



# Teaching STEM in the Metaverse: A Collection of Lesson Plans for Teachers

METaverse-BASED STEM EDUCATION FOR A SUSTAINABLE AND RESILIENT FUTURE  
2023-1-FR01-KA220-SCH-000151516



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# Introduction

Developed within the framework of the M-STEM project: Metaverse-Based STEM Education for a Sustainable and Resilient Future, this collection consists of fourteen lesson plans designed to support teachers in the delivery of selected STEM topics. The lesson plans contain structured instructional content that aims to make complex scientific and technology subjects easier for teachers to explain and implement in educational contexts.

The lesson plans cover a wide range of STEM subjects, including artificial intelligence, machine learning, mathematics, sciences, biology, and human anatomy, as well as applied and interdisciplinary topics like nuclear fission and pH in everyday life, pollen, mammoths, renewable energy and sustainable technologies, climate change, and greener living. Topics covered include both major STEM subjects as well as current scientific and environmental challenges.

Each lesson plan is a useful teaching resource, providing direction on class objectives, essential concepts, and learning activities linked to the topic. The lesson plans are meant to help teachers with their current teaching techniques and can be used or altered to fit diverse classroom settings, learner requirements, and accessible resources.

Integrating digital and virtual technology into STEM education is becoming increasingly vital as scientific, technological, and societal advances define the skills needed for future learning and employment. Teachers who are conversant with educational content intended for digital and virtual learning contexts are better positioned to address changing curriculum needs and support students in understanding technologies that are becoming more prevalent in everyday life.

Within this context, the lesson plans seek to raise teachers' awareness and preparedness for teaching STEM subjects in technology-enhanced environments, while emphasising content clarity, pedagogical flexibility, and practical classroom applicability across a variety of educational settings.





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## LESSON PLAN : ARTIFICIAL INTELLIGENCE

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## Purpose of Lesson:

Artificial Intelligence (AI) is revolutionizing numerous industries, such as education, medicine, and entertainment. This lesson aims to expose students to the basic concepts of AI, its relationship with STEM, and how it contributes to the development of virtual spaces such as the Metaverse. By learning about the strengths and weaknesses of AI, students will be able to develop a critical mind regarding the future of digital technology.

## Description of Lesson:

This lesson introduces students to the fundamental concepts of Artificial Intelligence (AI) and its role in shaping virtual environments like the Metaverse. Students will explore AI's key components, including Machine Learning, Neural Networks, Natural Language Processing (NLP), and Computer Vision. Real-world applications, such as AI-powered virtual assistants, self-driving cars, and adaptive learning systems, will be examined to highlight AI's growing impact on daily life. The lesson will also address the role of AI in the Metaverse, with emphasis on AI making virtual interactions more life-like through realistic NPCs (Non-Player Characters), customized experience, and automated world generation. Ethical issues, including AI bias, privacy threats, and automation of jobs, will be addressed to promote critical thinking.

## Lesson Teaching Method:

This lesson is delivered through an informative teaching method providing a clear, structured, and visually engaging way to introduce AI concepts. This method ensures that students receive consistent and well-organized information, making it easier to understand complex topics related with AI in the Metaverse. Additionally, the format of the lesson itself allows students to learn at their own pace, therefore students are able to review the material as needed. While primarily informative, this method can be supplemented with discussions and reflective exercises to enhance engagement and comprehension. This lesson also includes a discussion session encouraging student engagement, as well as a group activity encouraging collaboration and diverse perspectives.



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# Lesson Objectives:

By the end of this lesson, students will be able to:

- Define Artificial Intelligence (AI) Define Artificial Intelligence key components.
- Identify real-world applications of AI in different industries.
- Explain AI's role in the Metaverse and adaptive learning environments.
- Discuss the ethical challenges of AI in the metaverse.
- Apply critical thinking to analyze the implications of AI in everyday life.

The objectives of the lesson are achieved through a structured and informative approach, ensuring students grasp key AI concepts and their applications.

## Lesson plan:

### 1. Introduction: (10-15 minutes)

- Engagement Activity: Ask students to share their experiences with AI-powered tools (e.g., Siri, Google Assistant, ChatGPT).
- Brief Explanation: Define AI and its core functions.
- Discussion: Explain how AI differs from traditional programming and introduce its major components (Machine Learning, Neural Networks, NLP, and Computer Vision).

### Main Lesson ( 25-30 minutes)

#### 2. AI in the Real World:

- Showcase examples of AI in daily life (virtual assistants, self-driving cars, healthcare, chatbots).
- Discuss how AI improves efficiency in different industries.

#### 3. AI in the Metaverse:

- Explain how AI generates virtual environments, NPC interactions, and personalized experiences.
- Introduce adaptive learning systems and AI-driven virtual classrooms.



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#### 4. Ethical Considerations:

- Discuss AI biases, privacy concerns, job automation, and over-reliance on AI.
- Encourage critical thinking by asking students how they would regulate AI in virtual spaces.

#### 5. Practical Exercise: AI Capabilities and Limitations(15-20 minutes)

In this activity, the teacher will present a set of statements about AI's abilities and ask students to decide whether each statement is true or false. The teacher will guide students through the reasoning behind each answer, providing real-world examples to illustrate AI's strengths and limitations.

- Display the statements on the board or read them aloud.
- Ask students to decide which tasks AI can and cannot perform.
- Discuss each statement, explaining why AI excels in certain areas (e.g., data analysis, facial recognition) but has limitations (e.g., lacking human-like creativity and deep emotional understanding).
- Provide examples from real-world applications, such as AI-powered virtual assistants, self-driving cars, and AI-generated art.
- This exercise will engage students in critical thinking and help them develop a deeper understanding of AI's practical applications and boundaries.

#### 6. Conclusion (10 minutes)

- Recap key takeaways.
- Open discussion: "What excites or concerns you most about AI's future?"

# Lesson table

<b>Lesson Plan</b>	
<b>Introduction:</b> <ul style="list-style-type: none"><li>• Learning objectives</li><li>• “Share your experience” Discussion</li><li>• Definition of Artificial Intelligence</li></ul>	10-15 minutes
<b>Key components of AI</b> <ul style="list-style-type: none"><li>• Machine Learning</li><li>• Neural Networks</li><li>• Natural Language Processing</li><li>• Computer Vision</li></ul> <b>AI in the Real World</b> <ul style="list-style-type: none"><li>• Personal Assistants</li><li>• Self-driving Cars</li><li>• Healthcare AI</li><li>• Chatbots</li></ul>	15 minutes
<b>AI’s Role in the Metaverse</b> <ul style="list-style-type: none"><li>• Realistic NPCs (Non-Player Characters)</li><li>• Personalized Experiences</li><li>• Automated World Creation</li><li>• AI-Enhanced Learning</li></ul> <b>Adaptive Learning in Virtual Classrooms</b> <ul style="list-style-type: none"><li>• Real-Time Adjustment</li><li>• Custom Learning Paths</li><li>• Automated Grading &amp; Feedback</li></ul>	15 minutes



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# Lesson table

Lesson Plan	
<b>Ethical Challenges of AI in the Metaverse:</b> <ul style="list-style-type: none"><li>• Bias and Fairness</li><li>• Privacy and Data Security</li><li>• Job Automation</li><li>• Over-Reliance on AI</li></ul>	10 minutes
<b>Conclusion and Practical Exercise</b>	15 minutes

## Lesson resources

- Presentation slides on AI concepts and applications.
- Videos demonstrating AI in action (e.g., AI in self-driving cars, virtual assistants, NPCs in gaming).
- Online articles and reports on AI's impact in different industries.
- Internet access for group research.

### Resources used to create the lesson:

- Benjamins, R., Rubio Viñuela, Y., Alonso, C.: Social and ethical challenges of the metaverse: opening the debate. *AI Ethics* (2023). <https://doi.org/10.1007/s43681-023-00278-5>
- The basic components and branches of AI. (2023, July 14). *SOCi*. <https://www.soci.ai/knowledge-articles/branches-of-artificial-intelligence/>
- Navigating the ethical landscape of the metaverse: Challenges and solutions. (n.d.). The UK's technology trade association. <https://www.techuk.org/resource/navigating-the-ethical-landscape-of-the-metaverse-challenges-and-solutions.html>
- The role of AI in shaping the Metaverse: Bridging the virtual and real worlds. (2025, February 21). Dataleon - AI Powered Data Automation & Identity Verification. <https://www.dataleon.ai/en/blog/the-role-of-ai-in-shaping-the-metaverse-bridging-the-virtual-and-real-worlds>
- Valliani, J. (2024, October 30). Learn AI: Guide to understanding artificial intelligence | Atlassian. *Work Life by Atlassian*. <https://www.atlassian.com/blog/artificial-intelligence/learn-ai>
- Virtual classrooms & adaptive learning: Modern education. (n.d.). Giggle Academy. <https://www.giggleacademy.in/virtual-classrooms-and-adaptive-learning-modern-education>
- What are the components of AI?(2024, January 11). Ello Talent. <https://ello.io/components-of-ai/>

## Individual Work and Homework Assignments

### During Lesson:

1. Students analyze an AI application and present its pros and cons.
2. Group discussions on AI's ethical challenges in virtual spaces.

### Homework:

1. Research an AI system and write a one-page summary on how it impacts society.
2. Create a short presentation on an AI innovation that could improve virtual learning environments.

# Evaluation and indicators

Assessment will be conducted through student participation in discussions, accuracy in analyzing AI applications, and engagement in the practical exercise. Success indicators include the ability to correctly identify AI capabilities and limitations, articulate AI's role in the Metaverse, and critically assess ethical challenges. Homework assignments and group presentations will also be evaluated based on clarity, depth, and application of concepts.

<b>Evaluation and Indicators Specifics</b>	
Expected Outcomes	Students should demonstrate a clear understanding of AI fundamentals, its role in the Metaverse, and ethical implications
Assessment Methods	<ul style="list-style-type: none"><li>• Participation in discussions and group activities.</li><li>• Quality of AI application analysis and scenario-based responses.</li><li>• Clarity and depth in homework assignments.</li></ul>
Success Indicators	<ul style="list-style-type: none"><li>• Ability to explain AI concepts and applications accurately.</li><li>• Critical evaluation of AI's role in society and virtual environments.</li><li>• Thoughtful engagement in ethical debates on AI.</li></ul>



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## Overview of the lesson

This lesson is an in-depth exploration of Artificial Intelligence (AI) and its uses in the Metaverse. Students will explore the fundamentals of AI and its most significant components such as Machine Learning, Neural Networks, Natural Language Processing, and Computer Vision. Through engaging discussions and real-world examples, students will discover how AI is being utilized in various sectors such as healthcare, education, and virtual worlds. It dedicates a lot of the lesson to the impact of AI on the Metaverse where it provides value to users' experience through realistic Non-Player Characters (NPCs), user-specific experiences, and procedural world generation. Ethical concerns that accompany the application of AI are also accorded consideration in the lesson, and they encompass bias, privacy concerns, automation of work, as well as over-reliance on AI-driven systems. To reinforce their knowledge, students will undertake an interactive practical activity in which they examine AI capabilities and constraints. By the end of this session, students will have attained a well-rounded grasp of AI applications, ethical implications, and prospects, enabling them to critically evaluate the contributions of AI in designing our digital environment.



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# MSTEM

## LESSON PLAN : MACHINE LEARNING

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## Purpose of Lesson:

This lesson aims to introduce students to Machine Learning and its role in Artificial Intelligence. By understanding ML fundamentals, students will see how data-driven systems are transforming various industries, including the Metaverse. This knowledge will help them appreciate the power of AI in creating intelligent, interactive virtual environments.

## Description of Lesson:

This lesson introduces students to the fundamental concepts of Machine Learning (ML) and its applications, particularly in the Metaverse. Students will learn how ML algorithms process data, identify patterns, and make predictions without explicit programming. The lesson will explore the key components of ML, different learning methods (Supervised, Unsupervised, and Reinforcement Learning), and real-world applications such as AI-powered healthcare, self-driving cars, and intelligent virtual environments. A special focus will be placed on how ML enhances the Metaverse by creating adaptive, responsive, and immersive digital experiences. Through discussions, interactive exercises, and practical applications, students will develop a deeper understanding of how ML influences modern technology and future innovations.

## Lesson Teaching Method:

This lesson will be taught using a combination of informative instruction, practical exercises, and open-ended discussions. The informative segment will provide students with foundational knowledge of Machine Learning, including its key components and applications. Practical exercises will allow students to engage with ML concepts hands-on, such as analyzing datasets or identifying patterns in AI-driven technologies. Open-ended discussions will encourage critical thinking, prompting students to explore ethical considerations, future developments, and the role of ML in the Metaverse. By combining structured learning with interactive engagement, this approach ensures that students not only understand the technical aspects of ML but also develop the ability to apply their knowledge in real-world contexts.

# Lesson Objectives:

By the end of this lesson, students will be able to:

- Define Machine Learning (ML).
- Identify key components of Machine Learning.
- Explain different types of Machine Learning.
- Recognize real-world applications of ML, particularly in the Metaverse.
- Understand how ML systems "learn" and make predictions.
- Identify the process of training a machine learning model.
- Explain challenges and the future of ML.

## Lesson plan:

### Introduction (10min)

- Brief discussion on AI and Machine Learning.
- Real-life examples of ML applications (Netflix recommendations, self-driving cars).
- Explanation of ML's role in the Metaverse.

### Core Concepts (30 min)

- Definition of ML and key components (data, model, algorithm, feedback).
- Types of ML: Supervised, Unsupervised, and Reinforcement Learning.
- The process of training an ML model.

### Real-World Applications (20 min)

- ML in gaming and interactive virtual environments.
- How NPCs (non-player characters) adapt and improve through ML.
- Discussion on ML challenges like bias, overfitting, and data quality.

### Interactive Activity (20 min)

- A simple ML experiment where students classify data (e.g., identifying patterns in a dataset).
- Group discussion on the future of ML in the Metaverse.

### Conclusion & Q&A (10 min)

- Recap key concepts.
- Open discussion on the ethical implications of AI.

# Lesson table

<b>Lesson Plan</b>	
<b>Introduction:</b> <ul style="list-style-type: none"><li>• Learning objectives</li><li>• Defining Machine Learning</li></ul>	10 minutes
<b>Key components of Machine Learning</b> <ul style="list-style-type: none"><li>• Data</li><li>• Model</li><li>• Learning Algorithm</li><li>• Feedback/Prediction</li></ul> <b>Types of Machine Learning</b> <ul style="list-style-type: none"><li>• Supervised &amp; Unsupervised</li><li>• Reinforcement Learning</li><li>• Examples</li></ul>	15 minutes
<b>Real World Applications of Machine Learning</b> <ul style="list-style-type: none"><li>• Healthcare</li><li>• Entertainment</li><li>• Finance</li><li>• Metaverse</li></ul> <b>The Role of Data in Machine Learning</b> <ul style="list-style-type: none"><li>• Importance of Data Quality</li><li>• Training Data vs. Test Data</li></ul> <b>The Process of Training a Machine Learning Model</b>	15 minutes



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# Lesson table

Lesson Plan	
<p><b>Example of a Simple Machine Learning Task</b></p> <p><b>Common Challenges in Machine Learning</b></p> <ul style="list-style-type: none"><li>• Data Quality Issues</li><li>• Overfitting</li><li>• Bias in ML</li></ul> <p><b>The Future of Machine Learning</b></p> <ul style="list-style-type: none"><li>• AI Powered Healthcare</li><li>• Autonomous Vehicles &amp; Reinforcement Learning</li><li>• Smarter Personal Assistants &amp; Virtual Companions</li></ul>	15 minutes
<p><b>Discussion time</b></p>	10 minutes



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## Lesson resources

- Presentation slides on ML concepts and applications.
- Online articles and reports on AI's impact in different industries.
- Internet access for group research.

### Resources used to create the lesson:

- The basic concepts of machine learning. (n.d.). Discover the Domo Data Experience Platform | Domo. <https://www.domo.com/glossary/what-are-machine-learning-basics>
- Kapse, S. (2022). Ethics in AI in machine learning. Handbook of Research on Machine Learning, 3-24. <https://doi.org/10.1201/9781003277330-2>
- Machine learning, explained. (2021, April 21). MIT Sloan. <https://mitsloan.mit.edu/ideas-made-to-matter/machine-learning-explained>
- Nasteski, V. (2017). An overview of the supervised machine learning methods. HORIZONS.B, 4, 51-62. <https://doi.org/10.20544/horizons.b.04.1.17.p05>
- Real-world examples of machine learning (ML). (n.d.). Tableau. <https://www.tableau.com/learn/articles/machine-learning-examples>
- The role of AI & ML in transforming the Metaverse. (2024, February 9).
- Unlock Your Goals with GrowthJockey Digital Solution. <https://www.growthjockey.com/blogs/ai-and-ml-in-metaverse-development>

## Individual Work and Homework Assignments

### In-Class Assignments:

1. Answer discussion questions
2. After answering discussion questions, write a short reflection on how Machine Learning is transforming industries and how it may shape the future of technology.

### Homework Assignments:

1. Research a Metaverse platform and explain how it utilizes Machine Learning to enhance user experience.
2. Identify a real-world example of ML in action (e.g., self-driving cars, AI assistants) and analyze its benefits and potential challenges.



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# Evaluation and indicators

<h2 style="text-align: center;">Evaluation and Indicators Specifics</h2>	
<p>Expected Outcomes</p>	<p>Students are expected to demonstrate a clear understanding of Machine Learning concepts, including its key components, learning types, and real-world applications. They should be able to explain how ML is used in the Metaverse to create intelligent and adaptive virtual environments. Additionally, students should critically analyze ML’s future impact and ethical considerations.</p>
<p>Assessment Methods</p>	<p>Assessment will be conducted through participation in discussions, the quality of responses to discussion questions, and the depth of reflection in written assignments.</p>
<p>Success Indicators</p>	<p>Success indicators include students accurately defining ML, analyzing its applications, and actively discussing its challenges. Assessments will focus on clarity and depth in written reflections, originality in discussions, and practical engagement in activities like data analysis and pattern recognition.</p>



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## Overview of the lesson

This lesson introduces students to the fundamentals of Machine Learning (ML) and its role in shaping modern technology, particularly within the Metaverse. Students will explore key ML concepts, including how algorithms learn from data, different types of ML, and real-world applications across industries such as healthcare, finance, and gaming. A special focus will be placed on how ML enhances virtual environments by making them more interactive and adaptive. Through a combination of informative instruction, practical exercises, and open-ended discussions, students will develop both a theoretical understanding and a critical perspective on the future impact of ML in digital spaces.



# MSTEM

## LESSON PLAN: SCIENCES

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## Purpose of Lesson:

The purpose of a lesson on Climate Change and Technological Solutions is to educate students about the causes and effects of climate change while exploring innovative technologies that can help mitigate its impact.

## Description of Lesson:

This lesson provides an in-depth exploration of climate change, its causes, and its global impact, while highlighting technological innovations designed to mitigate its effects. Students will engage in discussions about greenhouse gases, global warming, and environmental consequences such as extreme weather, rising sea levels, and biodiversity loss.

The lesson will then shift focus to technological solutions, including renewable energy sources (solar, wind, hydro, and geothermal), carbon capture and storage, sustainable agriculture, green transportation, and smart city innovations. Through case studies, multimedia resources, and hands-on activities, students will analyze real-world applications of these technologies.

By the end of the lesson, students will gain a deeper understanding of climate challenges and be inspired to explore how science and technology can drive sustainable solutions. The lesson encourages critical thinking, innovation, and environmental responsibility, equipping students with knowledge and ideas for future climate action.

## Lesson Teaching Method:

To effectively engage students and enhance their understanding of climate change and technological solutions, a combination of interactive and student-centered teaching methods. The aim is for students to create **immersive experiences/virtual worlds** that show the impacts of climate change, such as melting glaciers or rising sea levels.



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# Lesson Objectives:

- Understand the causes and consequences of climate change on the planet.
- Explore data on climate change and its relationship with factors such as temperature and gas emissions.
- Use technological tools to analyze and propose solutions to mitigate the impacts of climate change.
- Foster the ability to work with scientific data and simulations

## Lesson Plan

### 1. Introduction (15m)

- Initial Activity:
  - Start the class with a brief introduction to what climate change is, addressing its main causes (greenhouse effect, deforestation, pollutant gas emissions) and the main global effects (global warming, melting of the polar ice caps, extreme weather events).
- Questions for reflection:
  - Ask students what they know about global warming and its consequences. Let them reflect on how human actions are contributing to the problem.
  - Use images or short videos of extreme weather events (such as hurricanes, droughts, floods) to illustrate visible impacts and generate discussion.

## 2. Development (50m)

### Part A: Scientific Research and Data Analysis (20 minutes)

- Climate Data Exploration:
  - Present students with graphs and charts showing the increase in global temperature over the past 100 years. Show how scientists monitor these changes using data from satellites and weather stations.
  - Use data analysis software, such as Excel or Google Sheets, to help students visualize and interpret climate data. They can look for trends in rising average temperatures, changes in sea levels, and more.

#### Group Activity:

- Divide students into groups and assign each group a set of climate data (average global temperature, CO2 levels, sea level variation, etc.).
- Students should create graphs and charts to visualize the data and identify patterns of change. Ask them how these changes might affect different regions of the world.

### Part B: Technological Solutions and Engineering Projects (30 minutes)

#### Exploration of Green Technologies:

Introduce the concept of green technologies, such as solar panels, wind turbines and electric cars, and how they can help mitigate climate change.

Show videos or animations about how these technologies work and how they contribute to reducing carbon emissions.

#### Practical Activity in Groups:

Each group will be responsible for designing a technological or structural solution to help combat the effects of climate change. They should think about how technology can be used to reduce CO2 emissions, generate renewable energy or improve the energy efficiency of buildings.

Using paper, recycled materials or modelling software such as Tinkercad, groups should create a model or mock-up of the solution they have developed. This could be an idea such as a sustainable house, a small wind turbine or a homemade solar panel.



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## Challenges and Discussion:

After groups present their projects, discuss how their solutions could be applied in the real world. What challenges and limitations would they face in implementing these solutions? How could these technologies be scaled to meet global needs?

### 3. Conclusion (15m)

- Presentation of Projects:
  - Groups present their solutions to the rest of the class. They should explain how their idea can help mitigate the impacts of climate change and how technology was used in the process.
- Final Reflection:
  - Conclude with a discussion of how science, technology, and engineering can work together to combat climate change.
  - Ask students what they can do in their daily lives to contribute to sustainability and environmental preservation.
- Closing:
  - Propose a small challenge: what actions can students implement in their school or community to reduce their carbon footprint and raise awareness about climate change?

## Lesson table

Lesson Plan	
<b>Introduction (15m)</b>	<p>Opening Question: Start with a thought-provoking question:</p> <ul style="list-style-type: none"> <li>• “What do you think is the biggest environmental challenge our planet faces today?”</li> <li>• “How do you think technology can help solve climate change?”</li> </ul>
<b>Development (50m)</b>	<ul style="list-style-type: none"> <li>• Causes of Climate Change</li> <li>• Effects of Climate Change</li> <li>• Class Discussion</li> <li>• Technological Solutions</li> </ul>
<b>Conclusion(15m)</b>	<p>Recap the main topics covered: causes/effects of climate change, technological solutions, and student ideas.</p> <p>Discuss how students can contribute (e.g., reducing waste, supporting renewable energy, advocating for policy changes).</p>

# Work and homework

## Homework:

As an extension activity, ask students to create a climate change awareness campaign using the solutions they developed, with the goal of sharing information with other classes or the school community

## Evaluation/ Assessment:

- Participation: Evaluate student participation in data analysis and technological solutions development activities.
- Data Analysis: Check students' ability to interpret climate data correctly and draw relevant conclusions.
- Creativity in the Project: Evaluate the creativity and feasibility of the solutions presented by the students.
- Collaboration: Observe how students work as a team to develop their solutions and how they communicate their ideas.

# Evaluation and indicators

Observing student engagement in discussions, Q&A, and brainstorming activities

Evaluation and Indicators Specifics	
Expected Outcomes	Students will understand the causes and effects of climate change.
Assessment Methods	<p>Class Discussions &amp; Participation Observe student involvement in discussions about climate change causes, effects, and technological solutions. Measure their ability to engage with and contribute to the conversation. Indicator: Active participation and relevant contributions.</p> <p>Group Work (Climate Tech Challenge) Evaluate students' teamwork, creativity, and critical thinking while developing their technological solutions. Indicator: Effective collaboration, innovative ideas, and clear presentation of the solution</p>
Success Indicators	<p>Students can accurately explain the causes and effects of climate change. Students analyze climate issues and propose practical, feasible technological solutions.</p>

## Overview of the lesson

This lesson explored the complex issue of climate change and examined innovative technological solutions that can mitigate its effects. Students gained a solid understanding of the causes and consequences of climate change, such as global warming, rising sea levels and extreme weather events. The class also presented various technological solutions aimed at reducing carbon emissions, promoting sustainability and adapting to environmental challenges



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## LESSON PLAN: MATHEMATICS

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## Purpose of Lesson:

The purpose of this lesson is to help students understand the importance of polygons in geometry, particularly their role in architecture and engineering. By exploring the basic properties of polygons and their practical applications in real-world designs, students will gain an appreciation for how geometry shapes the structures around us.

## Description of Lesson:

This lesson on polygons introduces students to the fundamental geometric shapes that form the basis of many structures in architecture, engineering, and product design. The lesson begins by defining polygons as flat, two-dimensional shapes made up of straight line segments called sides that meet at points known as vertices. Students will explore various types of polygons such as triangles, squares, pentagons, and hexagons, and understand how each polygon has unique properties that make it suitable for different applications. Throughout the lesson, students will learn how polygons are integral to real-world structures like buildings, bridges, and monuments. They will observe how architects and engineers use polygons to create stable, efficient, and aesthetic designs.

## Lesson Teaching Method:

The teaching method for this lesson on polygons incorporates a combination of direct instruction, visual aids, and hands-on activities to engage students and deepen their understanding. The lesson aims to combine theoretical knowledge with practical application, making learning both informative and interactive. Create virtual classrooms where students can manipulate 3D polygons, exploring properties such as area, perimeter and angles interactively.



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# Lesson Objectives:

By the end of this lesson, students will be able to:

- Identify the different types of polygons based on the number of sides.
- Understand the concept of polygons, their properties and classifications.
- Explore how polygons are used in various areas of technology, engineering and science (STEM).
- Promote the use of technological tools to simulate and design polygons.

# What are Polygons?

Polygons are flat, closed geometric figures delimited by straight line segments. Some examples of polygons are triangles, squares, and rectangles.

- **Types of Polygons:** Triangles, Quadrilaterals, Pentagons, Hexagons, Heptagons, Octagons
- **Properties of Polygons:** Sides, Internal Angles, Diagonals
- **Classification of Polygons** Regular and Irregular

# Lesson Plan

## 1.Introduction (10m)

- Start with a brief review of geometric figures, highlighting polygons.
- Explain that polygons are flat figures formed by straight line segments that meet at points called vertices.
- Present examples of polygons in everyday life (architecture, product design, civil engineering) and how they are important for building stable and efficient structures.

## 2.Main Lesson (25m)

Uses of Polygons in Daily Life, Architectural Design: Designing Architectural structures and monuments is extremely important for engineers. If we carefully observe, almost every architecture is a product of geometric analysis done with precision and accuracy.

## 3.Practical Activity (20m)

Objectives:

The teacher aims to help students apply geometry in a practical way, simulating the use of calculations and technologies to solve construction problems. It also aims to encourage teamwork and the communication of ideas to solve a real problem.

Construction of Polygons: -Divide the students into groups and hand out materials (cardboard, ruler and compass).

Each group must construct different polygons (triangles, quadrilaterals, pentagons, hexagons), drawing them and marking the vertices and sides. -For each polygon, calculate and mark the sum of the internal angles.

Digital Exploration:

Use programs like GeoGebra to have students draw polygons digitally, visualizing how angles and properties change as they change sides. Use programs like GeoGebra to have students draw polygons digitally, visualizing how angles and properties change as they change sides.

## 4. Conclusion (10m)

- Presentation of Projects: each group presents its construction to the rest of the class, explaining the choices made in terms of geometric shapes and calculations performed.
- Discussion: What did you learn about how geometry is used in real constructions? How has technology helped in the design and problem-solving process?



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## Lesson table

Lesson Plan	
<b>Introduction (10m)</b>	Define polygons and identify their key properties. Classify polygons based on the number of sides. Identify real-life applications of polygons in architecture, product design, and civil engineering.
<b>Main Lesson (25m)</b>	Understand the role of polygons in architecture and engineering. Recognize the use of polygons in creating stable, efficient structures
<b>Practical Activity (20m)</b>	Divide the students into groups Each group must construct different polygons GeoGebra
<b>Conclusion (10m)</b>	Presentation of Projects Discussion

# Lesson resources

**Lesson resources:** • Tablets, computers or smartphones with geometric modeling software (GeoGebra, Tinkercad). • Paper and pen for initial sketches and calculations. • Projector for demonstrations and visualizations.

## Resources used to create the lesson:

- Books: - "How to Solve It: A New Aspect of Mathematical Method" - George Pólya Publisher: Princeton University Press
- Geogebra Link: <https://www.geogebra.org>
- MIT OpenCourseWare - Mathematics Link: <https://ocw.mit.edu/courses/mathematics/>  
Desmos Link: <https://www.desmos.com>
- STEM Resource Center (NCTM) Link: <https://www.nctm.org>



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## Work and homework

**Homework:** Research how they think geometric concepts can be applied in other fields, such as science and engineering. With practical examples.

**Evaluation/ Assessment:** Students are assessed based on: - Participation in practical activities. - In the application of mathematical concepts in constructions and calculations. - Creativity in applying concepts in 3D modeling. - Clarity and precision in project presentations.

## Evaluation and indicators

Evaluation is essential to measure students' understanding and progress in learning polygons.

- Project-Based Assessment – Ask students to create a poster or presentation on real-life polygon applications.
- Homework/Practical Activity – Students find real-world polygons (e.g., road signs, windows) and explain their characteristics.

## Evaluation and Indicators Specifics

<p>Expected Outcomes</p>	<p>These outcomes will ensure students grasp the concept of polygons effectively while developing critical thinking and problem-solving skills</p>
<p>Assessment Methods</p>	<p>Worksheets &amp; Exercises</p> <ul style="list-style-type: none"> <li>• Classify polygons based on given diagrams.</li> <li>• Calculate the perimeter of different polygons.</li> <li>• Label polygons correctly based on their sides and angles</li> </ul> <p>Real-Life Application Assignment (Homework)</p> <ul style="list-style-type: none"> <li>• Find and take pictures/draw polygons seen in daily life (tiles, windows, road signs).</li> <li>• Write a short explanation of how polygons are used in different fields (architecture, nature, design)</li> </ul>
<p>Success Indicators</p>	<p>Knowledge-Based Indicators (Understanding the Concept)</p> <p>Skill-Based Indicators (Application &amp; Problem-Solving)</p> <p>Engagement &amp; Participation Indicators</p>



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# Overview of the lesson

This lesson on polygons aimed to introduce students to the basic geometric shapes that form the foundation of many structures in architecture, engineering, and design. By exploring the properties of polygons and their practical applications, students will gain a deeper understanding of how geometry contributes to the stability, efficiency, and aesthetic appeal of the built environment.



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# MSTEM

## LESSON PLAN: HUMAN ANATOMY

METaverse-BASED STEM EDUCATION FOR A  
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2023-1-FR01-KA220-SCH-000151516



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EURASIA INSTITUTE



INSPECTORATUL ȘCOLAR  
JUDEȚEAN TELEORMAN



City of Malmö



## Purpose of the lesson

The aim of this class is to help our students understand the complex phenomenon of digestion, through knowledge of the anatomy and physiology of the digestive system. In addition, concepts such as the different types of nutrients will be reviewed and the requirements of a balanced diet will be taken into account.

## Description of the lesson

Students will learn about the anatomy and physiology of the digestive system through the journey of a bite of a ham and tomato sandwich, with an emphasis on the parts where digestion of different nutrients occurs.

## Lesson teaching method

- **Learning based on thinking:**

The main thing is to teach how to work with and make the most of the information received. It teaches to contextualise, relate, analyse, put in common, argue... You teach, therefore, to think.

- **Virtual and augmented reality in training**

Virtual reality (VR) and augmented reality (AR) offer immersive environments that facilitate more dynamic and engaging learning. Simulations created through virtual reality provide learners with the opportunity to experience practical situations in a safe environment.

- **Flipped classroom**

Students will work at home on the parts of the digestive system to acquire the necessary basis for understanding the physiology of the digestive system, and to be able to spend more time on the practical side

- **Cooperative learning**

Improves attention, increases involvement and enhances knowledge acquisition. Each member has an assigned role and specific functions to be achieved successfully. Interacting and working in coordination is essential to achieve the common goal.



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JUDEȚEAN TELEORMĂN



# Lesson objectives

By the end of this lesson, students will be able to:

- Know the anatomy of the digestive system.
- Know how the process of digestion works, differentiating between what happens in each of the parts.
- Differentiate between mechanical and chemical digestion, and know where the digestion of each of the nutrients occurs.
- Recognise pseudoscientific hoaxes related to food, and be able to 'debunk' them using reliable sources of information.

## Lesson plan

### 1.- Introduction (less than 5 min):

- Engage students by telling them that in this part of the syllabus we are going to poop.

### 2.- Main lesson: (35-40 min)

- The digestive process: Explanation of the physiology of the digestive system, using a bite of our ham and tomato sandwich. We will look at all the parts it goes through, and what process occurs in each part.

### 3.- Metaverse activity: Practical exercise (25-30 min)

- Review of the process through a virtual journey through the digestive system. Students will have to solve the questions posed to them in order to progress and complete the digestion process in the best possible way (Alternative: Laboratory practice).

### 4.- Conclusion (10-15 min)

- Review of the most important points of the
- topic Explanation of the task



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# Lesson table

<b>Lesson plan</b>	
<b>Introduction:</b> <ul style="list-style-type: none"><li>Engaging approach</li></ul>	<b>1- 5 min</b>
<b>Main lesson:</b> <ul style="list-style-type: none"><li>The digestive process: Anatomy and physiology of the digestive system.</li></ul>	<b>35-40 min</b>
<b>Metaverse activity: Practical exercise</b> <ul style="list-style-type: none"><li>Virtual journey through the digestive system. Students will have to solve the questions posed and complete the digestive process, fulfilling the objective set: Pooping.</li><li>(Alternative: Laboratory practice).</li></ul>	<b>25-30 min</b>
<b>Conclusion</b> <ul style="list-style-type: none"><li>Review of the most important points of the topic</li><li>Explanation of the task</li></ul>	<b>10-15 min</b>

## Lesson resources

- Presentation slides on the thematic of the lesson
- Access to a VR platform for the Metaverse activity. Alternative: Access to the Laboratory

### Resources used to create the lesson:

- García López, M. (2022). *Biology and Geology 3, Secondary*. Fanfest Edelvives.
- Ballarín, P. L. (n.d.). *2.8. Mutations. Relationships with evolution*. Biologia-geologia.com. Retrieved April 16, 2025, from [https://biologia-geologia.com/BG4/28\\_mutaciones\\_relaciones\\_con\\_la\\_evolucion.html](https://biologia-geologia.com/BG4/28_mutaciones_relaciones_con_la_evolucion.html)
- Instituto de Enseñanzas a Distancia de Andalucía (IEDA). (n.d.). *1.1. Physiology of the digestive process*. Junta de Andalucía. Retrieved April 16, 2025, from [https://edea.juntadeandalucia.es/bancorecursos/file/025c9dfd-df1f-4147-91e1-79f591546c5b/1/es-an\\_2021062112\\_9201048.zip/11\\_fisiologa\\_del\\_proceso\\_digestivo.html?temp.hn=true&temp.hb=true](https://edea.juntadeandalucia.es/bancorecursos/file/025c9dfd-df1f-4147-91e1-79f591546c5b/1/es-an_2021062112_9201048.zip/11_fisiologa_del_proceso_digestivo.html?temp.hn=true&temp.hb=true)

## Work and homework

### Individual work:

- Work 1: Exercises applying the content seen to be able to complete the challenge of the journey of the morsel in the digestive tract.

### Homework:

- Homework 1: In pairs, you will have to look for pseudoscientific myths or hoaxes related to the effects of certain foods or habits on the digestive process and record Reel-type videos, debunking these myths.

# Evaluation and indicators

## Assessment Methods:

- Practical exercise: Students will be assessed on their ability to relate anatomy and physiology of the digestive system in order to be able to recreate the entire digestive process, recognising what happens in each part of it.
- Homework: The quality of the final product will be assessed on the basis of its final presentation, editing and editing of the video, quality of the information given, and oral expression.
- Teamwork and participation: Each student will evaluate the work of his/her partner, as well as his/her own work. In addition, the interaction between the two will be assessed, penalising those who divide up the work and then put it together without any kind of connection.

## Success Indicators:

- The student knows the parts of the digestive system
- The student is able to relate these parts to the function they perform.
- The student is able to recognise the enzymes involved in the digestive process, where they are found, and which nutrient they digest.
- Pupils work well in groups
- The student produces good group work, with information appropriate to the level required, and with an attractive final product.

## EVALUATION AND SPECIFIC INDICATORS

WHAT IS BEING ASSESSED?	INDICATORS
Practical exercises	<ul style="list-style-type: none"><li>• Ability to relate anatomy and physiology of the digestive system</li></ul>
Homework	<ul style="list-style-type: none"><li>• Final presentation of the video</li><li>• Quality of the information given</li><li>• Oral expression.</li><li>• Team work</li></ul>



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## Overview of the lesson

With this lesson, the student will acquire a complete knowledge of how the digestive process works, from the moment we ingest a food until we defecate, through a practical example, in which they will have to relate the different nutrients they have consumed with the parts of the digestive tract in which digestion takes place, and also with the enzyme that carries out the process. In addition, we will learn to recognise false information, and to contrast it with reliable sources of information.



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# MSTEM

## LESSON PLAN: BIOLOGY (GENETICS)

METAVERSE-BASED STEM EDUCATION FOR A  
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*2023-1-FR01-KA220-SCH-000151516*



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## Purpose of the lesson

The aim of this class is to help our students understand the complex phenomenon of mutations and their important effects, as well as the main tool currently used in gene editing (CRISPR). In addition, we will seek to develop students' critical thinking by analysing and debating the ethical aspects of gene editing techniques.

## Description of the lesson

Students will study the main types of mutations, differentiating them according to the cells affected (germ or somatic), or according to the mechanism that has caused the alteration in the genetic material (genetic or chromosomal). In addition, the main gene editing technique, CRISPR, will be studied, as well as the very important aspect of bioethics.

## Lesson teaching method

- **Learning based on thinking:**

The main thing is to teach how to work with and make the most of the information received. It teaches to contextualise, relate, analyse, put in common, argue... You teach, therefore, to think.

- **Virtual and augmented reality in training:**

Virtual reality (VR) and augmented reality (AR) offer immersive environments that facilitate more dynamic and engaging learning. Simulations created through virtual reality provide learners with the opportunity to experience practical situations in a safe environment. This is especially valuable in a discipline such as genetic engineering. Students can practice without the risks associated with real life.

- **Cooperative learning:**

Improves attention, increases engagement, and enhances knowledge acquisition. Each member has an assigned role and specific functions that must be successfully achieved. Interacting and working in coordination is essential to achieve the common goal.



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# Lesson objectives

By the end of this lesson, students will be able to:

- Differentiate between the different types of mutations according to the cells affected.
- Differentiate between different types of mutations according to the mechanism that has caused the alteration in the genetic material.
- Know the causes and types of mutations
- To understand what genetic engineering is and its most commonly used techniques. Know in detail how the CRISPR gene-editing tool works.
- To argue their opinion on the ethical implications of gene editing.

# Lesson plan

## 1.- Introduction (10-15 min):

- Engage students by showing pictures of mutant organisms (what they understand by mutant), and suddenly move on to show pictures of fruits and vegetables or of the teacher himself/herself.
- Ask the following question: What is a mutant for you?
- Open discussion

## 2.- Main lesson: (25-30 min)

- Explanation of the concept of mutation
- Types of mutations according to the type of cell affected Germline mutations and their relationship to evolution.
- Somatic mutations
- Types of mutations according to the mechanism that has caused the alteration in the genetic material: genetic and chromosomal.
- Explanation of the concept of genetic engineering Gene editing (CRISPR-Cas9) Bioethics

### 3.- Metaverse activity: Practical exercise (15-20 min)

- Students enter a virtual genetic engineering laboratory and practise the different types of mutations.
- Afterwards, they are given a problem to solve using CRISPR-Cas9.

### 4.- Conclusion (10-15 min)

- Recap key points.
- They are asked a series of questions and a debate is opened:

1. Is it ethical to modify the genome of a human embryo to prevent genetic diseases, and would your opinion change if the aim was to improve physical or intellectual characteristics?

2. In 2018, a Chinese scientist announced that he had edited the DNA of twin girls to make them resistant to HIV. What do you think of this decision? Was it ethical? Why or why not?

## Lesson table

<b>Lesson plan</b>	
<p><b>Introduction:</b></p> <ul style="list-style-type: none"> <li>• Engaging activity.</li> <li>• Open discussion: What is a mutant for you?</li> </ul>	<b>10-15 min</b>
<p><b>Main lesson:</b></p> <ul style="list-style-type: none"> <li>• Explanation of the concept of mutation and their different types</li> <li>• Explanation of the concept of genetic engineering</li> <li>• Gene editing (CRISPR-Cas9)</li> <li>• Bioethics</li> </ul>	<b>25-30 min</b>
<p><b>Metaverse activity: Practical exercise</b></p> <ul style="list-style-type: none"> <li>• Students enter a virtual genetic engineering laboratory and practise the different types of mutations.</li> <li>• Afterwards, they are given a problem to solve using CRISPR-Cas9.</li> </ul>	<b>15-20 min</b>
<p><b>Conclusion (10-15 min)</b></p> <ul style="list-style-type: none"> <li>• Recap key points.</li> <li>• Open discussion about bioethics</li> </ul>	<b>15 min</b>

## Lesson resources

- Presentation slides on the thematic of the lesson
- Access to a VR platform for the Metaverse activity

### Resources used to create the lesson:

- Agencia SINC. (n.d.). This is how CRISPR works: The revolutionary DNA editing tool. Agencia SINC. <https://www.agenciasinc.es/Visual/Infografias/Asi-funciona-CRISPR-la-revolucionaria-herramienta-de-edicion-de-ADN>
- Garrigues, F. (2023, June 6). CRISPR: What is it and how does it work? Genotipia. <https://genotipia.com/crispr-cas/>
- García López, Margarita. (2023). Biology and Geology 4, Secondary. Fanfest Edelvives.

## Work and homework

### Individual work:

- Work 1: Exercises on the recognition of different types of mutations.
- Work 2: Exercises on the application of the gene-editing technique CRISPR- Cas9

### Homework:

- Homework 1: In pairs, create a digital poster explaining animal experimentation and its bioethical considerations.
- Homework 2: Produce a scientific report on the five main mutagenic agents to which we humans are exposed.

# Evaluation and indicators

## Assessment Methods:

- Practical exercise: Students will be assessed on their ability to recognise the different types of mutations, as well as the accuracy in the resolution of the CRISPR-Cas9 application exercise.
- Homework: The quality of the final product will be assessed on the basis of its final presentation, quality of the information given, and written expression.
- Teamwork and participation: Each student will assess the work of his/her teammates and him/herself, and participation in class will be assessed, as well as the quality of the interventions.

## Success Indicators:

- The student knows the key terms related to the topic.
- The student is able to differentiate between the different types of mutations and what they consist of.
- The student performs the practical exercises correctly
- The student participates actively in class, presenting arguments and opinions clearly and using scientific language.
- The student participates actively in his/her group

## EVALUATION AND SPECIFIC INDICATORS

WHAT IS BEING ASSESSED?	INDICATORS
Class participation	<ul style="list-style-type: none"><li>• Number and quality of interventions</li><li>• Use of clear and specific language (scientific language)</li></ul>
Practical exercises	<ul style="list-style-type: none"><li>• Ability to recognise the different types of mutations</li><li>• Accuracy in the resolution of the CRISPR-Cas9 application exercise.</li></ul>
Homework	<ul style="list-style-type: none"><li>• Final presentation of the documents</li><li>• Quality of the information given</li><li>• Written expression.</li></ul>

## Overview of the lesson

This lesson introduces students to the concept of mutation, paying attention to the idea that not all mutations are bad. Linked to this, the concept of mutation is related to the concept of evolution. In addition, the different types of mutations are explained, as well as what each of them consists of. Subsequently, the concept of genetic engineering is introduced, the main tools used are given, and the functioning of the most important digital editing technique currently in use is explained in detail. It then moves into the field of bioethical considerations, with the aim of developing students' critical thinking and their ability to argue their opinions in an appropriate manner. At the end of the lesson, and after doing their group work, students will also learn about the most important mutagenic agents to which we are subjected in our daily lives, and where they are found.



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# M-STEM

## LESSON PLAN: NUCLEAR FISSION AND NUCLEAR FUSION

METaverse-BASED STEM EDUCATION FOR A  
SUSTAINABLE AND RESILIENT FUTURE

2023-1-FR01-KA220-SCH-000151516



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INSPECTORATUL ȘCOLAR  
JUDEȚEAN TELEORMAN



## Purpose of the lesson

Nuclear energy is a miracle that can do wonders for the existence of life on earth or turn everything into a nightmare - it depends on how and for what purpose it is used. Teaching students about nuclear fusion and nuclear fission is crucial because these concepts are fundamental for understanding modern energy production and the role of nuclear technology in society. By learning about these processes, students can appreciate the scientific principles that drive energy generation and the potential for sustainable energy through fusion. Moreover, this lesson offers students the possibility to discuss the benefits and risks associated with nuclear power, thus fostering critical thinking and informed decision-making.

## Description of the lesson

This lesson is aimed at helping students, aged 16-19, understand nuclear fission, nuclear fusion and nuclear energy; it is also targeted at familiarizing them with the components of a nuclear reactor and at offering them the chance to gain a well-rounded understanding of contemporary energy issues. By exploring the principles of nuclear fission, students will grasp how energy is produced on a massive scale, providing a clean alternative to fossil fuels. The activities included in this lesson plan will also teach students about the optimal conditions for the safe functioning of a nuclear reactor. Additionally, the scientific contents and didactical methods used will prepare students for potential careers in science, technology, engineering, and mathematics (STEM) fields, where they can contribute to innovative solutions for energy challenges.

## Lesson teaching method

In the teaching process, active-participatory, student-centered learning techniques and methods will be used. Participants in the activities will be trained to use the information acquired in practical exercises, to collaborate in completing work tasks, which will contribute to increasing intrinsic motivation for learning. Students will be challenged to discover facts and to bring arguments for and against. Metaverse technology will be used to create immersive learning experiences, in which students will experiment with the creation of a nuclear reactor, produce nuclear fission reactions. Thus, with the help of interactive exercises and practical applications, students will gain an advanced understanding of new content and be able to identify different causes of abnormal operation of a nuclear reactor.



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JUDEȚEAN TELEORMĂN



# Learning objectives

The lesson aims to convey knowledge/acquire practical skills to students, with the help of which they will be able to:

- understand nuclear fission and chain reaction;
- identify the structural elements of a nuclear reactor;
- (virtually) assemble a nuclear reactor
- analyze/identify possible effects of nuclear accidents
- critically assess the impact of the use of nuclear technologies on society and nature.

## Lesson plan

### 1. Introduction (5 minutes)

In order to prepare students for the new content, the teacher asks them to **present the poster** titled "Applying measures to protect the environment and oneself from nuclear radiation", which was the theme of the previous lesson. Divided into 4 groups, students present the poster they created for the lesson. A gallery tour is organized, a **peer-to-peer evaluation is carried out**, and students will express their appreciation in writing, using post-its.

### 2. Lesson progress (50 minutes)

#### a) Presentation of the concepts and objectives of the lesson (10 minutes)

The teacher projects two images – one illustrating the effects that the destructive use of nuclear energy has on life, and one capturing some of the benefits of nuclear energy for people and the environment. Organized into two groups, the students are invited to reflect on the content of the two images and add new ideas.

The teacher introduces the lesson objectives to the students and ensures that they understand the concepts they will be working with during the activities (nuclear fission reaction, chain reaction, critical mass, nuclear reactor, etc.). To do this, the teacher uses definitions of terms and suggestive images.

#### b) Interactive activities (40 minutes)

##### i). Nuclear fission (10 minutes)

With the help of a volunteer student, the teacher will demonstrate to the students the process of nuclear fission. Guided by the teacher, the student will press a button to release a neutron that will hit a nucleus of . After capturing a slow neutron, the uranium-235 nucleus splits into two intermediate nuclei of different masses and 2-3 neutrons.



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Students will notice that:

- the interaction potential energy for the uranium-235 nucleus is *minimum*
- after capturing the slow neutron, the total energy of the nucleus *increases*
- following the fission of the uranium-235 nucleus by capturing a slow neutron, energy equivalent to the difference in mass is released; *the result is two lighter nuclei* that have kinetic energy equal to the reaction energy  $Q=200\text{MeV}$  and several high-speed neutrons (fast neutrons).

The teacher explains to the students that the fission reaction of heavy nuclei ( $A>60$ ) that have an average binding energy lower than the maximum of  $8.6\text{MeV}$  is *exothermic*. The controlled fission reaction can be achieved using uranium 235 which fissions upon interaction with thermal neutrons (slow-speed neutrons, with kinetic energy much lower than  $1\text{MeV}$ ).

### ii). Chain reaction (10 minutes)

Students will be divided into two groups. Each team will appoint a representative who will use Metaverse technology for the following tasks:

- group 1 – fission chain reaction simulation: the designated student will press a button to release several neutrons that will hit several targets (unleashed uranium 235 nuclei). Using a counter, students will observe the number of nuclei that have fissioned. Students can rotate the neutron source to change the direction in which the neutron is sent, which will help them observe whether the chain fission reaction is influenced by the direction from which the neutron is released.
- group 2 - simulation of a nuclear explosion: the designated student will enlarge the space in which the chain fission reaction will occur, place a large number of uranium-235 nuclei in the enclosure, then initiate the reaction by releasing a neutron, pressing a button related to the activity. Students will notice that when the nuclei are placed in the enclosure, for larger radii of the enclosure that allow a large number of uranium-235 nuclei to fission (between 60 and 100), a nuclear explosion can occur.

### iii). Building a nuclear reactor (20 minutes)

Students will be divided into teams to complete the following task: building a nuclear reactor. For this, they will have a list of possible components for creating a nuclear reactor, but the list will also include some that are not part of the nuclear reactor. To begin with, students will select component elements to complete the task. Later, they will assemble them appropriately in order to build the nuclear reactor. Students will have an image of the final product they have to create.



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To carry out the practical activity, students will also receive information about the optimal conditions for normal operation of the nuclear reactor (stable temperature, proper functioning of the moderator, adequate neutron flux, efficient positioning of the control rods, constant coolant flow, etc.).

Subsequently, students will be challenged to identify possible malfunctions of a nuclear reactor (e.g., a break or leak in the cooling system, failure of control rod mechanisms or malfunction of neutron detectors, overheating of the reactor core, structural failure in the containment building, damage to fuel rods, etc.) and identify solutions.

### 3. Feedback on information/skills acquired (5 minutes)

The teacher will receive feedback, namely assess whether and to what extent the students have acquired new knowledge and skills by applying a test, such as the following:

#### Multiple Choice Questions (One correct answer)

1. Which of the following is a key component of a nuclear reactor?
  - A) Solar panels
  - B) Control rods
  - C) Wind turbines
  - D) Combustion chamber
2. What is the goal of using moderators in a nuclear reactor?
  - A) To slow down neutrons
  - B) To increase temperature
  - C) To absorb radioactive waste
  - D) To produce steam
3. Which of the following is a potential consequence of a nuclear accident?
  - A) Increased energy efficiency
  - B) Release of radioactive materials
  - C) Enhanced plant growth
  - D) Improved air quality
4. In nuclear fission, what happens to the nucleus of an atom?
  - A) It combines with another nucleus
  - B) It evaporates into gas
  - C) It remains unchanged
  - D) It splits into smaller nuclei



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- 5. What is the optimal condition for a nuclear reactor to function safely?
  - A) Controlled temperature and adequate coolant flow
  - B) High pressure and low temperature
  - C) Complete absence of control rods
  - D) Excessive neutron flux
- 6. How does changing the direction of the neutron source potentially affect the fission chain reaction?
  - A) It has no effect on the reaction
  - B) It allows for a better measurement of temperature
  - C) It influences the likelihood of neutrons hitting uranium-235 nuclei
  - D) It increases the number of neutrons available for fission

### True/False Questions

1. **True or False:** Nuclear fusion produces more energy than nuclear fission.
2. **True or False:** Nuclear fission can lead to the production of long-lived radioactive waste.
3. **True or False:** Control rods in a nuclear reactor are used to absorb neutrons and regulate the fission process.
4. **True or False:** Nuclear energy can only be used for peaceful purposes and has no potential for destruction.

### Answer key

*Multiple Choice Questions:* 1.B, 2.A, 3.B, 4.D, 5A, 6C,  
*True/False Questions* 1.True, 2. True, 3. True 4. False

## 4. Homework (5 minutes)

### Activity 1

Students will be asked to watch two video clips by accessing the following addresses:

- <https://www.youtube.com/watch?v=0I7QFfsHBks>
- <https://www.youtube.com/watch?v=Aza-2wopCFY>.

Based on the examples included in the films proposed for viewing, students will create a presentation on the effects of nuclear accidents. To create the presentation, students will use a digital application of their choice.

### Activity 2

Students will be divided into groups and will create a concept map regarding the impact of technologies on society and nature.



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## Lesson table

<b>Nuclear fission and nuclear fusion</b>	
<p><b>Introduction</b></p> <p>Preparing students for the new content (presentation of posters designed as homework of the previous class)</p> <p>Presentation of the concepts and objectives of the lesson</p> <ul style="list-style-type: none"> <li>• nuclear fission reaction,</li> <li>• chain reaction,</li> <li>• critical mass,</li> <li>• nuclear reactor, etc.)</li> </ul>	15
<p><b>i). Nuclear fission. Nuclear reactor</b></p> <p>A volunteer student, guided by the teacher, will demonstrate the process of nuclear fission</p>	10
<p><b>ii). Chain reaction</b></p> <p>Organized into two groups, students will</p> <ul style="list-style-type: none"> <li>• simulate a fission chain reaction</li> <li>• simulate a nuclear chain reaction</li> <li>• students will discuss what they have noticed while performing the tasks</li> </ul>	10
<p><b>iii). Building a nuclear reactor</b></p> <p>Divided into teams, students will complete the following task: building a nuclear reactor</p> <ul style="list-style-type: none"> <li>• Students will have some data to guide them in carrying out the task</li> <li>• Students will identify possible malfunctions of a nuclear reactor</li> <li>• Students will find possible solutions to the problems</li> </ul>	20

## Lesson table

<b>The importance of PH in every day life</b>	
<b>Assessment of acquired knowledge</b> Teacher assesses students' knowledge, using a quiz	5
<b>Homework</b> <ul style="list-style-type: none"><li>• <b>Activity 1</b> Students will create a presentation on the effects of nuclear accidents (students can use whatever informative information they can find, but the teacher will also provide some videos)</li><li>• <b>Activity 2</b> Students will be divided into groups and will create a concept map regarding the impact of technologies on society and nature.</li></ul>	5



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# Lesson resources

## Resources needed for the lesson

### Lesson resources

To carry out the activities, various informative materials on the topic of the lesson were used, from which the scientific content was selected, which was subsequently presented synthetically in a Power Point presentation.

### Digital resources

- <https://phet.colorado.edu/ro/simulation/nuclear-fission>
- <https://www.youtube.com/watch?v=0I7QFfsHBks>
- <https://www.youtube.com/watch?v=Aza-2wopCFY>
- <https://www.youtube.com/watch?v=dGr8ValTKbA>
- <https://www.youtube.com/watch?v=3nvkHjn1ETU>
- [https://www.youtube.com/watch?v=Kg\\_aSG2ZI6A](https://www.youtube.com/watch?v=Kg_aSG2ZI6A)
- [https://www.youtube.com/watch?v=a\\_E88op6cc](https://www.youtube.com/watch?v=a_E88op6cc)
- <https://iced.s.anu.edu.au/news-events/news/what%E2%80%99s-difference-between-fusion-and-fission-nuclear-physicist-explains>
- <https://www.solarreviews.com/blog/nuclear-energy-pros-and-cons>

## Evaluation and indicators

Assessment will be carried out throughout the learning activities; the teacher will assess the degree of involvement of the students in completing the tasks, applying knowledge in the construction of the nuclear reactor, identifying the dangers that may arise as a result of the improper use of nuclear energy, with disastrous effects on people and the environment. The teacher will provide feedback in a structured manner and will identify areas that require improvement. The teacher will assess the clarity and depth of the ideas expressed, their originality, as well as their level of applicability in everyday life.



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# Evaluation and indicators

Criteria	Excellent	Good	Satisfactory	Needs improvement
<b>Understanding of Nuclear Fission and Fusion</b>	Thorough understanding; clearly explains concepts and differences.	Good understanding; explains key concepts with minor errors.	Basic understanding; identifies concepts but lacks detail.	Limited understanding; struggles to explain concepts.
<b>Nuclear Chain Reaction Knowledge</b>	Provides a detailed explanation of the chain reaction process and its significance.	Explains the chain reaction with some details.	Basic description of the chain reaction process.	Limited explanation; major gaps in understanding.
<b>Benefits of Nuclear Energy</b>	Clearly articulates multiple benefits, supported by examples and relevance.	Identifies several benefits with some examples.	Lists benefits but lacks depth or examples.	Limited list of benefits; vague understanding.
<b>Components of a Nuclear Reactor</b>	Accurately identifies and describes all key components and their functions.	Identifies key components but with minor inaccuracies.	Names several components but lacks detailed descriptions.	Limited identification of components; significant gaps.
<b>Optimum Conditions for Functioning</b>	Thoroughly explains optimal conditions and their importance for safety.	Explains conditions with some details and relevance.	Basic understanding of conditions; lacks comprehensive explanations.	Limited explanation; unclear about safety significance.
<b>Overall Presentation and Clarity</b>	Ideas are exceptionally clear and well-organized; excellent use of terminology.	Clear presentation with minor issues in organization or terminology	Some clarity; organization could be improved.	Limited clarity; ideas are poorly organized.



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## Overview of the lesson

As global energy demands increase, knowledge regarding nuclear fusion, fission and nuclear reactors is essential, as it equips students with the scientific foundation needed to engage in discussions about sustainable energy solutions. This lesson focuses not only on providing theoretical understanding of these concepts and processes, but also on developing several practical skills. Moreover, this lesson challenges students to understand the necessary conditions for the correct functioning of a nuclear reactor, thus emphasizing the importance of safety, regulation, and ethical responsibility in technology use. Students are also encouraged to reflect on the benefits and drawbacks of nuclear energy. Through the activities included in the lesson, as well as through the methodological approach, students engage thoughtfully with energy issues and can contribute to the development of innovative solutions for a sustainable future. Equally important, the lesson offers students the possibility to improve problem-solving skills, team work and collaboration, analytical thinking, The simulation exercises, designed with the help of the Metaverse technology, will provide practical experience in applying theoretical concepts, reinforcing learning through active participation in the design process. Students will thus be prepared for future studies or careers in science, technology, engineering, and mathematics (STEM).



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# LESSON PLAN - THE IMPORTANCE OF PH IN EVERYDAY LIFE

METaverse-BASED STEM EDUCATION FOR A SUSTAINABLE AND RESILIENT FUTURE  
2023-1-FR01-KA220-SCH-000151516



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## Purpose of the lesson

The aim of the lesson is to develop a **solid understanding of pH** and its **impact** on different areas of life and the environment. The lesson aims to teach students how to **determine pH** through different methods, such as pH strips, chemical indicators or pH meters, to make students **aware of how pH influences** food, health, the environment, agriculture and various household and cosmetic products, which will allow them to **appreciate the relevance** of this concept in their daily lives, to be able to **identify** situations where it is **important to control pH** (e.g. water quality, plant health, correct use of cleaning products) and to know how to **apply solutions** to maintain **pH within appropriate ranges**.

## Description of the lesson

This lesson focuses on pH and provides students with **theoretical support** on the notion of pH, the pH scale, and the acidic, basic or neutral nature of solutions. The lesson **combines theory with practical examples** to facilitate understanding of the **applicability** of this concept in everyday life, in fields such as: medicine, food, agriculture, cosmetics, environment, etc. pH determinations will be made using pH strips, chemical indicators, or pH meters, highlighting the advantages and disadvantages of each method. The virtual lab allows students to **interactively explore** key concepts about pH, to conduct experiments, and to obtain **accurate data safely and quickly**, without the need for physical equipment and without the need for consumables. Students will analyze the change in water pH in a virtual aquatic ecosystem to which various pollutants are added and identify the effects of pollution on the aquatic environment and marine life.

## Lesson teaching method

This lesson is taught using an **interactive teaching method**, with the educator relying on a PowerPoint presentation to explain the concept of pH and the various methods of measuring it, while students will be invited to answer questions or provide examples of acidic or alkaline solutions. The teaching method is combined with the **discovery learning method**, in which students carry out practical work to determine the pH of different substances used in various fields; the teaching activity can be complemented with a *question-and-answer* session that encourages **critical thinking** and develops argumentation and communication skills.



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## Learning objectives

At the end of the lesson, students will be able to:

- **define** the concept of pH and understand the pH scale
- **use** various methods of measuring pH (pH strips, chemical indicators, pH meter)
- **explain** the importance of pH in various fields (food, health, environment, agriculture)
- **identify** the effects of pollution in everyday life (aquatic ecosystem), applying knowledge about pH.

## Lesson plan

### 1. Introduction (10 minutes)

Students will be challenged to answer the question "***What does pH mean and how do you think it influences everyday life?***" and will watch a video clip that illustrates/explains the importance of pH for the health of the human body, for nutrition, for soil quality.

The teacher will explain **the purpose of the lesson and its objectives**

Theoretical explanations:

- Definition of pH
- Explaining the pH scale
- Methods for determining pH
- The importance of pH in different fields

### 2. Lesson progress (40 minutes)

a). **Methods of determining pH values (5 minutes)**: students will be invited to watch a video showing different ways of determining pH (pH strips, chemical indicators and pH meter).

b). **pH determinations (10 minutes)**: Students will be organized into three groups, each team performing determinations for the same solutions (tap water, bottled carbonated water, cola, vinegar, NaOH, etc.), using one of the methods presented: pH strips, chemical indicators, and pH meter. Students will record the values of the determinations in a predefined table; the determinations can also be performed in a virtual format, using platforms such as *PhET pH Scale Simulation*.



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c). **Reflection activity (10 minutes)**: students will be challenged to participate in discussions about determining and recording pH values, to make small comparative analyses, as well as to highlight the advantages and disadvantages of the methods used.

d) **Interactive activity (15 minutes)**: analyzing the effects of pollution on the aquatic environment and marine life, through an experiment created with Metaverse technology. Students will determine the pH of water in a virtual aquatic ecosystem into which different polluting agents will be introduced: pesticides and fertilizers, detergents, petroleum products, acids, bases, etc.; students will observe the effects of pH changes on the ecosystem.

**3. Assessment of acquired knowledge (8 minutes)**: to assess the knowledge acquired, the teacher can use the following test:

**Multiple Choice Questions (one correct answer):**

1. What is the pH scale used to measure?

- A) Temperature
- B) Density
- C) Acidity and alkalinity
- D) Pressure

2. Which of the following pH values is considered neutral?

- A) 0
- B) 7
- C) 14
- D) 4

3. What is the primary advantage of using pH indicator paper for measuring pH levels?

- A) It provides precise numerical values.
- B) It is quick and easy to use.
- C) It does not require calibration.
- D) It can measure temperatures simultaneously.

4. What is a potential negative consequence of a high urine pH (alkaline urine)?

- A) Increased risk of kidney stone formation
- B) Enhanced absorption of nutrients
- C) Improved hydration levels
- D) Reduced risk of urinary tract infections

## Lesson table

<b>The importance of PH in every day life</b>	
<p><b>d) Interactive activity</b></p> <ul style="list-style-type: none"> <li>• Students analyze the effects of pollution on the aquatic environment and marine life</li> <li>• Students determine the pH of water in a virtual aquatic ecosystem into which different polluting agents are introduced</li> </ul>	15
<p><b>Assessment of acquired knowledge</b> Teacher assesses students' knowledge, using a quiz</p>	8
<p><b>Homework</b></p> <ul style="list-style-type: none"> <li>• <b>Activity 1</b> Create a material in which to present, synthetically, the optimal pH values for the development of plants</li> <li>• <b>Activity 2</b> In teams, create a poster, in digital format, presenting solutions for preventing/treating the negative consequences caused by changes in pH on the human body.</li> </ul>	2

## Lesson resources

### Resources needed for the lesson

- PPT presenting theoretical concepts and the importance of pH in everyday life
- Videos to raise awareness regarding the importance of knowing pH and to present methods for determining pH
- Materials needed: pH indicator paper, acid -base indicator solutions, pH meter, watch glass, test tubes, solutions to be analyzed, etc.

### Digital resources

- <https://www.youtube.com/watch?v=r3hirzIWILM>
- <https://www.youtube.com/watch?v=dSOFP6LDbXM>
- <https://www.youtube.com/watch?v=PJCSvGtoglY>
- <https://www.youtube.com/watch?v=zQowljL8e5E>
- <https://www.youtube.com/watch?v=9MYviGrhbfs&t=601s>
- <https://www.youtube.com/watch?v=le4wGv4wrgw&t=51s>
- <https://www.youtube.com/watch?v=hZolmlw3b2o>
- <https://www.youtube.com/watch?v=Ea-0QV89tf4&t=2s>
- <https://create.kahoot.it/details/1e5ab6b9-e15f-43d2-a631-4d5449cf2cc4>

## Evaluation and indicators

Evaluation will be carried out throughout the learning activities; the teacher will assess the degree of involvement of the students in completing the tasks, the application of knowledge in carrying out practical determinations and the accuracy of the results obtained, the identification of the effects of pollutants on the aquatic ecosystem, the provided answers in the assessment quiz. The teacher will provide feedback in a structured manner and will identify areas that require improvement.

## Evaluation and indicators

Criteria	Excellent	Good	Satisfactory	Needs improvement
<b>Knowledge of the pH Scale</b>	Accurately describes the pH scale (0-14), including definitions of acidic, neutral, and basic.	Describes the pH scale with minor inaccuracies.	Mentions the pH scale but has significant misunderstandings.	Does not understand the pH scale or its significance.
<b>Practical skills / abilities to determine pH values</b>	Accurately uses different laboratory utensils to determine pH values (pH indicator paper, solutions of acid-base indicators, pH meter, watch glass, glass rod, test tubes, test solutions)	Manages to use different laboratory utensils to determine pH values, fast but may make minor inaccuracies	Manages to use some laboratory utensils to determine pH values, but not all of them and makes recurrent errors	Cannot use different laboratory utensils to determine pH values and lacks ability to register pH values
<b>Negative Consequences of Inappropriate pH</b>	Identifies multiple negative consequences of inappropriate pH levels on health with concrete examples (eg, skin issues, digestive problems).	Identifies some negative consequences with a few examples.	Mentions a negative consequence but lacks detail or examples.	Fails to identify any consequences of inappropriate pH.
<b>Engagement and Participation</b>	Actively participates in discussions and activities, demonstrating enthusiasm and curiosity.	Participate in discussions and activities, showing interest.	Participates minimally but engages with prompts.	Rarely participates or shows disinterest in the lesson.
<b>Application of Knowledge</b>	Effectively applies knowledge of pH in hypothetical scenarios related to human health.	Applies knowledge to some scenarios but lacks depth in explanation.	Attempts to apply knowledge but does so inaccurately.	Does not apply knowledge to scenarios.



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## Overview of the lesson

This lesson plan is addressed to **students aged 13-19** and aims to familiarize them with **basic concepts** related to acidity, alkalinity, the **pH** scale and practical pH determinations for different substances. Students will receive information about how different pH values **influence** us in our daily lives. The lesson provides **knowledge with applicability** in different fields (health, food industry, cosmetics industry, pharmaceuticals, agriculture). This lesson is designed in an **interactive format**, with students being involved in practical pH determinations, as well as in a virtual experiment, using **Metaverse technology**. Thus, participants will understand and appreciate the essential role of pH in biological, chemical and ecological processes.



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# MSTEM

## LESSON PLAN: RENEWABLE ENERGIES

METaverse-BASED STEM EDUCATION FOR A  
SUSTAINABLE AND RESILIENT FUTURE  
2023-1-FR01-KA220-SCH-000151516



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# Purpose of Lesson

The purpose of this lesson is to introduce students to renewable energy sources, their importance, and their role in sustainable development. Students will explore different types of renewable energy, their advantages, and challenges.

# Description of Lesson

Students will learn about solar, wind, hydro, geothermal, and biomass energy. The lesson includes discussions, interactive visual demonstrations, and a brief activity in the Metaverse where students can explore a virtual renewable energy facility.

# Lesson Teaching Methods

## Problem-Solving Approach

- Students will analyze a sustainability challenge (e.g., reducing plastic waste or improving energy efficiency in homes).
- Encourages creative and analytical thinking.

## Flipped Classroom

- Students review case studies of sustainable technologies before class.
- Allows more time for hands-on activities and discussions.

## Metaverse simulation

- Students will explore a virtual environment showcasing renewable energy infrastructure..

# Lesson Objectives

- Identify different types of renewable energy.
- Explain how renewable energy contributes to sustainability.
- Evaluate the benefits and challenges of various renewable energy sources.
- Engage with a virtual renewable energy facility to enhance understanding.



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# Lesson plan

- **Introduction (10-15 min):**
  - Engage students with a discussion on their energy consumption habits.
  - Show brief videos on different types of renewable energy.
- **Main Lesson (25-30 min):**
  - Explain how solar, wind, hydro, geothermal, and biomass energy work.
  - Discuss the pros and cons of each source.
  - Explore real-world applications and innovations in renewable energy.
- **Metaverse Activity (15 min):**
  - Students enter a virtual wind farm and explore how wind turbines generate electricity.
  - Discuss observations and reflections on the experience.
- **Conclusion (10 min):**
  - Recap key points.
  - Open discussion: "What renewable energy source would you implement in your community and why?"

## Lesson table

lesson plan	
Engagement Activity: Students brainstorm examples of renewable energy in daily life.	10-15 min
Exploring Renewable Energy: The teacher explains solar, wind, hydro, geothermal, and biomass energy with interactive visuals.	30 min
Virtual Renewable Energy Tour: Students enter a VR simulation of a renewable energy facility to observe solar panels, wind turbines, and hydropower stations in action.	15 min
Discussion & Summary: Recap key concepts and discuss the role of renewable energy in the future.	15 min



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## Lesson resources

- Presentation slides on renewable energy sources
- Access to a VR platform for the Metaverse activity

Resources used to create this lesson:

- Intergovernmental Panel on Climate Change (IPCC). (2022). Climate Change Mitigation: Renewable Energy Solutions. Retrieved from <https://www.ipcc.ch>
- International Renewable Energy Agency (IRENA). (2021). World Energy Transitions Outlook 2021. Abu Dhabi: IRENA. Retrieved from <https://www.irena.org>
- National Renewable Energy Laboratory (NREL). (2020). Renewable Electricity Futures Study. Golden, CO: NREL. Retrieved from <https://www.nrel.gov>
- United Nations (UN). (2023). The Sustainable Development Goals Report 2023. Retrieved from <https://unstats.un.org/sdgs/>
- World Green Building Council. (2022). Advancing Net Zero: Renewable Energy in the Built Environment. Retrieved from <https://www.worldgbc.org>
- Ellen MacArthur Foundation. (2021). Renewable Energy and Circular Economy. Retrieved from <https://www.ellenmacarthurfoundation.org>



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# Work and homework

## Individual work:

- work 1: Compare and contrast two renewable energy sources.
- work 2: Research a local renewable energy project.

## Homework:

- Homework 1: Write a short essay on the feasibility of renewable energy in their country.
- homework 2: Create a poster illustrating different renewable energy sources.

# Evaluation and indicators

## Assessment Methods:

- Class Discussions & Participation: Students will be evaluated based on their engagement and ability to articulate key concepts.
- Metaverse Activity: Teachers will assess students' ability to recognize and describe components of renewable energy or sustainable technology in the virtual environment.
- Work & Homework Assignments: Grading will be based on the depth of research, clarity of explanation, and creativity in presenting solutions.

## Success Indicators:

- Students can identify and explain different renewable energy sources or sustainable technologies.
- Students actively participate in discussions and contribute meaningful insights.
- Students demonstrate comprehension through their work and homework assignments.
- Successful completion of the Metaverse activity with correct identification of key elements.



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Evaluation Indicators	
Method	Indicator
Class Participation	Contributions to discussions and activities
Metaverse Activity	Ability to identify key renewable/sustainable features
Homework & Work	Depth of analysis and creativity in solutions

## Overview of the lesson

This lesson introduces students to the fundamentals of renewable energy, highlighting its role in sustainable development. Through interactive discussions and visual demonstrations, students will explore various renewable energy sources, such as solar, wind, hydro, geothermal, and biomass energy. The lesson emphasizes the benefits and challenges of these energy sources and includes an immersive Metaverse activity, where students will virtually explore a renewable energy facility. By the end of the lesson, students will gain a deeper understanding of how renewable energy contributes to a greener future and its real-world applications.



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# MSTEM

## LESSON PLAN: SUSTAINABLE TECHNOLOGIES

METaverse-BASED STEM EDUCATION FOR A  
SUSTAINABLE AND RESILIENT FUTURE  
2023-1-FR01-KA220-SCH-000151516



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# Purpose of Lesson

This lesson introduces sustainable technologies that minimize environmental impact while supporting economic growth and social well-being.

# Description of Lesson

Students will explore key sustainable technologies, including energy-efficient systems, green building techniques, and circular economy practices. A simple Metaverse activity will allow students to navigate a virtual eco-friendly city.

# Lesson Teaching Methods

## Problem-Solving Approach

- Students will analyze a sustainability challenge (e.g., reducing plastic waste or improving energy efficiency in homes).
- Encourages creative and analytical thinking.

## Flipped Classroom

- Students review case studies of sustainable technologies before class.
- Allows more time for hands-on activities and discussions.

## Metaverse simulation

- VR-based interaction with a sustainable city model.

# Lesson Objectives

- Define sustainable technologies and their role in reducing environmental impact.
- Identify examples of sustainable technologies in different sectors.
- Analyze how sustainability is implemented in urban planning.
- Experience a virtual eco-friendly city model.



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# Lesson plan

- **Introduction (10-15 min):**
  - Students discuss the importance of sustainability in daily life.
- **Main Lesson (25-30 min):**
  - Teacher presents case studies on green buildings, energy-efficient appliances, and smart grids.
- **Metaverse Activity (15 min):**
  - Students explore a VR city showcasing sustainable buildings, green spaces, and efficient transportation.
- **Conclusion (10 min):**
  - Students share insights from their Metaverse experience and discuss future applications.



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## Lesson table

<b>lesson plan</b>	
Brainstorming Activity: Students discuss the importance of sustainability in daily life.	10-15 min
Exploring Sustainable Technologies: Teacher presents case studies on green buildings, energy-efficient appliances, and smart grids.	30 min
Virtual Eco-Friendly City Tour: Students explore a VR city showcasing sustainable buildings, green spaces, and efficient transportation.	15 min
Reflection & Summary: Students share insights from their Metaverse experience and discuss future applications.	15 min



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## Lesson resources

- Lesson slides on sustainable technologies
- Access to a VR platform for the Metaverse activity
- Case studies on green buildings, smart grids, and energy-efficient systems

Resources used to create this lesson:

- United Nations (UN). (2023). The Sustainable Development Goals Report 2023. Retrieved from <https://unstats.un.org/sdgs/>
- World Green Building Council. (2022). Sustainable Cities and the Built Environment. Retrieved from <https://www.worldgbc.org>
- Ellen MacArthur Foundation. (2021). Circular Economy and Sustainable Technologies. Retrieved from <https://www.ellenmacarthurfoundation.org>



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# Work and Homework

## Individual work:

- Work 1: Research an existing sustainable technology and present its impact.
- Work 2: Create a plan for making their school or home more sustainable.

## Homework:

- Homework 1: Write a short essay on a country leading in sustainable technologies.
- Homework 2: Develop a simple blueprint for an eco-friendly building.

# Evaluation and Indicators

## Assessment Methods:

- Class Discussions & Participation: Students will be evaluated based on their engagement and ability to articulate key concepts.
- Metaverse Activity: Teachers will assess students' ability to recognize and describe components of renewable energy or sustainable technology in the virtual environment.
- Work & Homework Assignments: Grading will be based on the depth of research, clarity of explanation, and creativity in presenting solutions.

## Success Indicators:

- Students can identify and explain different renewable energy sources or sustainable technologies.
- Students actively participate in discussions and contribute meaningful insights.
- Students demonstrate comprehension through their work and homework assignments.
- Successful completion of the Metaverse activity with correct identification of key elements.



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JUDEȚEAN TELEORMAN



Evaluation Indicators	
Method	Indicator
Class Participation	Contributions to discussions and activities
Metaverse Activity	Ability to identify key sustainable technology features
Homework & Work	Depth of analysis and creativity in solutions

## Overview of the lesson

This lesson focuses on sustainable technologies that minimize environmental impact while promoting economic and social well-being. Students will learn about energy-efficient systems, green building techniques, and circular economy practices through case studies and interactive discussions. A key highlight of the lesson is a virtual tour in the Metaverse, where students will explore an eco-friendly city model featuring sustainable buildings, green spaces, and smart grids. By the end of the session, students will have a clear grasp of how sustainable technologies shape modern urban development and their role in addressing global environmental challenges.



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# MSTEM

## LESSON PLAN: CLIMATE CHANGE

METaverse-BASED STEM EDUCATION FOR A  
SUSTAINABLE AND RESILIENT FUTURE  
*2023-1-FR01-KA220-SCH-000151516*



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## Purpose of the lesson

Often news report on unusual and extreme weather around the globe both in different continents but also where we live ourselves. In this lesson plan the students will get to know, explore and work with different kinds of extreme weather and how it affects us both in a short term but also long term perspective. Basic understanding of the causes, consequences and possible solutions of climate change. Discussions of the subject where the students show factual knowledge and reflection on their own role in the climate transition

## Description of the lesson

Students will discover the origin of pollen by studying the anatomy of a flower. Using VR, they will be able to dissect a flower and identify the pollen-producing organ. Extreme weather refers to powerful and unusual weather events that go beyond the normal. Examples of extreme weather include intense heatwaves, severe droughts, heavy floods, and violent storms. These events can be dangerous and cause significant damage to both communities and nature. Researchers observe a link between extreme weather and climate change, making it crucial for us to understand and act to mitigate the risks. Students will explore and work with different kinds of extreme weather and how it affects the people living there but also the world. What are the ripple effects?

## Lesson teaching method

- Problem-solving approach

Comparing students' ideas about the climate change from what they have heard, learned but also experienced in the Metaverse.

Students can take an active role in being an active Swedish, European and World citizen and act upon climate change.

- VR simulation

Observing and live through different climate change simulations and act in different ways to solve them in a safe environment.



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## Lesson objectives

This lesson aims to provide students with a basic understanding of the causes and consequences of climate change, as well as to introduce them to possible solutions. By exploring climate change in an interactive 3D environment in the Metaverse, students will develop an interest in STEM subjects and gain a deeper understanding of complex relationships. The lesson should also encourage discussion and critical thinking about environmental issues.

## Lesson plan

- Introduction

The teacher starts with a short discussion about weather and climate, explaining the difference between them.

Images and short videos of extreme weather events such as droughts and floods are shown to the class.

Students are asked questions like: “What do you think causes these events?”

Students then take on the role of meteorologists and explore a real extreme weather event that has occurred anywhere in the world.

- Causes of Climate Change

The lesson continues with a simple review of the greenhouse effect.

The teacher explains how human activities, especially burning fossil fuels, increase greenhouse gases in the atmosphere.

The concept of a carbon footprint is introduced and explained in an easy way.

Students work in small groups to discuss the question: “How do our daily choices affect the climate?”

# Lesson plan continues

- Metaverse Activity: The Effects of Climate Change

Students are divided into small groups and given access to a prepared 3D environment in the Metaverse. This virtual environment represents different locations around the world that are affected by climate change, such as heat waves, blizzards, and hurricanes. Each group is assigned one location to explore. While exploring, students observe what is happening in that environment and record their findings. They identify the effects and consequences of climate change and then present what they discovered to the class.

- Solutions and the Future

The class discusses possible solutions to climate change, including renewable energy, energy efficiency, and sustainable consumption.

Students first brainstorm ideas in small groups and then share their thoughts with the whole class.

Guiding question: “What can we do to reduce our impact on the climate?”

The teacher then reviews and presents key milestones from the lesson to summarize learning and connect ideas.

## Lesson plan continues

- Class Discussion and Reflection

Students brainstorm ideas in small groups and then share them with the whole class in response to the question:

“What can we do to reduce our impact on the climate?”

The teacher then goes through and shows the key climate milestones to help students understand important steps taken to protect the planet:

<https://our-planet-our-future.climate.ec.europa.eu/milestones>

- Conclusion

The lesson ends with a short summary of the main points covered. Students are given time to ask questions or clarify anything they did not understand. Finally, the teacher explains the homework assignment and what is expected from the students.

## Teaching methods and the reason for their choice

**Discussion:** Encourages active participation and helps students develop critical thinking skills.

**Visual Aids :** Using images and videos makes complex topics easier to understand and more engaging for students.

**Metaverse Activity :**Creates an interactive and immersive learning experience. By exploring the consequences of climate change in a 3D environment, students develop a deeper understanding of the topic and become more motivated to learn. This activity also increases interest in STEM subjects by combining technology, exploration, and real-world issues.

**Brainstorming:** Encourages students to share their own ideas and express creativity.

**Group Work:** Helps students develop collaboration, communication, and teamwork skills.

## Lesson resources

Lesson resources:

- Computers/Tablets
- Access to metaverse platform and prepared 3D environment.
- VR headsets
- Images and videos about extreme weather and climate change.

(Use the Our planet Our future material, there is newspaper, quiz, board games to download and use).

- Information on renewable energy and sustainable consumption.

Links to use:

Climate change. (n.d.). European Climate Pact. <https://climate-pact.europa.eu/about/climate-change>

Goals archive. (2021, September 17). The Global Goals. <https://globalgoals.org/goals/> (Number 7, 12 and 13)

Klimat. (2025, December 15). Världsnaturfonden WWF. <https://www.wwf.se/klimat/>

Our planet, our future. (n.d). Climate change. <https://our-planet-our-future.climate.ec.europa.eu/>

SMHI's website (Swedish Meteorological and Hydrological Institute):  
<https://www.smhi.se/>

Var planet, Var framtid. (2018, September 19). Publications Office of the EU. <https://op.europa.eu/sv/publication-detail/-/publication/6af369ed-6221-11e8-ab9c-01aa75ed71a1>

WWF International. (n.d.). Climate & energy. WWF.  
<https://explore.panda.org/climate>



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# Work and homework

## INDIVIDUAL WORK WITH SHORT EXPLANATION

- Document observations and results from the Metaverse activity.
- Actively participate in discussions and brainstorming.
- Reflect on their own impact on the climate.

## HOMEWORK WITH SHORT EXPLANATION

- Write a factual text about a specific consequence of climate change.
- Investigate and present an example of a solution to climate change.



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# Work and homework

## INDIVIDUAL WORK WITH SHORT EXPLANATION

- Document observations and results from the Metaverse activity.
- Actively participate in discussions and brainstorming.
- Reflect on their own impact on the climate.

## HOMEWORK WITH SHORT EXPLANATION

- Write a factual text about a specific consequence of climate change.
- Investigate and present an example of a solution to climate change.



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## Overview of the lesson

This lesson plan introduces students to the interconnected topics of plant biology, extreme weather, and climate change through interactive and inquiry-based learning. Students begin by exploring the anatomy of a flower using virtual reality, where they investigate how pollen is produced and develop scientific observation skills. The lesson then shifts focus to extreme weather events, helping students understand what they are, why they occur, and how they are linked to global climate change. Through discussions, visual materials, and real-world examples, students examine both local and global impacts of phenomena such as heatwaves, floods, and storms. The core of the lesson centers on developing a basic understanding of the causes and consequences of climate change. Students learn about the greenhouse effect, human influence on the environment, and the concept of a carbon footprint. Using a Metaverse-based 3D environment, they explore different locations affected by climate change, analyze ripple effects, and document their observations. Collaborative group work and class discussions encourage critical thinking, problem-solving, and reflection on sustainable solutions.

Throughout the lesson, students are actively engaged through a variety of teaching methods, including visual aids, group activities, brainstorming, and technology-enhanced learning. The lesson aims to strengthen students' STEM skills while fostering environmental awareness and personal responsibility. By the end of the lesson, students are expected to demonstrate factual knowledge about climate change, reflect on their own role in the climate transition, and propose practical actions that contribute to a more sustainable future.



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# MSTEM

## LESSON PLAN: DESIGNING A GREENER FUTURE – ENVIRONMENTAL INNOVATION IN THE METAVERSE

METAVERSE-BASED STEM EDUCATION FOR A  
SUSTAINABLE AND RESILIENT FUTURE

2023-1-FR01-KA220-SCH-000151516



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JUDEȚEAN TELEORMAN



City of Malmö



## Purpose of the lesson

The purpose of this lesson plan is to help students develop a practical and applied understanding of renewable energy and sustainable living. By exploring how different energy sources can be integrated into a modern home, students learn how everyday energy use affects the environment and how smarter choices can contribute to a greener future. The lesson aims to strengthen students' knowledge regarding environmental issues but especially of energy efficiency, renewable technologies, and environmental innovation while also developing important skills such as collaboration, creativity, and problem-solving. Through hands-on work in a virtual Metaverse environment, students are encouraged to think critically about sustainable housing solutions and to reflect on how technological innovation can support climate action.

## Description of the lesson

This lesson plan focuses on renewable energy in the home and gives students the opportunity to explore sustainable housing in an interactive and creative way. The lesson begins with an introduction to energy consumption in everyday life and the importance of renewable energy sources. Students are introduced to key concepts such as solar power, wind power, geothermal energy, and biomass, and learn how these can be used to create more energy-efficient homes. Working in small groups, students are tasked with designing and building a virtual house in the Metaverse. Each group must integrate at least two different renewable energy sources into their design while considering both functionality and aesthetics. Using digital tools and simulations, students experiment with energy production and consumption and explore how different solutions can reduce environmental impact. Throughout the lesson, students collaborate, discuss, and apply their knowledge in a practical context. The lesson concludes with group presentations where students explain their design choices and reflect on the advantages and challenges of sustainable construction. Assessment is based on participation, creativity, teamwork, and the ability to demonstrate understanding of renewable energy concepts.

# Lesson teaching method and the reason for their choice

- Collaboration: Group work promotes collaboration, communication, and problem-solving. Active Learning: Students learn by doing and experimenting in the Metaverse environment.
- Visual learning: The metaverse environment offers a visual and engaging learning environment where students can see and interact with their houses.
- Discussion: Discussions help students reflect on their own choices and learn from each other.
- Application: Students will have the opportunity to apply their knowledge of renewable energy in a practical and relevant context. These methods have been chosen because they promote active participation, collaboration, and a deeper understanding of renewable energy in the home. By combining theoretical knowledge with practical application in an engaging Metaverse environment, a meaningful and motivating learning experience is created.

## Lesson objectives

In this lesson, students will explore different forms of renewable energy and how they can be integrated into a modern home. By designing and building smart and sustainable energy sources into a virtual house in the Metaverse, students will develop their understanding of energy use in everyday life, energy efficiency, and the potential of renewable energy to create sustainable housing.

## Lesson plan

### 1. Introduction:

The teacher begins with a discussion about how we use energy in our homes and why it is important to think about energy consumption. Pictures and short films are shown as examples of different energy sources and how they can be used in the home, both renewable and non-renewable. (Introduction: The teacher begins with a short discussion about weather and climate. What's the difference? Images and short videos illustrating extreme weather events (e.g. droughts, floods) are displayed. Questions for students: "What do you think could cause these kinds of events?" Students can be meteorologists and explore an extreme weather event that has happened anywhere in the world. Causes of climate change: Review of the greenhouse effect.

Explanation of how human activities, such as the burning of fossil fuels, contribute to increased greenhouse gases. Introduction of the concept of "carbon footprint".



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## **1.Short discussion in small groups:"How do our choices affect the climate?"**)

The concept of "renewable energy" is introduced and explained, focusing on its relevance to households. Students will be introduced to the Metaverse platform and the tools they will use to build their houses.

## **2. Exploration of renewable energy sources for the home:**

The students are divided into groups of 3-4 people. Each group is tasked with focusing on how to integrate at least two different renewable energy sources into a home: Solar energy (solar panels on the roof, solar thermal) Wind power (small wind turbine on the plot) Geothermal energy (geothermal energy) Biomass (wood stove with efficient combustion)

## **3. Designing and Building a Sustainable Home in the Metaverse:**

In the Metaverse, each group gets access to a virtual house that can be redesigned. In the building, the group will integrate the chosen renewable energy sources in an efficient and aesthetically pleasing way. The students get access to different building materials, furnishings and resources, as well as tools to simulate energy production and consumption in the house. The teacher is available to help and guide the students in the design and construction process.

## **4. Presentation and discussion:**

Each group presents their virtual house to the others. They explain how they have integrated the renewable energy sources, what energy-saving measures they have taken and how their houses contribute to a sustainable lifestyle. The teacher leads a discussion about the different buildings, the chosen energy solutions and the challenges and opportunities that exist in sustainable construction.

## Lesson resources

- Computers/tablets with access to the Metaverse platform.
- Information texts, videos and interactive simulations about renewable energy and energy efficiency in the home.
- Drawing materials to sketch out the houses before construction in the Metaverse.

Information about the Metaverse platform and its tools. Global Goals: 7 Affordable and clean energy, 11 Sustainable cities, 13 Climate action  
European Commission - Energy, Climate and Environment - Energy Explained  
Information on sources and materials used:

- o Training videos [https://energy.ec.europa.eu/energy-explained/educational-videos-and-quiz\\_en](https://energy.ec.europa.eu/energy-explained/educational-videos-and-quiz_en)
- o Interactive infographic [https://energy.ec.europa.eu/energy-explained/interactive-infographics\\_en](https://energy.ec.europa.eu/energy-explained/interactive-infographics_en)
- § Building renovation [https://energy.ec.europa.eu/energy-explained/interactive-infographics/infographic-building-renovation\\_en](https://energy.ec.europa.eu/energy-explained/interactive-infographics/infographic-building-renovation_en)
- § Renewable energy [https://energy.ec.europa.eu/energy-explained/interactive-infographics/infographic-renewables\\_en](https://energy.ec.europa.eu/energy-explained/interactive-infographics/infographic-renewables_en)



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# Work and homework

## INDIVIDUAL WORK WITH SHORT EXPLANATION

During the lesson:

1. Each student writes a short summary of the two energy sources their group has chosen to focus on.
2. Each student contributes at least two ideas to the group's design of the virtual house.

## HOMEWORK WITH SHORT EXPLANATION

- At home: 3. Students investigate a specific aspect of sustainable living (e.g. solar panels, wind turbine, geothermal energy, wood stove) and write a short factual text.



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## Evaluation and indicators and expected outcomes

Expected results: Students should demonstrate an understanding of the concept of renewable energy and be able to describe different energy sources that are relevant to the home. They should be able to collaborate in groups, communicate their ideas, and use the Metaverse platform's tools to design and build a sustainable house. Evaluation: The teacher observes the students' participation in discussions and group work. Virtual houses are judged on how well they integrate the chosen energy sources, how energy-efficient they are, and how creative and innovative they are. The presentation on sustainable housing is judged on the basis of content and clarity. Success indicators: Students can explain what renewable energy is and give examples of different energy sources that can be used in the home. They can describe the advantages and disadvantages of different energy sources. They can identify different ways to reduce energy consumption in a house. They can collaborate in groups and communicate their ideas clearly. They can use the Metaverse platform's tools to design and build a virtual house.



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# Overview of the lesson

This lesson plan introduces students to the interconnected topics of plant biology, extreme weather, and climate change through interactive and inquiry-based learning. Students begin by exploring the anatomy of a flower using virtual reality, where they investigate how pollen is produced and develop scientific observation skills. The lesson then shifts focus to extreme weather events, helping students understand what they are, why they occur, and how they are linked to global climate change. Through discussions, visual materials, and real-world examples, students examine both local and global impacts of phenomena such as heatwaves, floods, and storms. The core of the lesson centers on developing a basic understanding of the causes and consequences of climate change. Students learn about the greenhouse effect, human influence on the environment, and the concept of a carbon footprint. Using a Metaverse-based 3D environment, they explore different locations affected by climate change, analyze ripple effects, and document their observations. Collaborative group work and class discussions encourage critical thinking, problem-solving, and reflection on sustainable solutions. Throughout the lesson, students are actively engaged through a variety of teaching methods, including visual aids, group activities, brainstorming, and technology-enhanced learning. The lesson aims to strengthen students' STEM skills while fostering environmental awareness and personal responsibility. By the end of the lesson, students are expected to demonstrate factual knowledge about climate change, reflect on their own role in the climate transition, and propose practical actions that contribute to a more sustainable future.



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# MSTEM

## LESSON PLAN: FLOWERS, POLLEN, HAY FEVER

METAVVERSE-BASED STEM EDUCATION FOR A  
SUSTAINABLE AND RESILIENT FUTURE  
2023-1-FR01-KA220-SCH-000151516



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## Purpose of the lesson

Every spring, many people sneeze, have itchy noses and watery eyes. They are allergic to pollen. The aim of this session is to understand where pollen comes from and identify which types of pollen cause allergies.

## Description of the lesson

Students will discover the origin of pollen by studying the anatomy of a flower. Using VR, they will be able to dissect a flower and identify the pollen-producing organ. Next, by studying allergenic pollens, they will discover flowers that do not really resemble their idea of what a flower is. They will also learn about how pollen is transported.

## Lesson teaching method

- Problem-solving approach

Comparing students' ideas about the origin of allergies will enable them to identify the scientific problem and test their representations.

- VR simulation

Observing and dissecting a large flower in VR will enable them to discover the anatomy of a flower.

## Lesson objectives

- Recognize the different parts of a flower
- Identify the pollen-producing organ
- Understand the role of pollen and how it is transported
- Link the mode of pollen transport to its allergenic potential

# Lesson plan

- Introduction (whole class)

Present a newspaper article on spring allergies and discuss allergies with the pupils.

This discussion will raise the question of the origin of spring allergies.

- Main lesson (group work)

Give each group of pupils:

- a set of documents: close-up photos of flowers, a flower with a bumblebee feeding on it, a tree with a cloud of pollen, male flowers on a tree with pollen flying away, a table classifying allergenic pollen.
- a VR headset with a flower animation that shows the parts of a flower and where pollen comes from.
- Conclusion (whole class)

Compare the students' posters and discuss the origin of allergies and the role of pollen.

## Lesson table

<b>Lesson plan</b>	
Starting point: Get students talking about the beginning of a newspaper article or TV news report on spring allergies.	10-15min
Group work to identify: <ul style="list-style-type: none"><li>• the origin of allergies</li><li>• the origin of pollen</li><li>• the role of pollen</li></ul> Use of paper documents and VR flower animation. Final output: a poster with drawings and explanations.	30-45 min
Presentation of posters, discussion Review of the origins of allergies and the role of pollen.	15-20 minutes

# Lesson resources

## Documents used

### 1. Photos

- Pine and alder in the wind, showing the tree and male flowers (visualisation of pollen grains being released into the atmosphere)
- close-up of grass and nettle flowers
- Insect covered in pollen feeding on a flower
- Explanatory document on pollen dispersal methods (anemophily and entomophily)

### 2. Table of the most allergenic pollens

### 3. Diagram explaining the role of pollen grains in flowering plants

### 4. VR headset and access to VR flower animation

## For more information

<https://pollencount.eu/#europe>

# Work and homework

## **INDIVIDUAL WORK WITH SHORT EXPLANATION**

- Create a poster presenting pollen (origin, role, modes of dispersal) and its role in allergies.

## **HOMEWORK WITH SHORT EXPLANATION**

- Collect or photograph flowers in your immediate environment to discover them in class.

## Evaluation and indicators

<b>Critères d'évaluation</b>	
Search, extract and use useful information	1
Communicate your actions, results and choices in writing and orally, using precise language and appropriate tools.	1

## Overview of the lesson

This session allows students to discover pollen (its origin, role, modes of dispersal) and its involvement in allergies.

This session is best done when flowers are in bloom, allowing the teacher to bring samples or take the students on a nature walk, and also allowing students to see the plants in their immediate environment in a different light.

In this session, virtual reality is a tool that allows students to manipulate a 'large flower' and separate its different parts. The fact that insects come to feed on it puts students at the same level as pollinators. This immersion and the ability to easily manipulate the flower facilitate knowledge building.

The assessment focuses on the information that students gather and their ability to connect it to create the poster that is the final product.

Depending on the teacher's objectives, an oral presentation of the posters and research can be organised.

After the session, students will undoubtedly be curious about other topics related to flowers and pollen, which will provide ideas and questions for exciting science lessons.

- the extinction of insect populations due to pesticides
- the role of pollinators in human nutrition
- the immune mechanisms of allergies
- do all plants have flowers?
- Why do flowers have colours?



# MSTEM

## MAMMOTHS, POLLENS AND CLIMATE

METaverse-BASED STEM EDUCATION FOR A  
SUSTAINABLE AND RESILIENT FUTURE  
2023-1-FR01-KA220-SCH-000151516



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# Pollens and climates of the past

The session allows pupils to identify the climate change that took place around 11,000 years ago (Pleistocene-Holocene transition) by studying fossil pollens collected in European peat bogs. The pollen data is available on the [European Pollen Database](#).

Each pupil/group chooses a sample appropriate to the period. A poster will be produced with the group's pollen diagram, the identification of some characteristic pollens under the microscope and an estimate of the age of the Pleistocene-Holocene transition according to the chosen location.

## Added value of the metaverse

- Getting several groups from different countries to work together and compare the results obtained. Pollen data is available for all European countries. It is therefore possible to imagine parallel research and then the organisation of a European conference on the climate 11,000 years ago.
- Identification of the organs that produce pollen through VR dissection of a flower.
- Microscopic observation of fossilised pollen corresponding to temperate or cold periods.
- Visualisation of the formation of sediments in a lake with fossilisation of the pollen from the surrounding plants.
- Serious game: create your cold/warm climate pollen layer.

# Teaching Method

- Problem solving

The mammoth will be used as a hook to identify the climate change that took place around 11,000 years ago.

The mammoth, an animal familiar to students, allows the students' representations of ancient climates and the methods used by scientists to reconstruct climates to emerge.

Based on the students' comments and questions, various scientific problems will be developed in the classroom. One of these problems will be to determine whether there was a change in the climate in Europe about 11,000 years ago.

Other problems such as the feasibility of cloning the mammoth and the role of humans in the disappearance of the mammoths may be addressed later.

# Lesson plan

2 photos of mammoths (one reconstruction and one fossil). Let the pupils discuss and note down their ideas.



Title: reconstruction of woolly mammoths and woolly mammoth fossil preserved in the permafrost of Russia (wikipedia)

## Examples of comments or questions from pupils

- Mammoths had hair because it was very cold.
- Mammoths have disappeared.
- There are researchers who want to revive mammoths using mammoths frozen in the ice in Siberia.
- It's like in the film Ice Age, the ice is melting because it's getting warmer and Manny and his friends are looking for an area where they can continue to live.

## Example of questions the teacher can ask to help the pupils think

When were the mammoths? When did they disappear? Because of what?

## Writing one or more problems to be solved

The problem to be solved in this lesson will be:

How were scientists able to establish that the climate had warmed up around 11,000 years ago?

Students formulate hypotheses and then formulate a problem

How does the study of fossilised pollen enable us to identify the warming of the climate around 11,000 years ago?

# Lesson plan

## Stages of the pupils' work

- Choice of the site for collecting pollen from the European Pollen Database
- Creation of a pollen diagram with a spreadsheet (Excel, Libreoffice Calc)
- Identification of some pollens under a microscope
- Communication of the results in the form of a poster

## Ideas for further thinking

- What made the mammoths disappear: the climate? Hunting? Or both?
- Contributions of ice cores to identifying climate variations.
- Is mammoth cloning possible?

# Lesson table

Stages of the course	
Mammoths' picture to bring out the pupils' representations.	20 min
Pooling of pupils' ideas and development of a scientific problem	15 min
Choice of site and analysis of palynological data by research groups	1h
Communication of data in the form of a poster. All the posters can be put online on an interactive European (or world) map (Genially). Conference of schools in the metaverse.	1h



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## Lesson resources

- European pollen database <https://libmol.org/pollens/>

Students will be able to find pollen data that can be used for different locations around the world.

It is possible to use the [netoma explorer](#) website, which is in English but where downloading and using the data is not as simple as on the previous site.

- What is pollen?

[https://www.youtube.com/watch?v=tYj-QYDM6Vw&ab\\_channel=ScienceForStudents](https://www.youtube.com/watch?v=tYj-QYDM6Vw&ab_channel=ScienceForStudents)

This video presents the origin of pollen grains and the characteristics of their membranes.

It is a video for students who have studied meiosis.

The 3D pollen project

If you have a 3D printer, you will be able to print your pollen grains

<https://3dpollenproject.wixsite.com/main>

- Excel or Libreoffice spreadsheet
- Table of the ecological requirements of different plants
- Microscopic observations of different pollens
- Work at home
  - <https://kids.tpl.ca/wonders/why-did-woolly-mammoths-go-extinct>
  - <https://www.mnhn.fr/fr/pourquoi-les-mammouths-ont-ils-disparu>



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# Work and homework

## INDIVIDUAL WORK

The pupils will explore the various coring sites in order to find a palynological record that includes the period around -11,000 years ago.

The extraction of the data and its presentation in graphic form makes it possible to highlight the succession of climatic conditions in the area and, above all, to identify the climatic change that characterises the transition to the Holocene.

## HOMEWORK

Article to read or podcast on the causes of the disappearance of the mammoths.

# Evaluation and indicators

Evaluation criteria	
Contents of the poster <ul style="list-style-type: none"><li>graph showing species characteristic of the climate change from the transition to the Holocene</li><li>Highlighting of the change in flora</li><li>Photos of characteristic pollens with captions</li></ul>	1
Layout of the poster <ul style="list-style-type: none"><li>General title, organisation that facilitates reading, pleasant to read</li></ul>	1



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# Overview of the lesson

This lesson allows students to practise a scientific approach and discover the role of pollens in climate reconstruction. Based on the principle of actualism (also known as uniformitarianism, the basic principle that past phenomena acted in the same way as current phenomena), students will be able to observe pollens under a microscope and work with real pollen data from the European Pollens Database platform.

The richness of the theme allows for further work on other methods of climate reconstruction, on the phylogeny of Proboscideans or on the comparison of climate change 11,000 years ago with that which we are currently experiencing.



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