of the plants (under the different conditions)
This experiment should be repeated using the activities of the Chemistry lesson.

Conclusion

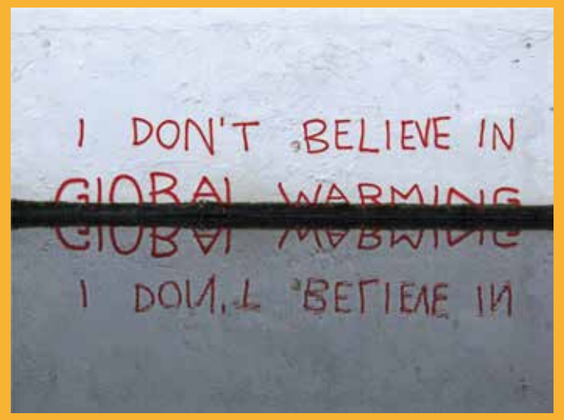
Each group will compare the hypothesis formulated in the conceptualization phase with the results of the experiment.
They will answer how each factor influences plants growing and they will observe that different kind of plants react in the same way at climate changes.
After that, each group will communicate the results of the experiment to all the students.

Evaluation

Discussion Compare the temperature condition inside the greenhouse and the ambient temperature of the air?
What do you think it will happen if the climate evolves so that the plants we used to feed will not adapt to these new conditions of life?
What do you think we should do to reduce the effects of the people activities to the environment? What we can do, each of us, at home or in school?
How can we contribute to the 2050 European Green Deal?

Lesson 4 – **Empowering the A on STEAM**

Ask students to create e.g., drawing, painting, illustrating climate change impacts or recommendations for sustainable lifestyles, and reinforce that instead of a passive approach, arts encourage us to engage and take action. Therefore, visual arts play a key role in understanding climate change in-depth and creating a climate-friendly world.



See A(r)tivism Activity

ACTIVITY 2 A(R)TIVISM - THE ART OF THE WASTE

The learning activity A(r)tivism, the art of waste	
Real life questions 1. Do all pollutants have an impact on our planet´s climate and thus, in our life quality?	2. What is the 2050 European Green Deal?

A brief description of the learning activity The relationship between human beings and nature has been predatory and destructive for centuries. Waste is considered one of the biggest environmental problems of our society: population and per capita consumption are growing and, along with them, the amount of waste produced. Art has a provocative potential and many artists use it as a tool for activism. Among the existing currents, environmental activism stands out. With contemporary art, artistic production has reinvented its boundaries and started to move into new territories, making new approaches and new concepts possible. The artists I will present below, use waste as raw material for the creation of artistic objects, whether in a plastic or musical approach. In addition to the aesthetic and artistic nature associated with their work, there is also a message of environmental awareness and WARNING against unbridled consumerism.

Outcomes for teachers Learn how to design educational activities that facilitate deep learning to enhance 21st century skills such as critical thinking, collaboration, communication, creativity and divergent thinking, among others.

Aims of the lesson

1. To promote a critical attitude towards environmental impacts and to understand that the alteration of the natural Greenhouse Effect mainly originates from pollution from anthropogenic activities that generate pollutants that increase the concentration of greenhouse gases in the Earth's atmosphere.
2. To promote students' motivation and creativity in learning science and art subjects
3. To implement Inquiry Based Science Education and Project Based Learning approach in teaching and science and art subjects
4. Develop environmental awareness;
5. Reflect on the art - environment relationship;
6. Share different artistic universes;
7. Develop skills in the field of expression and communication;
8. Develop critical spirit;
9. Encourage artistic creation;
10. Contribute to another look at the world and materials;
11. Contribute to the aesthetic and artistic training of students.

Outcomes for students

1. Develop social competences in the prevention of pollution, becoming proactive citizens
2. Express social competences through arts and literature.
3. Understand that "Climate change is the single greatest threat to a sustainable future but, at the same time, addressing the climate challenge presents a golden opportunity to promote prosperity, security and a brighter future for all."

TIPS BEFORE THE LEARNING ACTIVITY Ask students to make some research about these artists:

The Art of Waste by Bordalo II. Artur Bordalo, better known by his artistic nickname Bordalo II or Bordalo Segundo, born in Lisbon in 1987, is a Portuguese graffiti artist and painter. He is the grandson of the also painter Artur Real Chaves Bordalo da Silva, known as Bordalo. His art is based on the use of urban waste, guided by the motto "one man's bin be another man's treasure". Taking graffiti as a starting point, using spray paint, he uses abandoned objects, waste and refuse from construction sites, ruins of buildings, cars and factories, among others, mixing them to create a new artistic object. In this way, he intends to denounce an "extremely consumerist, materialist and avaricious" society and to promote "sustainability, ecological and social awareness". As a consequence, his graffiti is three-dimensional, often going beyond the limits of the plane, becoming bas-reliefs and high-reliefs.

Extraordinary waste by Vik Muniz At the gigantic open-air dump, Muniz meets the catadores, workers who sort through the tonnes of rubbish dumped there every day to separate what can be recycled. There are close to five thousand men and women who work hard and receive a very low salary with which they struggle to survive. They will be the protagonists of Muniz's new work and with this they will gain a strength and dignity that shows that art has a transformative power.

Erika Iris Erika Iris Simmons is an American artist who uses old music and movie tapes to create her artworks. Quoting the artist " I like to take ordinary things like what you would find in a garage or a junk shop and make artistic compositions out of them". To do this she does not add any kind of paint or pigment to the work, but simply cuts or puts the pieces together as appropriate.

Francisco de Pajaro With a lot of creativity and an unmistakable touch of humour, Pájaro brings rubbish to life and reflects on society's consumerist attitude. As a way of getting around the prohibition of creating works in public facilities, he uses all kinds of materials discarded by the residents themselves, such as paint, rubbish bags, cardboard and even furniture.

Alejandro Durán uses art to highlight the ongoing destruction of our marine ecosystems. In this breathtaking talk, he shows how he meticulously organises and reuses plastic waste from various parts of the world that ends up on the Caribbean coast of Mexico - everything from water bottles to prosthetic legs - to create living, eco-friendly works of art that may leave you perplexed.

USEFUL RESOURCES

1. https://www.youtube.com/watch?v=N3hHnUeBeOY
2. https://www.youtube.com/watch?v=HUCXzbRBcuY
3. https://www.youtube.com/watch?v=oyN7w2pwgSI
4. https://www.artistrash.es
5. https://www.ted.com/talks/alejandro_duran_how_i_use_art_to_tackle_plastic_pollution_in_our_oceans?language=pt#t-385949

ACTIVITY 3
NAVIGATE YOUR CITY

The learning activity Navigate your city

Real life questions

1. What kind of economic activities do we find in the Central Business District (CBD)?
2. How is the city organized in the CBD: vertically and horizontally?
3. Did the urban space have the same type of occupation?

The brief description of the learning activity The evolution of the society gave the mobile phone an importance that goes behind the typical communication between people, it becomes imperative to use this media to promote/ increase new activities that are motivating and challenging for students.

In this context emerges a new educational paradigm – the Mobile Learning – which associate principles such as flexibility, adaptability and ubiquity that allow students to experience learning environments that go beyond the traditional classroom walls.
With this activity teachers can explore Geospatial Science to analyze the human and the physical variables that influence the evolution of the urban areas. This activity suggests that students will have a contextual learning provided by using the App Wikiloc.
Wikiloc is an outdoor navigation App that lets the user track his hiking, cycling and more activities with GPS.
This activity can contribute to an alternative way of learning, showing that the urban games are not simply an outdoor activity with mobile technologies, we are allowing students to interact and explore culturally, socially and historically a certain location.

Outcomes for teachers

Learn how to design educational activities that engage the 21st century skills and the core curriculum learning such as critical thinking, collaboration, communication, creativity and divergent thinking, among others.

Aims of the lesson

1. Distinguish the different types of economic activities in the CBD.
2. Visualize the vertically and horizontally organization of the buildings in the CBD.
3. Distinguish the different types of occupation of the CBD (city).
4. Teaching students how to use navigation outdoor apps (geospatial technologies).
5. To promote students' motivation and creativity in learning geography and economics subjects.
6. To implement Mobile Learning (geospatial thinking) and Project Based Learning approach in teaching geography and economics subjects.

Outcomes for students

- Analyze patterns of spatial distribution of different functional areas, highlighting the heterogeneities in the cities as a result of recent urban expansion.
- Apply Geographic Information Technologies to analyze changes in urban expansion processes.
- Analyze the Portuguese economic reality, comparing the main indicators of the Portuguese economy with those of the EU and equating problems and challenges that may be faced by the Portuguese economy in the near future.

TIPS BEFORE THE LEARNING ACTIVITY

1. The Teacher has to select the streets that the students should study
2. The Teacher should divide the class in groups of 2 or 3 students, then distribute to each one a street.
3. The students have to install the App Wikiloc in the link: https://www.wikiloc.com/
4. Open the App and in the outdoor area of the school experiment the App.

USEFUL RESOURCES

How do I download a trail from wikiloc? https://www.youtube.com/watch?v=141XTbh0bYk

How do I find trails on wikiloc? https://www.youtube.com/watch?v=biMP4_kTpi8

LESSON PLAN

The subject Geography and Economics	**The grade** 11th grade (16 years old students)
Preparation time 1 hr	**Lesson time** 4 hrs

Topic

- What kind of economic activities do we find in the Central Business District (CBD)?
- How is the city organized in the CBD: vertically and horizontally?
- Did the urban space have the same type of occupation?

Resources

- Mobile Phone with internet and camera
- Computer and Projector

Part 1 - Field Trip

When the group arrives at the beginning of the street to be studied, they must open the Wikiloc APP and click on "record trail". You must have the GPS turned on during the journey.
Along the way you should take pictures, pausing the recording at stops. Use the stops to take pictures: for example the street; photos with different orientations, integrating the various existing economic functions (shops, restaurants, hotels, ...)
Make a brief caption of the photos taken, for future memory.
Walk the trail using all 5 senses. Capture images and/or short videos of what catches your eye.
The group must give the following name to the trail [Street X_name of the school].
This aspect is very important so that the tracks can be easily found in the application.

Part 2 - Classroom

In the classroom, the students will use a computer with the internet to view and edit the track recorded. they have to go https://pt.wikiloc.com/ and log in with the user they created on their smartphone.
After entering, they have to look for "Your tracks" in the upper right corner and edit their trail:
If they doesn´t enter the desired name, they have to correct the name to the requested format.
Then they have to write information about the track/street in the description space: type of economic activities found, type of occupation, type of vertical and horizontal zoning.
They also can edit the caption of each of the photos and put relevant information related to what was photographed. Example: history of a photographed element; information on economic activity, (...). In the caption they can put text but also put links to "learn more".
Record the complete track and share with classmates.

Conclusion

Each group will present their track to the class and express their conclusions in order to respond to the following questions:
What kind of economic activities do they find in their street?
How is the street organized vertically and horizontally?
Did the urban space have the same type of occupation?
After that, each group can ask questions.
At the end of the class presentation the teacher and the students debate in order to conclude how the CBD is organized geographically and economically.

Evaluation

Focusing on this context and with the aim of contributing to the creation of new educational opportunities, the pedagogical activity carried out falls within the so-called Mobile Location-based Games, possibility of deconstructing the traditional habits of student assessment by the teacher. By answering and recording the answers to the various tasks proposed, the teacher had the necessary data to assess the knowledge and classify the students. This activity allowed students to mobilize and consolidate the acquired knowledge in an autonomous and spontaneous way.0

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ACTIVITY 1 - BIOLOGY

The learning activity Presentation of components of the secondary school curriculum, in the discipline of Biology, through the use of Augmented Reality as a technique of representation and artistic presentation of certain scientific contents.

The brief description of the learning activity Augmented Reality (AR) is a technology that allows us to superimpose virtual elements on our vision of reality. As a resource that arouses the curiosity and interest of children and adolescents, in addition to being relatively accessible (any tablet or smartphone with a camera is capable of reading the AR markers), augmented reality has become a tool powerful in the classroom. With it, the teacher can work on proposals that aim to make the content of the printed book closer to the reality of the students.
In this case, an example situation was produced, for a subject, through which teachers and students could be made aware of their pedagogical interest, while also associated with capturing their interest in the use of artistic creation techniques, facilitating his interest in the arts, and in particular digital art.

Outcomes for teachers

Imagine having illustrations that come to life and "jump out" of the printed book to bring the information to your students; allowing access from the didactic material to videos, animations and contextualized activities for each moment of learning. With augmented reality, these situations are increasingly facilitated and used within schools, which is why this example is another contribution to the use of these artistic techniques.

To be effective, this interaction needs, of course, the guidance of an Augmented Reality technician. Technology alone is not capable of capturing the student's interest and contributing to overcome the barriers to its use for the learning of school subjects. In this dynamic, the role of the mediator is fundamental, from the planning of activities to their transposition into classroom practice.

When well planned and used in a relevant and contextualized way, Augmented Reality can bring several benefits to pedagogical practice. We list some of them below.

1. Attracts attention and delights students.
2. It generates more interest and motivation in studies.
3. Uses a language very close to the students of the new generations.
4. Enables interaction between printed material and digital media.
5. Stimulates communication and the exchange of experiences in the classroom.

Outcomes for students

1. They will be more motivated by the selected subjects.
2. Classes will also be directed to your interests and already vast knowledge in the scope of new technologies.
3. They will be part of the teaching process, participating in its construction.

TIPS BEFORE THE LEARNING ACTIVITY

USEFUL RESOURCES

What is Augmented Reality? https://pt.wikipedia.org/wiki/Realidade_aumentada

Difference between Augmented Reality and Virtual Reality
https://tecnoblog.net/responde/qual-a-diferenca-entre-realidade-virtual-e-realidade-aumentada/

EXAMPLE OF PERSONAL EXPERIENCE

The subject Biology	**The grade** 11th grade (16 years old students)
The topic Photosynthesis	
The resources Computer or tablet	**Lesson time** Two 90 minutes classes

The knowledge outcomes for students

1. Students will know what Augmented Reality is and how it can be used for learning in a fun way
1. Students will be able to know better the process of photosynthesis on a molecular scale

The skills' outcomes for students

1. Students will develop skills of information analysis, skills of structuring and visualising information
1. Students will be able to create their own augmented reality experience, with the help of an augmented reality specialists.

Criteria for the learning task for students

1. Based on an example video of the photosynthesis process, break it down into 3 distinct sequences
2. Create text content to serve as textual support
3. Review texts
4. Integrate 3D animation sequences based on the sequences chosen in the application

Technical criteria

1. The information used in the augmented reality app is scientifically sound and accurate
2. The information used in the augmented reality app is structured and easy to understand

ACTIVITY 2
GEOGRAPHY

The learning activity Presentation of components of the secondary school curriculum, in the discipline of Geography, through the use of Augmented Reality as a technique of representation and artistic presentation of certain scientific contents.

The brief description of the learning activity Augmented Reality (AR) is a technology that allows us to superimpose virtual elements on our vision of reality.
As a resource that arouses the curiosity and interest of children and adolescents, in addition to being relatively accessible (any tablet or smartphone with a camera is capable of reading the AR markers), augmented reality has become a tool powerful in the classroom. With it, the teacher can work on proposals that aim to make the content of the printed book closer to the reality of the students.
In this case, an example situation was produced, for a subject, through which teachers and students could be made aware of their pedagogical interest, while also associated with capturing their interest in the use of artistic creation techniques, facilitating his interest in the arts, and in particular digital art.

Outcomes for teachers

Imagine having illustrations that come to life and "jump out" of the printed book to bring the information to your students; allowing access from the didactic material to videos, animations and contextualized activities for each moment of learning. With augmented reality, these situations are increasingly facilitated and used within schools, which is why this example is another contribution to the use of these artistic techniques.

To be effective, this interaction needs, of course, the guidance of an Augmented Reality technician. Technology alone is not capable of capturing the student's interest and contributing to overcome the barriers to its use for the learning of school subjects. In this dynamic, the role of the mediator is fundamental, from the planning of activities to their transposition into classroom practice.

When well planned and used in a relevant and contextualized way, Augmented Reality can bring several benefits to pedagogical practice. We list some of them below.

1. Attracts attention and delights students.
2. It generates more interest and motivation in studies.
3. Uses a language very close to the students of the new generations.
4. Enables interaction between printed material and digital media.
5. Stimulates communication and the exchange of experiences in the classroom.

Outcomes for students

1. They will be more motivated by the selected subjects.
2. Classes will also be directed to your interests and already vast knowledge in the scope of new technologies.
3. They will be part of the teaching process, participating in its construction.

TIPS BEFORE THE LEARNING ACTIVITY

USEFUL RESOURCES

What is Augmented Reality? https://pt.wikipedia.org/wiki/Realidade_aumentada

Difference between Augmented Reality and Virtual Reality
https://tecnoblog.net/responde/qual-a-diferenca-entre-realidade-virtual-e-realidade-aumentada/

EXAMPLE OF PERSONAL EXPERIENCE

The subject Geography	**The grade** 11th grade (16 years old students)
The topic Urban planning	
The resources Computer or tablet	**Lesson time** Two 90 minutes classes

The knowledge outcomes for students

1. Students will know what Augmented Reality is and how it can be used for learning in a fun way
1. Students will be able to know better the process of photosynthesis on a molecular scale

The skills' outcomes for students

1. Students will develop skills of information analysis, skills of structuring and visualising information
1. Students will be able to create their own augmented reality experience, with the help of an augmented reality specialists.

Criteria for the learning task for students

1. Collect and select photographic images of 3 or 4 iconic ancient places in Faro.
2. Overlay 3D video animations, based on old images, when visiting iconic buildings/places in the city in real life.
3. Create text content to serve as textual support
4. Review texts
5. Add selected images to the application

Technical criteria

1. The information used in the augmented reality app is scientifically sound and accurate
2. The information used in the augmented reality app is structured and easy to understand

ACTIVITY 3
CHEMISTRY

The learning activity Presentation of components of the secondary school curriculum, in the discipline of Chemistry, through the use of Augmented Reality as a technique of representation and artistic presentation of certain scientific contents.

The brief description of the learning activity Augmented Reality (AR) is a technology that allows us to superimpose virtual elements on our vision of reality.
As a resource that arouses the curiosity and interest of children and adolescents, in addition to being relatively accessible (any tablet or smartphone with a camera is capable of reading the AR markers), augmented reality has become a tool powerful in the classroom. With it, the teacher can work on proposals that aim to make the content of the printed book closer to the reality of the students.
In this case, an example situation was produced, for a subject, through which teachers and students could be made aware of their pedagogical interest, while also associated with capturing their interest in the use of artistic creation techniques, facilitating his interest in the arts, and in particular digital art.

Outcomes for teachers

Imagine having illustrations that come to life and "jump out" of the printed book to bring the information to your students; allowing access from the didactic material to videos, animations and contextualized activities for each moment of learning. With augmented reality, these situations are increasingly facilitated and used within schools, which is why this example is another contribution to the use of these artistic techniques.

To be effective, this interaction needs, of course, the guidance of an Augmented Reality technician. Technology alone is not capable of capturing the student's interest and contributing to overcome the barriers to its use for the learning of school subjects. In this dynamic, the role of the mediator is fundamental, from the planning of activities to their transposition into classroom practice.

When well planned and used in a relevant and contextualized way, Augmented Reality can bring several benefits to pedagogical practice. We list some of them below.

1. Attracts attention and delights students.
2. It generates more interest and motivation in studies.
3. Uses a language very close to the students of the new generations.
4. Enables interaction between printed material and digital media.
5. Stimulates communication and the exchange of experiences in the classroom.

Outcomes for students

1. They will be more motivated by the selected subjects.
2. Classes will also be directed to your interests and already vast knowledge in the scope of new technologies.
3. They will be part of the teaching process, participating in its construction.

TIPS BEFORE THE LEARNING ACTIVITY

USEFUL RESOURCES

What is Augmented Reality? https://pt.wikipedia.org/wiki/Realidade_aumentada

Difference between Augmented Reality and Virtual Reality
https://tecnoblog.net/responde/qual-a-diferenca-entre-realidade-virtual-e-realidade-aumentada/

EXAMPLE OF PERSONAL EXPERIENCE

The subject Chemistry	**The grade** 11th grade (16 years old students)
The topic Ozone formation and composition	
The resources Computer or tablet	**Lesson time** Two 90 minutes classes

The knowledge outcomes for students

1. Students will know what Augmented Reality is and how it can be used for learning in a fun way
1. Students will be able to know better the process of photosynthesis on a molecular scale

The skills' outcomes for students

1. Students will develop skills of information analysis, skills of structuring and visualising information
1. Students will be able to create their own augmented reality experience, with the help of an augmented reality specialists.

Criteria for the learning task for students

1. Understand and separate the different components of an ozone model mockup and their interactions
2. Create text content to serve as textual support
3. Review texts
4. Integrate animations and interactions in the application

Technical criteria

1. The information used in the augmented reality app is scientifically sound and accurate
2. The information used in the augmented reality app is structured and easy to understand

ACTIVITY 1 - FLATSCREEN UNDER THE LENS

The subject Technology	**The grade** 7th grade (13 years and older)
The learning activity Disassembling and assembling flatscreens	
Preparation time 30 min	**Workshop time** 4 hours

Overview Students will learn about the materials used for the construction of flatscreens, they will disassemble and assemble flatscreens themselves.

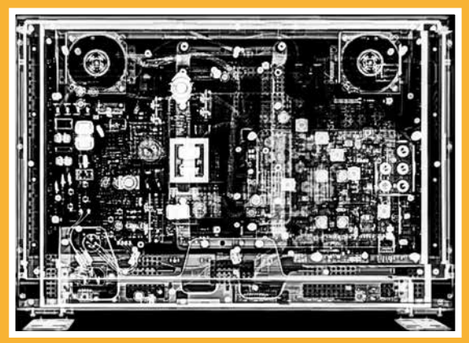
1. At the beginning give the students a short introduction about the materials used for the construction of the flatscreens- properties, occurance, recycling options etc.
2. Assign the students to write narratives (comics, stories etc.) or make posters with the involvemnet of the materials necessary for the construction of flatscreens. The characters in the comics can be the materials.
3. Ask the students to tell each other their stories or show the posters and then discuss about the materials, radioactive waste, degradation conditions, risks (environmental protection, human dignity, health).
4. After the discussion tell the students to think of the ways by which we all can contribute to the more careful and environmentally friendly usage of the resources.
5. After the exchange of thoughts it's time for the practical part. Ensure that the students have all instructions and tools for dismantling the flatscreens. One, two, three, go!!!
6. The students will have breaks if the long version of the workshop is planned.
7. As a last step of the project the students start assembling the flatscreens.
8. Participants will have a discussion evaluation the whole project.

The outcomes for students

- Students get general information about flatscreens: their components, functions, structure etc.
- Students learn what happens to flatscreens after their usage, how they the environment and how they can be recycled more effectively.
- Students disassemble and assemble flatscreens on their own.

The resources

Stock screens,
Tablets/laptops with PPT program installed
Tools- screwdrivers, pliers etc.
A4 paper,
Pens,
Flipchart,
Boxes for storing the small items,
Protective clothing (smocks),
Gloves,
Goggles,
Handouts,
Teacher's manual



TIPS FOR THE LEARNING ACTIVITY

IMPORTANT NOTICE! Use only old flatscreens for the workshops. The lights of the flatscreens including poisonous chemical elements must be removed before handing the flatscreens to students.

1. Give general information to the students about the workshop--sequence of the steps, timetabel etc. Ask the students to introduce themselves and ask what flatscreens they know and what they know about the materials in them.

   Give the students general information about flatscreens and materials used for their construction.

   Make sure to speak about all these aspects of materials:
   - Properties
   - Occurrence (place and mass)
   - Amount needed per year
   - Mining (who, where, how, ...)
   - Transport and processing
   - Uses
   - Recycling
   - Political and social aspects
   - Cost of use
   - Alternatives

   Here is an example of the timetable, which may vary depending on a workshop, teacher etc.

   Timetable:
   Acquaintance, introduction 30 min.
   Creating and presenting stories (comics, flipchart) 60 minutes.
   Break 15 minutes.
   Disassembling flat screens 30 min.
   Assembling flat screens 30 min.
   Evaluation 30 min.

2. Ask the students to write short stories (comics etc.) using as characters the materials introduced to them. Make sure to give them your own example of story or comics or cite it from the relevant source (book, online resources etc.).

   (You can find some examples in German in the "Useful links" section).

3. If the workshop is intended for 4 hours, there is enough time for the students to make up the stories or the comics. But if you are considering the short version of the project (1-2 h), instead of stories (comics) the students can be assigned to make flipcharts or posters about the chemical elements.
4. After the students are ready with their stories (comics, flipcharts etc.) , ask them to introduce and discuss their works in a group. Make sure that every student is given equal time to present his/her work.
5. After all the students presented their works, make sure to speak about "Sustainable development goals" and separate all the mentioned elements into the groups of "Environmentally critical" and "The rest". Discuss with the students which measures can be taken to make the production and recycling of flat screens more environmentally friendly.
6. After the theoretical part you instruct students to start disassembling flat screens. As all the flatscreens are different from each other, there is no single instruction or handout how it should be done. Make sure you give basic instructions to students before they start their work and you are always around for questions and guidance.
7. Close to the end of the workshop, the students start assembling the flat screens. Again, make sure you give basic instructions to students before they start their work and you are always around for questions and guidance.
8. If time is left, do evaluation of the workshop and ask students which skills and knowledge they acquired because of the workshop.

Help students with any issues they encounter during the workshop.

Example 1

Challenge: The hardest challenge for the students can be the disassembling and assembling part of the workshop.
Question: What if I break the flatscreen while disassembling it?
Answer: For the workshops only old and non-functioning flatscreens are used, from which the lights with poisonous chemical elements have been removed beforehand.
So safety-wise there is no problem if the screen is broken. It can be replaced with another flatscreen so that the student can continue the workshop.

Example 2

Challenge: After assembling the flat-screen some screws or other parts may be left out.
Question: What shall I do if the whole screen is assembled but some screws are left out?
Answer: If the assembled flatscreen looks good and complete, it is not a big issue, if some of the screws have not been used. However, if the assembled flatscreen looks incomplete and unfinished, then you should dismantle the screen again and start from the beginning. Trial and error, that is how it's going!

Example 3

Challenge: As some of the tasks in the workshops can be complicated for students, it may take them more time than planned.
So make sure you follow the time and give the students reminders about the time left.

DISCUSSION

It is always good to look back and reflect on the work done.
- Ask the students to review all the steps taken during the workshop.
- Ask the students which part of the workshop was the most difficult and challenging for them and which part they enjoyed the most.
- Ask the students what they learnt during the workshop and how they are going to use the knowledge they gained.

USEFUL RESOURCES

“Rare Earths, information on sustainability”
https://www.bgr.bund.de/DE/Gemeinsames/Produkte/Downloads/Informationen_Nachhaltigkeit/seltene_erden.pdf?__blob=publicationFile&v=3

“Flatscreen & Co, Environmentally critical materials, Theory”
file:///C:/Users/Comp/Downloads/Handbuch_Flatscreen_Band1_2020.pdf

“Flatscreen & Co, methodology, implementation, handouts” -
file:///C:/Users/Comp/Downloads/Handbuch_Flatscreen_Band2_2020.pdf

Photos from
“Flat screens under the lens“ workshop in **solaris** FZU Chemnitz.2

ACTIVITY 2
PLASTIC - A CURSE OR A BLESSING

The subject Chemistry and properties of polymers (STEAM). Media approach	**The grade** 7th grade (13 - 16 years old students)
The learning activity Science + Sustainability = Future	
Preparation time 20 min	**Workshop time** 1,5 hour + 1 hour

Overview The students will learn about the different types of plastics, their chemical composition and structure by examine different chemical properties on selected plastic examples and conclude the final range of uses. Beyound this the students will learn about the appropriate disposal of plastic waste and how to avoid it.

1. At the beginning give the students a short introduction about the structure of a workshop, about specific information.
2. Create the possibility to have a complex approach of thema: curricular workshop and a medial/digital aspect
3. Divide the first workshop into 3 parts:
   - Introductory section
   - Practical section
   - Refection/Evaluation
4. Introductory section
   Ensure first the working place and proceed with work safety instruction for all student.
   Ensure that the following information reaches students:
   - Plastic - an ingenious material
     > Density test
     > Deciphering the recycling code
   - Circular economy theory and practice
   - Plastics recycling
     > Recycling example pulling thermoplastic into fibers
   - Outcome for the future
     > Producing bioplastics by yourself

   Talk about the properties of plastic as well as its application in everyday life.
   Each of the students could present some example.
   Pregateste o prezentare (power point) pentru a oferi cat mai multe detalii si informatii despre tematica.
   Ensure during whole workshop to not forget the learning goals: sustainability, avoiding plastic waste and protect the environment.
4. Practical section
   Prepare as many experiments as the time permits: 2 or 3 at least.
   Explain and prepare the materials and equipment you need.
   Explain to students how the equipment works.
   Prepare for each experiment how it will be carried out and write down all the information on a sheet of paper, which you give to the students (the group carrying out the experiment).
   Reciclyng. How much is recycled and effects if not recycled.
5. Reflection/Evaluation
   - Assign the students to think of examples from daily life, where they use plastic. Where is plastic everywhere? How many kg of plastic packaging does an average person consume per year? How many kg of waste is generated in the production of a cell phone?
   - Ask the students to discuss about this topic (environmental protection, human dignity, health) and issue ideas, how they contribute to reduce plastic and to the more careful and environmentaly friendly usage of the resources.
   - Ask about evaluation using creative methods like: three glasses for three categories (good, satisfactory and poor) in which students insert a pipette for the evaluation they decide on)
   - Watch a film together “Plastic in the world”.
6. Subsequent workshop. Storytelling. Video. Animation film.

   Introduction
   Animation can be used to record results, to show what has been learned or to present own perspectives.
   Ask about inspirational texts and stories connecting to thema and clear up what message do you want to convey?
   Agree on the kind of digital product to be made (Storytelling. Video. Animation film) and on following facts: the story is adapted to the target group, the story has a clear message, the audience can identify with the story told.
   Present the students the material they have at their disposal and assign group responsability.

   Basics of animated film technique
   The students are given an overview of different animation techniques (pixilation, layering, stop motion), supported by real-life examples. They learn how individual photos can be converted into moving pictures and which technical means can be used (music, sounds, voices, graphics).

Development and visualisation of a story
The students choose an animation technique that is interesting for them and create figures for their story out of waste and handicraft material or use everyday objects. They also prepare their animation set and create a landscape for their story (for example they can also use rests, paper, or daily objects).

Production of the animated film
The students produce their own animated film story in small groups (4-5 persons).
They use a tablet equipped with an animation app (Stop Motion Studio). In this app, they can take the photos and have them played as a film. They can also select and insert background music, noises and sounds for their animated film from a music library integrated in the app. They can also make their own voice recordings with the app.
The students are encouraged to bring in their own cultural and linguistic diversity.

The outcomes for students

- Students learn about the different types of plastics, their chemical composition and structure.
- Students learn recycling symbols.
- Students examine different chemical properties on selected plastic examples and conclude the possible uses.
- Students talk about the correct disposal of plastic waste and how to avoid it.
- Students get general information about sustainability goals (Agenda 2030), about environment and specific knowledge.
- Students acquire new skills and further competence (digital competence).
- Students reflect on their own media experiences with animated film.

The resources

- Video projector
- Tablets/laptops with the App Stop Motion Studio
- Various tools - molecule kit, starting materials (starch, water, salt), fire source and chemical fume cupboard etc.
- Lab equipment
- Paper
- Flipchart
- Boxes for storing the small items,
- Protective clothing
- Gloves
- Teacher's manual

TIPS FOR THE LEARNING ACTIVITY

IMPORTANT NOTICE!

1. Give general information to the students about the workshop-sequence of the steps, timetabel,etc.
   Make sure to speak about all these aspects of materials: properties, ooccurrences, and mining (why, how, for what), needs, uses, recycling, economic, political, and social aspects, costs, alternatives.
   Here is an example of the timetable, which may vary depending on a workshop, teacher etc.

TIMETABLE
Workshop 1: 1,5 hour • Workshop 2: 1 hour • Break: 15 min

2. Make sure to speak about "sustainable development goals" and discuss with the students which measures could be taken to ensure a properly recycling of plastic.
3. Animation film connected to the topic. Ask the students to write short stories (like comics) using various characters.
   Alternatively you may give by yourself some example and initiate the "story" behind the trick film using some famous character from the relevant source (books, online resources etc.).
4. Plan enough time. Possibly create a subsequent workshop, but in a short time frame, so that the topic is still present in the students' minds.
5. Initiate a group discussion, after students have created their own stories to present to the group.
   Make sure that every student is given equal time to present his/her work.
6. Ensure that the students own functional knowledge like operating a tablet and the Stop Motion Studio app.
7. Ensure that the students respect aesthetic design knowledge like camera position, shot sizes and perspective in film and animation techniques.
8. Animation production in-group work, development of own film ideas, passing on own values and attitudes.
9. Selection and use of different animation techniques, which are suitable for the realisation of the film idea.
10. Ask the students the skills and knowledge they acquired because of the workshop.
11. Challenge issues/ Mistakes

Example 1
Challenge: The hardest challenge for the students can be the length of the workshop.
Answer: It is therefore advisable to add innovative elements that raise interest. Such as the animation film or other options.

Example 2
Challenge: Lack of digital skills, which eventually extends the length of the workshop.
Answer: Try to actively involve all team/group members who can help less digitally gifted students.

DISCUSSION

- Through the subsequent critical analysis according to aesthetic, technical and content-related aspects, the teams can make their own suggestions for improvement and incorporate them into the further process.
- Ask the students which part of the workshop was the most difficult and challenging for them and which part they enjoyed the most.
- Ask the students what they have learnt during the workshop and how they are going to use the knowledge they gained.

USEFUL RESOURCES

- CO2-Vermeidung durch Kunststoffrecycling (chemie.de)
- Ökodesign: Wer gestaltet das nachhaltigste Produkt? | Umwelt im Unterricht: Materialien und Service für Lehrkräfte – BMUV-Bildungsservice | Umwelt im Unterricht (umwelt-im-unterricht.de)
- Startseite | Portal Globales Lernen

Annex 1

ACTIVITY 3
THE FUNCTIONALITY OF RENEWABLE ENERGIES AND PRACTICAL APPLICATION

The subject Physics/Sciences	**The grade** 5th - 9th grade
The learning activity Renewable energies. Solar energy. Solar Car. Sustainability goals	
Preparation time 45 min	**Workshop time** 3 to 4hr

Overview The students deal with the topic of renewable energy sources and they will get information about renewable energy. It is important for students to understand that wherever we localize power, movement, heat or light, we have energy. The power plant sun as a solution to the energy problem! We conduct experiments with the sun's power and build a solar car.

1. Enable the students to gain a detailed understanding of the topic - renewable energies, using practical exercises. In addition, the acquired knowledge could be used to develop a topic related boarding game
2. At the beginning, the students receive a short overview about the structure of the workshop and about the main topics
3. There are several options for the construction of the solar car. Namely the classic one or the with creative elements. *Optionally you can also go in the direction of building solar powered boats.
4. Divide the workshop into three parts:

- **Introductory part** The students can begin by getting information about the material they will use. Talk and present the solar cell, the central part of the workshop.
  - > Prepare all workstations Have all the necessary materials ready, but make sure that all potential dangers are kept safe.
  - > **Safety work!** No matter what is the construction plan, own safety always comes first! Make sure the students have the appropriate protective clothing (e.g. gloves, safety glasses), the right workplace, safe tools and the proper work materials. The students should consult the teacher if they are unsure or do not trust themselves during the workshop. Remember to have always first aid kit close to you.
  - > When handling tools and materials, always take care to avoid the risk of injury.
- **Practical part** Following the instructions, students will build the solar car individually or in groups of 2-3 students.
  - > Preparation of materials and equipment
  - > Assembling the gearbox
  - > Preassembly
  - > Assembly of the base frame on the solar cell
  - > Brazing
  - > Front axis
  - > Brazing and final assembly
- **Evaluation** Analysing the steps taken. Ideas and reviews. Highlighting mistakes and improvement proposals.
  - > Specific, topic-related questions should be asked.
  - > Requires the student to revisit the content of the workshop and to share ideas.
  - > Topics to be discussed: advantages and disadvantages of renewable energies, benefits in our everyday lives
  - > Ifor the development of future activities related to the theme. Example: creating a sustainability game.

5. **Workshop Creating /Playing Boarding game**

In order to make the subject more affordable and to increase students' interest in the topic, the students can be encouraged to create a boarding game, putting on paper the knowledge they have already acquired in the workshop, together with new approaches/questions.

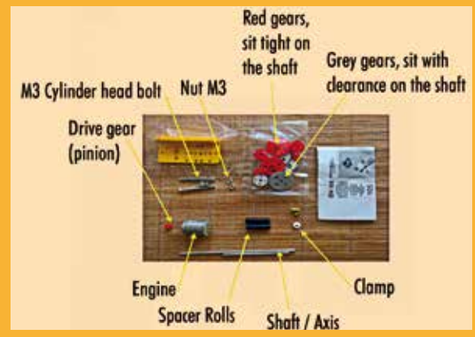
a. At the beginning give the students a short introduction about the topic. How do games reflect the society and how they sum up ideas and facts from different fields.
b. Begin with warm-up activities, approx. 15 minutes, in order to activate team spirit and creativity.
c. Divide the students into groups of 4-5 people, each group being given a specific task. Students will be asked to establish the basic features of the game: name, type of game, number of players, average game duration, game figures, game rules and layout.
d. There is no specific prescription, but it is important that the description of the game is clear, short, understandable, using familiar symbols and clear words.
e. The students will set up and create the material: game board, figures, etc. using materials such as cardboard, coloured pencils, paper, wood.

The outcomes for students

- Students learn about the different sources of energy.
- Students learn the differences between renewable and fossil energy sources.
- Students learn about the impact of energy sources on us and on environment.
- Students learn basic information about the Sustainable Development Goals (Agenda 2030).
- Students rethink their behaviour related to the topic.
- Students learn to use technical equipment and think practically.
- Students will be able to create a boarding game and devolpe soft skills (team spirit, creativity, fair play) and increase creativity and teamwork.

The Resources

- Engine
- Spacer rolls
- Axis
- Clamp
- Drive gear
- Cylinder M3
- Nuts
- Read gears
- Grey gears
- Paper, writing material
- Flipchart



Important notice

1. When selecting groups, be sure to pay attention to the group dynamics.
2. The experiments should be properly explained to ensure an independent and confident work.

TIPS FOR THE LEARNING ACTIVITY

Example 1

Together with the children, create an energy-saving pin word for the classroom. Each student should write down on a post-it how and when to save energy in daily life.
Collect the post-its and staple them onto the pin board.
Ideas: shower with cold water, wear an extra sweater when it is cold, switch off electrical devices when not in use, travel by train/bike as much as possible instead of driving a car.

Example 2

Challenge: The most difficult part for the students is to work independently.
Question:
What happens if something breaks during the experiment?
Answer:
The teacher has replacement parts for each component of the experimental set-up. Thus, a broken part can be quickly replaced and experimentation can continue.

Example 3

Challenge: Time pression
Question:
What happens if there is not enough time?
Answer:
If tasks are too complicated for students, the schedule can be adjusted to allow for more time. Make sure you inform students how much time they have left for each step of the process.

Example 4

Challenge: The experiment does not go as expected.
Question: How does the teacher handle this?
Answer: Everyone can learn from mistakes.
Components could be replaced and checked. If the student finds the error himself and corrects it, this could be motivated. If the student does not find the error on his own, classmates or the teacher can help.

DISCUSSION

- It is always very important to summarize the project at the end.
- Honest feedback and critical thinking are important for teachers and students.
- By creative! It's motivating!
- Discuss beyond the topic with the students.

USEFUL RESOURCES

solaris FZU :: **solaris** Jugend- und Umweltwerkstätten (solaris-fzu.de)
https://www.deutsches-spielemuseum.de/ueber-das-museum/museum.html
(the sustainability game used, but also many other games on this topic are available here)
https://www.youtube.com/watch?v=Giek094C_I4
(Child friendly and simple explanation of the subject matter)
https://www.bmwk.de/Redaktion/EN/Dossier/renewable-energy.html
(Germany's "green" energy and electricity)
https://www.energy.gov/energy-sources
(Energy Resources, Department of Energy)

ANNEX 1

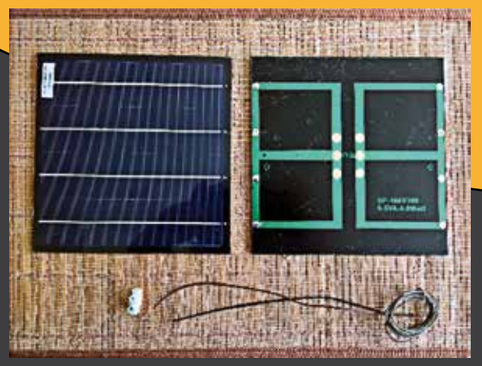
Instructions for building a solar car

Material

1. A gearbox kit
(motor, gears, shafts, screws)

- It is important to keep the total weight as low as possible!

2. Two solar cells and thin cable

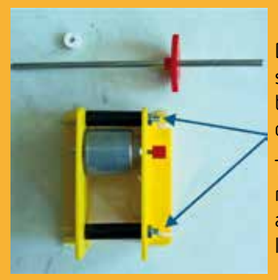


3. Wheels and wooden sticks

4. Tools – Auxiliary

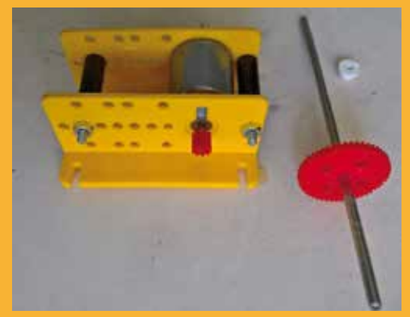
- Soldering iron.
- Quality glue (suitable for the material).
  Recommended is a hot glue gun (except for foams!).
- Carpet cutter
- Precision saw.
- Folding yardstick or alternatively a ruler
- Drilling machine (optional).

Gearbox assembly



Do not tighten both screw connections until this gearbox has been completed.

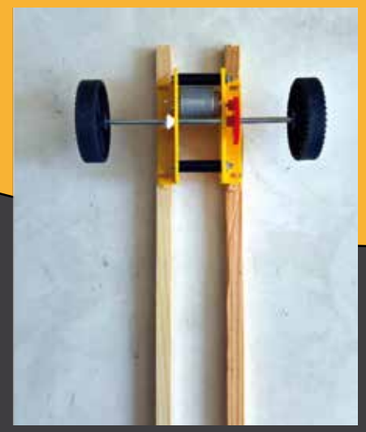
The finished gear unit must be easy to twist, and then tighten the locknut.



Make sure that there is some space left between the gearwheel and the body wall, so that the wells will rotate slowly.

Solar car preassembly

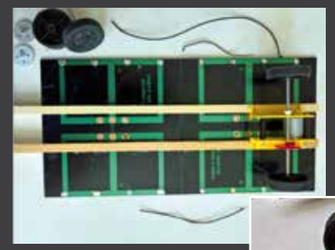
Length of the bars:
max. 40 cm
Place the bars parallel and the gearbox on the bars



Tack, glue or screw

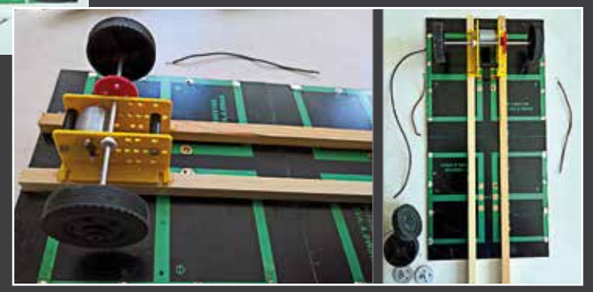
Length of the bars: max. 40 cm
Place the bars parallel and the gearbox on the bars.

Basic Frame on Solar Cell



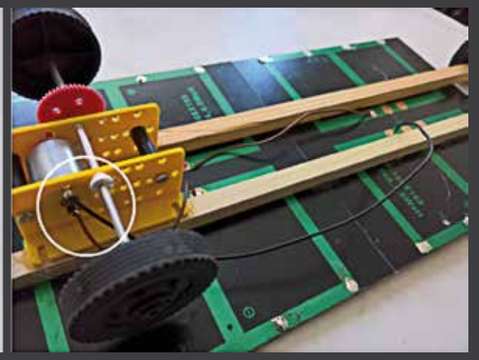
Place the solar cells in the opposite position, in order to accomplish the series connection plus minus.

Brazing 1

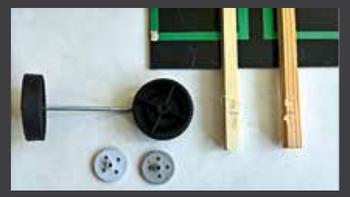


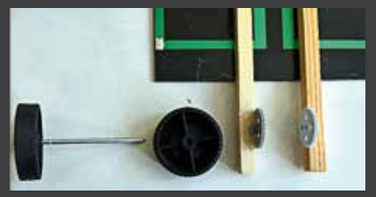
Cut cable to length and strip ends

Brazing 2

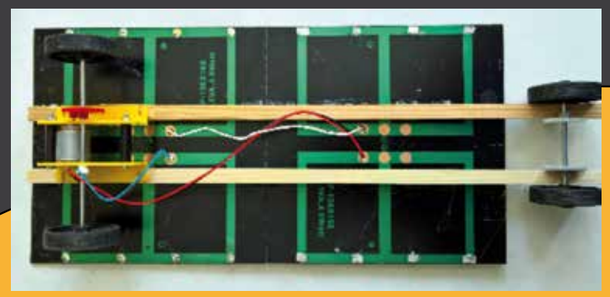


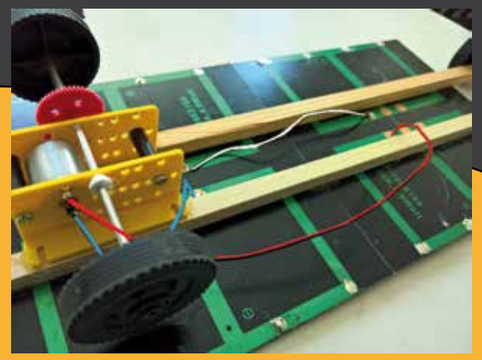
Front axis





Two gray gears are recommended as bearings for the front axis. These have a larger bore, so the shaft can rotate well. These gears can be attached to the wooden rods with hot glue (see pencil marks in the picture above). This sets the distance. The wheels must not extend beyond the rods, so that the length of 40 cm is not exceeded.





ANNEX 2

Workshop creating a sustainability boarding game

ACTIVITY 1
PROCEDURE FOR SUSPENDED SOLIDS AND VOLATILE SUSPENDED SOLIDS

The subject Science, environment protection	**The grade** 16th - 18th (18 - 21 years old students)
The learning activity Procedure for suspended solids and volatile suspended solids	
Preparation time 30 min	**Workshop time** 3 to 4 hours

Overview students are using laboratory tools to identify phenomena that occur in the environment. During this activity students have to:

1. To analyse the physical processes that take place.
2. To understand how different phenomena occur both in nature and during technological processes.
3. To identify possibilities to apply processes that lead to the purification of a product / liquid.
4. To identify ways of using the processes used, in everyday life or in the context of technological processes.

The outcomes for students

1. Students will understand how physical and chemical processes take place, both in nature and in the industry.
2. Students will have the opportunity to identify the processes they have learned about when they encounter them in their daily lives.

The resources

Glass fibre filters
Vacuum filtration system
Drying oven
Desiccator
Balance
Literature and information sources about the chosen topic

TIPS FOR THE LEARNING ACTIVITY

1. Before starting the experiment, you need to clean the filters. By using tweezers place them on the Buchner funnel which is attached to the Erlenmeyer flask with side arm connected to the pump. Switch on the pump and pure approximately 200 ml of the distilled water to the funnel. When all water pass through the filter, disconnect the pump from the flask and then switch it off. Place the filter on the aluminum tray and dry in the oven in 105 °C. Then place it in the oven in 550 °C for another 2 hours (note that the aluminum trays cannot be placed in such a high temperature, place your filters on the crucibles or special plates). Cool down in desiccator before using. You need to have 2 filters of one cut off ready for each of your samples. It is up to you to choose the cut-off.
2. Weight and note down the weight of each filter with the aluminum tray.
   Remark: You can write on the aluminum tray but not on the filter.
3. Place your filter on the Buchner funnel, switch on the pump and start purring a known amount of your sample on the filter. When all sample passed through the filter, disconnect the pump from the flask and then switch it off. (You may have to wash the graduated cylinder with distilled water to remove any material attached to it).
4. Place the filter on the same aluminum tray. Weight it and note the result down.
5. Place filter with the aluminum tray in the oven for drying (103 - 105°C) for 24 hours. Weight them after cooling in desiccator and note the result.

DISCUSSION

1. What is solid residue?
2. What is the role of the filter?
3. What is the role of the partial vacuum process?
4. Where does this type of filtration occur in nature or industry?

USEFUL RESOURCES

https://en.wikipedia.org/wiki/Filtration
https://en.wikipedia.org/wiki/Separation_process
https://www.scritub.com/stiinta/fizica/FILTRAREA-SUSPENSIILOR-LICHIDS18419221423.php
https://aquasys.ro/produse/filtre-mecanice/
https://pdfslide.net/documents/filtrarea-suspensiilor.html?page=16
https://aquapro.ro/filtrare-mecanica/

ACTIVITY 2
MICROSOFT WORD EDITOR USAGE (SYNTHESIS LESSON)

The subject IT, computers, text editing	**The grade** 14th - 18th (18 - 21 years old students)
The learning activity Concepts: Microsoft word editor usage (synthesis lesson)	
Preparation time 30 min	**Lesson time** 1 to 2 hours

Overview Students are using pre-primate information in order to integrate them into a unitary whole. During this activity students have to:

1. Demonstrate knowledge of how to create a complex document in the Microsoft word editor
2. Write a text using WordArt
3. Insert images from ClipArt into the document
4. Know the role of buttons from Picture and WordArt bars
5. Use table-making operations in Microsoft word
6. Combine elements within the word documentation: artistic writing, image, table

The outcomes for students

1. Students will know how to insert images into a text file
2. Students will know how to format a text so as to increase its attractiveness
3. Students will have the opportunity to insert tables in a text file
4. Students will be able to make a complex document, much more attractive, comprising both text and images, tables, or artistic writing.

The resources Computer / Microsoft Word / Literature and information sources about the Microsoft Word editor usage.

TIPS FOR THE LEARNING ACTIVITY

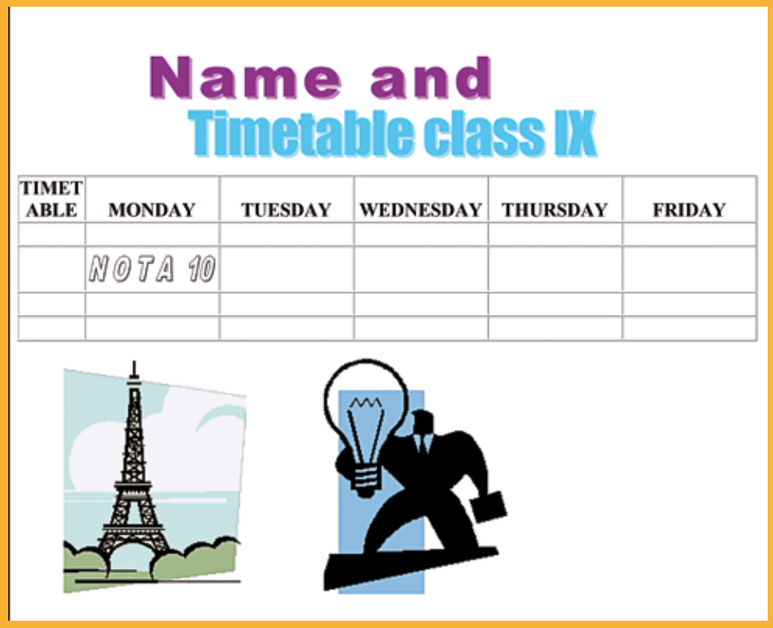
Learning methods used: Conversation / Demonstration / Exercise / Group/Teamwork
Scenario of teaching activity: Updating knowledge
Through conversation, the teacher updates the students' knowledge by asking questions:
- How to access WordArt?
- How to insert an image into the document?
- How to insert a table in the document?
- How to change the appearance of a text written in WordArt?
- How do you change the appearance of an image?
- How to change the content and appearance of a table?
- How to insert and arrange in the same document, text written in WordArt, images, table?

Deepening and establishing knowledge:
The students receive the worksheets, and based on them they make on the computer the document presented in the sheet expecting the requirements of the worksheet.
The teacher constantly tracks how the students relate the document and intervenes when necessary, with explanations and additions.

Assessment of the achievement of the proposed objectives.
Through the reverse connection, achieved by appreciating the works executed by the students, the achievement of the objectives is confirmed.

Notes and final conclusions
The papers are graded, and the students make assessments regarding the degree of difficulty of the document.

Worksheet
Using the Word Editor create a document identical to the document shown in the next page.



Customize the document as follows:
- Page format: A4.
- Page orientation: view type.
- Margins: UP - 3cm, DOWN, LEFT, RIGHT by 1 cm.
- The table must have 6 columns and 8 lines. Column 1 should be 1,5 cm wide and columns 2 to 6 should be 3 cm wide.
- use ARIAL font, size 10, (WARNING! - The first line should be written in THICK font, size 12)
- The messages that appear in the test should be written in WORDART. Message NOTA 10, should be placed behind the table.
- The cells in the first row should be yellow and the text written in the cells should be BLUE
- The images on the left and right of the table must have the same size and height as the table.

DISCUSSION

1. What is the use of formatting a text?
2. What are the tables for?
3. Where does the reader's attention go in the first place?
4. What would you do to improve the document?
5. What doesn't make sense in the document?

USEFUL RESOURCES

https://www.thewindowsclub.com/microsoft-word-tutorial-for-beginners
https://funtech.co.uk/latest/microsoft-word-lessons-for-kids
https://www.testsstestsstests.com/microsoft-office/word/tutorials/3-formatting/1-formatting-text/microsoft-word-tutorial-for-matting-text/
https://www.youtube.com/watch?v=yV4i29XoOiM
https://www.youtube.com/watch?v=Ut9B_DFxH7g

ACTIVITY 3
WORKING WITH FOLDERS AND FILES

The subject IT, computers, basics	**The grade** 11 - 12 years old students
The learning activity Working with folders and files	
Preparation time 30 min	**Lesson time** 1 to 2 hours

Overview Students are using known as well as new information. They will be able to develop new computer skills.
During this activity students must:

1. Analyse the order in which the various stages of work with folders and files should be thought and done.
2. Know functional possibilities.
3. Know the usage of software.
4. Create a social issue ad about the chosen topic Working with folders and files

The outcomes for students

1. acquiring new knowledge of the Windows operating system
2. deepening theoretical notions and training of operating skills.
3. acquiring a proper technical language
4. developing mobility in thinking, the capacity for abstraction.
5. training of independent and group intellectual work skills.

Based on the previously acquired knowledge and new notions conveyed in this lesson, students will be able to:

1. Know the form of organizing data on the information media.
2. Identify operations and execute operations with files and folders.
3. Use the computer

At the end of the lesson students will know how to create, delete, rename, copy a folder or file.

The resources Computer / Windows operation system / The handbook / Literature and information sources about Working with folders and files.

TIPS FOR THE LEARNING ACTIVITY

Steps:

1. Open My Computer
1. Identify the interface elements.
1. Complete the worksheet requirements

On external memory media:
hard disk
CD / DVD / memory stick

The file is the form of data organization. The file is identified by name and extension.

name.extension
The name is a string of maximum 255 characters.
The extension is a string of 3-4 characters and indicates whether the file belongs to a file class.

Example:

test.doc
balloons.bmp
game.exe
From the point of view of the information that the files contain, the files can be:
Executable files – which contain executable programs.
Non-executable files – containing numerical data, texts, images, sounds, etc.

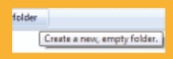
audio files	executable files	Doc files
.wav .mp3, .mp4	.bat .exe .com	.doc, .docx (Microsoft Word files format)
graphic files	**archive files**	**.ppt** sau **.pptx** (file format Power-Point)
.gif .jpg, .jpeg .png .tif, .tiff	.zip .rar	**.txt** (text format)

Identify:
- the disk and the directory in which the file or folder is located (ex: C:\ana);
- size.
- content - only for files and specify how many files and folders it contains.
- date of creation.
- date of modification.
- date of access.
- attributes:
- read only – write protected
- hidden file

Files and folders can be:
- created.
- visualized.
- renamed.
- deleted.
- copied.
- moved.

To perform these operations, you may use My computer or Windows Explorer applications.

How to create a folder



Or

Click right / New / Folder

Rename a folder
- select the folder:
- click right / Rename

Delete a folder
- select the folder:
- click right / Delete
- Delete

Copy the folders
A) select the file
- click right / Copy
- select the destination folder
- click right / Paste

B) use drag and drop method

Selection of files
A) several consecutive files:
- with the mouse.
- Click on the first folder, keep the Shift key pressed, click on the last folder.

B) non-consecutive files:
- keep the Ctrl key pressed while selecting the folders with the mouse

Worksheet

1. Create on disk D : a folder with the name of the class.
2. In the class folder create the following folder structure.
3. In each folder create 3 separate folders.
4. Rename the folders as: input, output, input-output.
5. Delete the 3 files.
6. Where do we find them after deleting?
7. Recover them.
8. Delete the 3 files again by holding the Shift key.
9. Look for them in the Recycle Bin.
10. Can we get them back?
11. Move the input file to the peripheral devices folder.
12. Rename the entry file with your first name and move it back to the DP-entry folder
13. Rename the file with your first name with your first name.

DISCUSSION

1. What are the Windows operating system interface elements?
2. How do we create a shortcut?
3. How do we customize the work surface?
4. What is useful in what is learned?
5. What do you think is missing from what you have learned today?
6. What would you change/optimize?

USEFUL RESOURCES

https://en.wikipedia.org/wiki/File_Explorer

https://learn.microsoft.com/en-us/windows/uwp/get-started/fileio-learning-track

https://edu.gcfglobal.org/en/windowsbasics/working-with-files/1/

https://support.anydesk.com/knowledge/file-manager-and-file-transfer

CHAPTER IV
PARTNERS ON PRACTICES

Explore+ - Study Visit Faro

Children's Culture and Cultural Participation

Youth Cultures and Participation Explore+ C2 Study Visit Faro

From March 7th to 9th, 2022 a study visit took place in Faro, Portugal, which was hosted by the Portuguese project participants, and attended by representatives from Latvia, România and Germany.

According to the OECD, "The future of education and skills 2030", there are two central questions that we must answer as a society:
- What kind of knowledge, skills, attitudes and values will students need to succeed and shape their world?
- How can education systems develop this set of competences?

We believe that the answer to the first question is to develop in our students skills that enable them to read the world around us from different perspectives and to give them the tools to be able to intervene in that world. And if education systems manage to integrate these students in a collaborative learning model, where students have a more active role in the development of school programmes, we are closer to answering the second question.

The aim of the visit was to provide the participants with ways, starting from their local environment, to develop the school programmes in an interdisciplinary approach.

On the first day of the project, all the participants were involved in a warm-up game, which was a special challenge to find graffiti's and hidden signs in downtown Faro. The challenge was an interesting way to get acquainted with the city and learn about its history, architecture and sights. It was also an opportunity to get to know technological instruments to support school learning.

After the city game the participants headed to the city hall, where the project "MI.MOMO.FARO" was presented to them. Through this educational project school students reproduce modernist architecture buildings of Faro on the Minecraft Education platform.

After the presentation of the project, the team of the project took a boat and headed to the island of Culatra where they were presented with the project "Culatra 2030". Aware of the clean energy opportunities on Culatra, the local community decided to take their future into their own hands. Partnering with the University of Algarve, the Culatra Island Residents Association is planning to design a roadmap and implement a clean energy transition framework on the island. Their common goal is to convert Culatra into the first Portuguese clean island community.

On the second day we start to visit the archaeological site of Ruínas do Milreu (Milreu Ruins). This is an old Roman villa, which was occupied as far back as the 1st century A.D. It had baths and a religious building built in the 4th century. It is also part of Pinheiro e Rosa's project to transform them into an "Open Space STEAM LAB", contributing to an interdisciplinary approach to school learning.

Giving depth to the idea that schools should also participate and integrate civil society projects, through stable partnerships with these organisations, we continued with a visit to the Museu Zer0 Headquarters, a former food factory that is currently being transformed into a museum for media art and is intended to become an alternative space for artists and other creative people.

With the same purpose we went to dinner at Associação Recreativa e Cultural de Músicos and got to know the Capsula project, which aims to support the creation of new artists from Faro, an ECCFaro2027 initiative.

Empowering the "A" in STEAM

If to educate is to prepare for the future (which does not exist and we do not know), it is necessary that education prepares for the unknown, not only for what is already known for sure. The arts are, in this context, a way of nurturing imagination and creativity, helping us to be prepared to solve problems, to learn to manage uncertainty as part of life, not to be afraid of making mistakes and to be resilient. Creativity depends on the diverse stimuli we have: the more varied and meaningful the experiences, the greater the creative potential. In this sense, Arts should be integrated, with all its recognized importance, in a STEAM approach, together with Sciences, Technologies, Engineering and Mathematics

So, on the last day of the project the participants attended the presentation "Culture is the soul of Europe" by Paulo Pires do Vale, Commissioner of the National Plan for the Arts, who presented us with the Porto Santo Charter, a guiding map of principles and recommendations for applying and developing a working paradigm for cultural democracy in Europe.Then we discuss how can we help to implement (as organizations and as citizens) the principles of the charter.

Based on Explore + Study Visit Faro

Explore+ - Study Visit Cesis
Gamification and new media for science communication

Space Education Center (Cēsis municipality)

During the study visit in Cēsis project partners from Chemnitz, Faro and Timişoara participated in several workshops which were related to the topic of "Space Exploration".

One of the workshops was about how to use infographics to visualise information and teach and learn STE(A)M subjects. During this workshop participants learned how to create effective infographics using ICT tools - the platform www.infogr.am. Participants learned what is infographic, why and how it can be used for structuring information and tried to create their own infographic about the Space Mission Apollo 11.

Another workshop was dedicated to the exploration of the moon where participants, working in teams, analysed data on the potential moon landing sites for astronauts. Data obtained were based on the current NASA mission Artemis. Participants had to make a decision which place out of five could be the one where the moon camp would be built in the future.

After the exploration of the moon surface participants took part in the workshop which was dedicated to testing astronaut landing module. After the participants have chosen a place where to build a moon base, they have to design an astronaut landing module. Using the materials available in the classroom, participants working in teams created a safe module that does not tip over when it hits the ground falling from the heights of the table.

During the workshop "Human programming" participants learned about the fundamentals of programming and how algorithms for programs are created. Using a role-play method, participants "programed" ecah others moon track path to reach the end point at the moon base. While in the workshop "Mission to the Moon" participants working in teams guided the rover along a pre-marked map of the moon using the basics of visual programming. During the rover testing, participants needed to improve the program so that the rover arrives at the planned endpoints.

The final workshop during the study visit in Cēsis was "Space Launch" in which participants had to find out what is needed to make a paper rocket fly as accurately as possible to the specified target. Participants built their own module and tested it with an air pump to analyze the motion and the speed of the rocket.

Explore+ - Study Visit Chemnitz
Curiosity & Creative Exploration

Between, 18. to 20. May 2022 solaris Foerderzentrum fuer Jugend und Umwelt gGmbH Sachsen organised the Study Visit event, in Chemnitz/Germany, which was attended by student and youngsters aged 14 to 18, as well as teachers, trainers, pedagogues, youth workers and representatives of youth structures in municipal administrations from 4 countries.

The program was structured by days and included several workshops.

Workshop 1
Visit the experimental pedagogical center – a mix between an educational center „Sigmund Jähn" about space, and the Chemnitz High Ropes Garden. The Center combines its key services with a scholastic and family-related youth work. Their focus lies on building youth´s social skills and key qualifications, beneficial for future career building. The activities of this project day: test of the flight deck, astronautic and cosmos-related activities, archery, and team building activities.

Workshop 2
The participants attended workshops at solaris Jugend- und Umweltwerkstätten, which offer extracurricular youth education and promote active engagement of children and young people in science, technology and environment. Method used was Learning through experimenting. The Workshop focused topics in chemistry, technique, electronics, and solar energy. Beyond that, a great emphasis was put on teamwork, exchanging ideas and supporting each other emotionally and practically.

Workshop 3
The main activity was the creation of a board game in small teams, by using special predefined elements (a theme for each group, papers, pencils, scissors, and other various materials). Method was learning through playing.

Workshop 4
Station Chemnitz Multigenerational House, where the participants learned the concept of this establishment, which gathers together people from different generations and different educational and social backgrounds. Method used was social sustainability, bringing into focus elements of social work such as volunteering, inclusion, multiculturalism, tolerance, etc.

Workshop 5
At ART Factory participants worked in a fully equipped workshop and learned a special type of art - Monotypie. The activity was a free experimentation, under the supervision and coordination of professionals. The organization offers the possibility of individual artistic development, to bring out the creative potential of the individual and connect with STEM by using knowledge from Chemistry.

The choice of this specific program. The program was aimed to introduce learning methods, best practice, but in the same time to create new non formal exercises and experimenting them. Participating to various workshops, gave the participants an opportunity to observe the variaties of approaches, learning through different methods like: competitions, workshops, games, presentations, which ensured the interactivity and variability of learning.

The project was mapped taking into account the age and interests of the participants. The project participants were students, educators and social workers aged 14 to 45. The partners were involved in order to give feedback on the program, its structure and timeframe, and on the interest in certain activities. In the preparation of the visit, the organizer involved the participants themselves, trainees and volunteers, project staff, as well as own staff. During the whole project the protection of the minors was taken into consideration and the protection of the personal data of all the participants were under constant attention of the project organizers.

Methodology
The working methods used and shared during Study Visit in Chemnitz tried to highlight the variety of activities carried out within the organization, but also the fact that the result, with all the variety of methods used, is the same. Namely, attracting young people, helping them to discover their skills and personal competences, to be motivated, in order to not drop the education.

At the same time, it increases the quality of the education activities and possibilities offered to them.

We used the "reference group", where the participants could work in small groups in order to get to know each other better, to change questions, to get adapted answers, and to feel safe.
The tools and methods used and experimented by the participants: practical activities, interactive activities, competitions, board games, team building, social activities, dialogue, presentations.

Obstacles. The language of communication between participants was English. English language skills were different from participant to participant, which made it some harder to express themselves and to share impressions, however made no real barrier between the participants.


Presentations


Games


Art


Experiments

Expectations. Evaluation.

We expected the participants to gain skills and knowledge.

Achievements:

- personal and social skills (from communication with the people from different countries and cultures)
- strengthened linguistic skills
- intercultural competences and sensitivity
- learning to learn (through competitions, creative and technical activities, workshops, presentation etc.)
- networking and exchange of best practices in education
- important knowledge in the STEM field, arts and game creation
- from practical workshops

We assess that the main impact on the participants was achieved based on the feedback and mood of the participants after the project.

Workshop recommendations

1. Workshop
"Simulated space flight" vs. Workshop "Space physically skills".

Methodology

Schedule

1. Warm-up
2. Q&A round
3. Content
4. Evaluation of the day

Best practice

Simulated space flight and space test

Space test. TO GO version

Since you are not in the solaris Cosmonaut Centre, we give you the chance to do "Space test" ***TO GO***

Get the **Actionbound App** for free
Scan the QR code with the Actionbound app in App Store or at the Google Play Store.

What's behind it?

Target group	Key words
Students, youngsters	Interaction, creativity, digital skills
Teachers, trainers, pedagogical staff, youth workers	Digital skills, creativity

2. Workshop „Inventing Board-Game".

In the workshop the participants are learning everything about the creation and design of own personal board game with cards, dice and game plan like real game inventors!

Methodology

1. Warm-up
2. Q&A round
3. Content
4. Evaluation of the day

Instruments

1. Reference group, where the participants can work in small groups in order to get to know each other better, to change questions, to get adapted answers, and to feel safe.
2. In-group work. Each group receives various materials and a certain subject. The group must:
Approach the subject, decide what for a game particularly will be created (such as a strategy game, a card game, plan game, etc.) and the other characteristic (name, design, layout, and rules

What's behind it?

Target group	Key words
Students, youngsters	Interaction, creativity, reflection, team work, acquiring knowledge, diversity
Teachers, trainers, pedagogical staff, youth workers	Creativity, reflection, emotional intelligence, diversity


Erasmus+