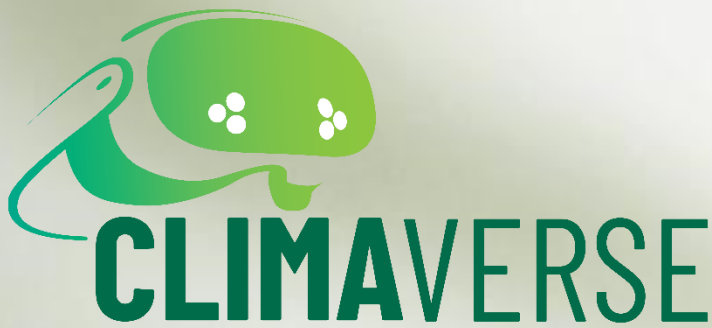

CLIMAte change education for secondary schools using MetaVERSE

ERASMUS+ KA220-SCH – 000248238

Cooperation partnerships in school education

CLIMA-VERSE situation-based curriculum

Author of the document: Naiara Yuste (Politeknika Txorierri)
with contribution of project partners

Table of contents

1. INTRODUCTION....1
2. GREENCOMP....1
3. TARGET GROUP....3
   3.1. PRIMARY TARGET GROUP....3
   3.2. SECONDARY TARGET GROUP....3
4. LEARNING OUTCOMES....4
5. LEARNING STRATEGIES....8
6. LEARNING SCENARIOS....20
   6.1. DESCRIPTION OF THE SCENARIO 1....20
   6.2. DESCRIPTION OF THE SCENARIO 2....21
   6.3. DESCRIPTION OF THE SCENARIO 3....25
   6.4. DESCRIPTION OF THE SCENARIO 4....27
7. ASSESSMENT METHODS....30
8. PROGRESSION LEVELS....31
9. LIST OF NEEDED EQUIPMENTS....32
10. BIBLIOGRAPHY....33
Legal notice....34

1. INTRODUCTION

This project arises from the fusion of two imperative needs in today's reality:

On one hand, CLIMA-VERSE project, aims at increasing the capacity and readiness of formal education to govern and manage the Metaverse technology, to exploit its advantages and to contribute to the effective shift towards digital education through the creation of a virtual curriculum and the provision of adequate trainings for teachers and trainers.

On the other hand, this “Meta-education model” will be used to raise awareness of environmental challenges among youths. Since current environmental education can foster students’ science performance but does not impact on their pro-environmental convictions and agency (PISA,2022), CLIMA-VERSE will develop a situation-based curriculum based on the GreenComp framework that will use the advantages of Metaverse to help students have a more direct, real and meaningful experience of the impact of individual choices and behaviours and accelerate their feeling of the urgency to act for the environment.

In this regard, the project aims to contribute to standardize the GreenComp framework in school curriculum with the integration of several pedagogical approaches and the metaverse technology to shape both students’ individual behaviours, perspectives, beliefs, values and decision-making in consumption and lifestyle patterns and promote their sense of community and shared responsibility for environmental issues, by encouraging students to reflect together on challenges and causes and cooperate to find solutions.

2. GREENCOMP

The development of a European sustainability competence framework is one of the policy actions set out in the European Green Deal as a catalyst to promote learning on environmental sustainability in the European Union.
GreenComp identifies a set of sustainability competences to feed into education programmes to help learners develop knowledge, skills and attitudes that promote ways to think, plan and act with empathy, responsibility, and care for our planet and for public health.

GreenComp comprises four interrelated competence areas: 'embodying sustainability values', 'embracing complexity in sustainability', 'envisioning sustainable futures' and 'acting for sustainability'. Each area comprises three competences that are interlinked and equally important.

GreenComp is designed to be a non-prescriptive reference for learning schemes fostering sustainability as a competence.

GreenComp can support education and training systems in shaping systemic and critical thinkers who care about our planet's present and its future. All 12 competences of the framework are applicable to all learners, irrespective of their age and their education level and in any education setting – formal, non-formal and informal.

The proposed model can complement and strengthen existing international, national, regional and local efforts to capture sustainability competences. Its added value is that it provides:

- A model of sustainability competence areas and competences
- A common reference that everyone working in education and training for environmental sustainability can use, share and refer to
- An initial list of competence components, namely knowledge, skills and attitudes, as examples of how to put the competences into practice
- A common reference basis for dialogue, exchange of practices and peer learning among educators involved in lifelong learning across the EU
- A contribution to help make the competences portable and promote mobility in the EU for a full participation in European society.

Source: European Commission (2022). *GreenComp – The European Sustainability Competence Framework*. https://doi.org/10.2760/094757. Licensed under CC BY 4.0.

3. TARGET GROUP

3.1. PRIMARY TARGET GROUP

- Secondary school students: will gain interactive and innovative green and digital education that equips them with the necessary knowledge and skills to become responsible and active citizens.
- Girls and disadvantaged students: both presented lower STEM and ICT performance and lower career expectations (PISA,2018). CLIMA-VERSE wants to offer them inclusive learning opportunities and more attractive participatory activities
- Secondary school teachers, trainers and educators in STEM/STEAM, ICT, and green education: CLIMA-VERSE aims to support them in integrating innovative pedagogical resources and will provide training opportunities.

3.2. SECONDARY TARGET GROUP

- Universities and researchers: academic community investigating on edutainment and Metaverse will use CLIMA-VERSE as case study and support the project for its long-term mission to further develop the learning environment to meet more learning needs and adapt to new trends/regulatory requirements.

- SMEs, startups: the ICT sector will be targeted to further improve innovations in Metaverse and to accelerate the development of accessible equipment and support for school settings
- VET learners: it will be possible to implement a further development of CLIMA- VERSE learning environment to meet VET learners' needs to acquire necessary skills and competences to work in the ICT sector and to contribute to boost EU digital economy.
- CSOs: CLIMA-VERSE will address CSOs and other stakeholders involved in the development and implementation of informal and non-formal green and digital education initiatives at local, regional, and national levels to disseminate project results and involve other organisations to work, test and experiment the CLIMA-VERSE learning environment
- Youth organizations: CLIMA-VERSE curriculum and learning environment can be used to foster raising awareness and green literacy campaign among youths

4. LEARNING OUTCOMES

The learning outcomes of the Climaverse curriculum are directly based on the GreenComp competencies to ensure that students work on and acquire sustainability competence, as this is the objective of this European initiative.

Because of that, the metaverse will be designed in such a way that, as students immerse themselves in it, they will need to carry out actions and make decisions that require them to work on the competencies established in the GreenComp.

GreenComp consists of four competences 'areas' that correspond to the definition of sustainability; and the 12 'competences', taken together, make up the building blocks of the sustainability competence for all people.

In this regard, these are the defined learning outcomes related to the **SUSTAINABILITY COMPETENCE** for this curriculum:

1. Reflect on personal values; identify and explain how values vary among people and over time, while critically evaluating how they align with sustainability values.
2. Support equity and justice for current and future generations and learn from previous generations for sustainability.
3. Acknowledge that humans are part of nature; and to respect the needs and rights of other species and of nature itself in order to restore and regenerate healthy and resilient ecosystems
4. Approach a sustainability problem from all sides; to consider time, space and context in order to understand how elements interact within and between systems
5. Assess information and arguments, identify assumptions, challenge the status quo, and reflect on how personal, social and cultural backgrounds influence thinking and conclusions
6. Formulate current or potential challenges as a sustainability problem in terms of difficulty, people involved, time and geographical scope, in order to identify suitable approaches to anticipating and preventing problems, and to mitigating and adapting to already existing problems
7. Envision alternative sustainable futures by imagining and developing alternative scenarios and identifying the steps needed to achieve a preferred sustainable future.
8. Manage transitions and challenges in complex sustainability situations and make decisions related to the future in the face of uncertainty, ambiguity and risk.
9. Adopt a relational way of thinking by exploring and linking different disciplines, using creativity and experimentation with novel ideas or methods.
10. Navigate the political system, identify political responsibility and accountability for unsustainable behaviour, and demand effective policies for sustainability.
11. Act for change in collaboration with others.
12. Identify your own potential for sustainability and to actively contribute to improving prospects for the community and the planet.

The use of Metaverse to achieve all these objectives, can have a lot of positive impact: the learning experience could be limitless in time and space, more interactive and effective; it can

trigger the democratization of education (Girvan, 2018), providing a more accessible digital way of communicating and learning; its applications can improve quality of education, increasingly develop new knowledge and new resources.

So, using the metaverse experience through the course, students will also achieve these learning outcomes related with the **DIGITAL COMPETENCE:**

1. Enhance digital Literacy and Technical Skills; students develop advanced digital competencies by navigating and interacting within immersive 3D virtual environments, creating and customizing digital avatars or using cutting-edge virtual and augmented reality tools.
2. Improve engagement and Motivation; The metaverse learning experience makes the learning process more exciting and attractive, facilitates better understanding and retention of concepts and increases student participation through interactive and gamified elements.
3. Enhance collaboration and Global Perspective; Metaverse-based educational projects offer opportunities for real-time collaboration with peers from around the world, exposure to diverse cultures and opportunities to interact with experts and professionals from various disciplines.
4. Applicate practical and theoretical knowledge; The immersive nature of the metaverse allows students to engage in realistic simulations and virtual experiments, apply theoretical concepts in practical, hands-on scenarios or develop problem-solving skills in contextualized virtual environments.

Table 1. *GreenComp* areas, competences, and descriptors.

AREA	COMPETENCE	DESCRIPTOR
1. *Embodying sustainability values*	1.1 **Valuing sustainability**	To reflect on personal values; identify and explain how values vary among people and over time, while critically evaluating how they align with sustainability values.
	1.2 **Supporting fairness**	To support equity and justice for current and future generations and learn from previous generations for sustainability.
	1.3 **Promoting nature**	To acknowledge that humans are part of nature; and to respect the needs and rights of other species and of nature itself in order to restore and regenerate healthy and resilient ecosystems.
2. *Embracing complexity in sustainability*	2.1 **Systems thinking**	To approach a sustainability problem from all sides; to consider time, space and context in order to understand how elements interact within and between systems.
	2.2 **Critical thinking**	To assess information and arguments, identify assumptions, challenge the status quo, and reflect on how personal, social and cultural backgrounds influence thinking and conclusions.
	2.3 **Problem framing**	To formulate current or potential challenges as a sustainability problem in terms of difficulty, people involved, time and geographical scope, in order to identify suitable approaches to anticipating and preventing problems, and to mitigating and adapting to already existing problems.

Source: European Commission (2022). *GreenComp – The European Sustainability Competence Framework*. https://doi.org/10.2760/094757. Licensed under CC BY 4.0.

Table 1. *GreenComp* areas, competences, and descriptors.

AREA	COMPETENCE	DESCRIPTOR
3. *Envisioning sustainable futures*	3.1 **Futures literacy**	To envision alternative sustainable futures by imagining and developing alternative scenarios and identifying the steps needed to achieve a preferred sustainable future.
	3.2 **Adaptability**	To manage transitions and challenges in complex sustainability situations and make decisions related to the future in the face of uncertainty, ambiguity and risk.
	3.3 **Exploratory thinking**	To adopt a relational way of thinking by exploring and linking different disciplines, using creativity and experimentation with novel ideas or methods.
4. *Acting for sustainability*	4.1 **Political agency**	To navigate the political system, identify political responsibility and accountability for unsustainable behaviour, and demand effective policies for sustainability.
	4.2 **Collective action**	To act for change in collaboration with others.
	4.3 **Individual initiative**	To identify own potential for sustainability and to actively contribute to improving prospects for the community and the planet.

Source: European Commission (2022). *GreenComp – The European Sustainability Competence Framework*. https://doi.org/10.2760/094757. Licensed under CC BY 4.0.

5. LEARNING STRATEGIES

Learning for sustainability aims to transform how we view learning content, outcomes, pedagogy, learning environments, and assessment. It requires teachers not only to understand this transformative approach but also to be able to put it into practice. It is essential to recognize that Education for Sustainable Development uses learning approaches that promote emancipatory pedagogical strategies, such as reflective critical thinking, systems thinking, interdisciplinary learning, future thinking, place-based learning, transformative learning, action-oriented learning, and participatory learning. These strategies are necessary for young people

to develop the skills needed to better understand the interconnected global challenges we face, such as the climate crisis, environmental degradation, and biodiversity loss—all of which involve environmental, social, economic, and cultural aspects.

The methodologies detailed here are active, participatory, and complementary to one another, allowing educators to respond to students' interests and initiatives. These are teaching strategies and pedagogical models that will facilitate the development of various activities, enabling learning experiences to be created according to the context of the metaverse, making these experiences open, flexible, dynamic, and inclusive.

The following outlines pedagogical methodologies that have been proven successful for acquiring competencies related to environmental education.

PROJECT BASED LEARNING

Project-Based Learning (PBL), as its name indicates, focuses on the development of a project that must be real and contextualized. It is advisable that the project responds to a situation that is close and familiar to the group of students. Therefore, work is conducted in the immediate environment of the educational institution or even within the institution itself.

Questions serve as the catalyst for initiating the activity and allow for the establishment of hypotheses that guide the product to be developed. The teacher's role is crucial in guiding this process and motivating the group.

The problem or information can be presented in full during the initial stages, enabling students to work from it, focusing on the design of the process, its development, and completion. In any case, it is important to work with various sources of information, including contributions from external agents, families, and other community groups.

By its nature, it facilitates collaboration across different areas, subjects, or fields, and even across different educational stages. It also allows for work with various types of groupings that may vary throughout the project.

HOW CAN WE APPLY THIS IN THE METAVERSE?

Here are some examples:

1. Urban Architecture and Design Project

In a metaverse environment, students can collaborate on building a virtual city. Using 3D modeling tools, they design buildings, public spaces, and transportation systems, applying concepts of architecture, urban planning, and sustainability. Students receive real-time feedback from peers and mentors, and they can explore and refine their designs within an immersive environment. At the end, they present the city to their peers in a virtual tour, showcasing the impact of their decisions.

2. Creating a Virtual Ecosystem to Study Biology:

In a metaverse, students can work together to create a digital ecosystem, learning about species interactions and environmental factors. Each student could simulate different species or climate conditions, collaborating to observe how each element influences the others. In this environment, students can visually see, in real-time, how changes in flora, fauna, or climate impact the ecosystem, bridging theoretical learning with hands-on experience in a dynamic, visual setting.

CASE STUDIES

The case study is a methodology based on the study and analysis of a real problem or situation, preferably nearby, in order to promote quality learning and facilitate effective decision-making.

The case narrative should include issues that affect the center and its students in such a way that a close reality is closely scrutinized. The cases can be more or less complex depending on the educational stage we want to work on. For the narrative of the case, resources and documents can be used, as well as testimonies from experts in the subject or people affected.

This methodology can be developed through work in small groups that examine the information both in and out of the classroom. It makes it possible to connect different areas or subjects by being able to review the case from the different elements, actors or situations involved.

The aim is for students to be able to make effective and possible decisions that also take into

account the short-, medium- and long-term consequences, as well as their repercussions on ecosystems or social groups.

HOW CAN WE APPLY THIS IN THE METAVERSE?

Here are some examples:

1. Virtual Corporate Sustainability Analysis:

Students are presented with a detailed virtual replica of a real company's operations. They explore the company's facilities, analyze data visualizations, and interview virtual employees to assess the company's sustainability practices. The goal is to develop recommendations for improving the company's environmental performance.

2. Historical Environmental Disaster Investigation:

Learners are transported to a metaverse recreation of a past environmental disaster (e.g., an oil spill or nuclear accident). They examine the scene, collect evidence, and interview virtual witnesses to analyze the causes, impacts, and responses to the disaster.

SERVICE LEARNING

Service Learning (SL) is an educational methodology in which learning takes place while performing a service to the community, which allows for a good knowledge of the environment, different communities and their needs.

The ApS methodology is based on the idea of learning by doing and, in this case, it is combined with a specific service. It allows the design of rich and complex learning situations as they are inserted in the community itself.

An ApS project arises from a social need that may have been raised by the community itself, from social entities that are linked to the educational center or from some kind of collective. It may also have been the result of a previous work of the students by detecting problems or needs through a PBL or a case study.

It allows the center and the students to get to know the reality first hand and to establish positive alliances with the environment.

HOW CAN WE APPLY THIS IN THE METAVERSE?

Here are some examples:

Virtual Community Garden Project:

Students design and maintain a virtual community garden in a low-income neighborhood within the metaverse. They research local food insecurity issues, plan the garden layout, and collaborate with virtual community members to grow and distribute produce. The project can be linked to real-world community gardens, with students applying lessons learned in the virtual space to physical projects.

Global Water Access Initiative:

Learners participate in a virtual water infrastructure development project in a developing country. They assess the community's needs, design water distribution systems, and implement education programs on water conservation and hygiene. The metaverse allows students to experience the challenges and cultural contexts of different global communities.

LEARNING IN NATURE

This methodology proposes activities that students will carry out, as its name indicates, in a natural environment (riverbanks, forests, beaches, etc.). It allows them to interact with and in nature, promoting meaningful learning. Numerous studies link good physical and mental health to continuous and direct contact with a healthy and diverse natural environment. The practice of outdoor activities improves motor functions and moderates the impact of stress at all ages.

This connection with the natural environment also has multiple benefits for learning. It promotes positive interactions, motivation, creativity and connection to the environment. Biophilia, named after biologist E.O. Wilson, refers to the innate affinity that humans feel for nature as a whole and that is maintained into adulthood when individuals spend time and engage in activities in the natural environment from an early age.

In the absence of nearby safe natural spaces, we can use naturalized playgrounds, school gardens and nearby parks and gardens, as well as the myriad of available facilities such as farm schools, environmental education facilities, etc.

HOW CAN WE APPLY THIS IN THE METAVERSE?

Here are some examples:

1. Marine Conservation Adventure

In consist on creating a virtual ocean where students can explore coral reefs and deep-sea ecosystems, participate in ocean cleanup activities and marine life rescue or observe the impact of pollution and overfishing in accelerated time. This immersive experience can increase awareness about marine conservation and the importance of aquatic ecosystems.

2. Interactive Botanical Garden

It consists on developing a virtual garden where students can plant and care for different species of plants, experiment with various environmental conditions or learn about pollination and seed dispersal in an interactive manner.

FUTURE SCENARIOS

This methodology allows us to understand the complexity of the problems from a systemic perspective. Through it we establish a description of an ideal or desired future at a given point in time. The construction of a future scenario is not based on what may happen, but on what we want or expect to happen. Therefore, it is neither a forecast nor a prediction.

The purpose is to imagine an ideal future, not at the individual level, but at the community level, whether local or global. A livable future in which, using the objective of the 2030 Agenda, no one is left behind.

The concept of scenario may reflect a static idea of a fixed image. Nothing could be further from the truth, it is necessary to structure the variables that help define that scenario and that,

in our case, can be illuminated by the Sustainable Development Goals and Human Rights, for example.

The importance of building future scenarios lies, on the one hand, in their narrative potential, both to construct ideal futures and to advance in the proposals that can bring us closer to them and, on the other, in the need to recognize the interrelationships and dependencies of the elements that converge in them.

The idea underlying this methodology is that there are different possible futures depending on the decisions we make today. It is not a matter of making predictions, but of using contrasted data to assess the evolution of certain processes. We do not have certainties about the future, but we do have scientific evidence that shows us what effects different human activities have on the environment.

HOW CAN WE APPLY THIS IN THE METAVERSE?

Here are some examples:

1. Climate Change Impact Simulator:

Students interact with a dynamic model of a coastal city in the metaverse. They can adjust variables like greenhouse gas emissions, sea level rise, and adaptation measures, then fast- forward to see the long-term impacts on the city's infrastructure, economy, and population.

2. Sustainable Technology Evolution Explorer:

Learners navigate through different time periods in a virtual city, observing how sustainable technologies evolve. They can interact with future versions of renewable energy systems, waste management solutions, and transportation networks, analyzing their potential impacts on society and the environment.

STEAM METHODOLOGY

STEAM Education is an approach to learning that uses Science, Technology, Engineering, the Arts and Mathematics as access points for guiding student inquiry, dialogue, and critical thinking.

Using STEAM education results in students who take thoughtful risks, engage in experiential

learning, persist in problem-solving, embrace collaboration, and work through the creative process. These are the innovators, educators, leaders, and learners of the 21st century.

There are actually 6 steps to creating a STEAM-Centered classroom, no matter what area you teach. In each step, you're working through both the content and the arts standards to address a central problem or essential question.
These are the steps to go through.

1. Focus

In this step, we're selecting an essential question to answer or problem to solve. It's important to have a clear focus on both how this question or problem relates to the STEM and the Arts content areas you've chosen.

2. Detail

During the detail phase, you're looking for the elements that are contributing to the problem or question. When you're observing the correlations to other areas or why the problem exists, you begin to unearth a lot of key background information, skills or processes that students already have to address the question.

3. Discovery

Discovery is all about active research and intentional teaching. In this step, students are researching current solutions, as well as what ISN'T working based on the solutions that already exist. As a teacher, you can use this stage to both analyze the gaps your students may have in a skill or process and to teach those skills or processes explicitly.

4. Application

This is where the fun happens! After students have dived deep into a problem or question and have analyzed current solutions as well as what still needs addressed, they can begin to create their own solution or composition to the problem. This is where they use the skills, processes and knowledge that were taught in the discovery stage and put them to work.

5. Presentation

Once students have created their solution or composition, it's time to share it. It's important that the work is presented for feedback and as a way for expression based on a student's own perspective surrounding the question or problem at hand. This is also an important opportunity to facilitate feedback and help students learn how to give and receive input.

6. Link

This step is what closes the loop. Students have a chance to reflect on the feedback that was shared and on their own process and skills. Based on that reflection, students are able to revise their work as needed and to produce an even better solution.

HOW CAN WE APPLY THIS IN THE METAVERSE?

Virtual Sustainable City Design (Engineering + Mathematics + Technology)

Students can collaborate in the metaverse to design a sustainable city. They would focus on creating eco-friendly buildings, renewable energy sources (like solar panels, wind turbines), and waste management systems, using principles from engineering, mathematics, and technology. They would have to calculate energy efficiency, plan green spaces, and ensure the designs promote environmental sustainability. Students can also use simulation tools to test their designs for sustainability, such as measuring carbon footprints or predicting the impact of climate change.

Virtual Ecosystem Restoration (Science + Technology + Engineering)

In this activity, students could participate in a virtual ecosystem restoration project in the metaverse. They can select a damaged ecosystem, such as a forest, coral reef, or wetland, and work to restore its balance. They would apply scientific knowledge of ecosystems and biodiversity, use technology to model the environment and track the effects of their actions, and use engineering to implement solutions like artificial reefs or reforestation efforts.

Art & Sustainability: Virtual Eco-Art Projects (Arts + Technology + Science)

This activity integrates art, science, and technology in a sustainable way. Students in the metaverse could design digital art installations or sculptures made from virtual sustainable materials (like recycled items or natural resources). They could create interactive experiences where their art reflects environmental themes such as climate change, pollution, or conservation. The art can also include educational elements, teaching other avatars about sustainability and the importance of eco-friendly living.

Virtual Sustainable Farming Simulation (Science + Technology + Engineering)

In the metaverse, students could engage in a virtual farming simulation that teaches them about sustainable agriculture. They would learn about crop rotation, water conservation, and organic farming practices. Students can design their farms, experiment with renewable energy for irrigation, and optimize resource use, such as minimizing water waste and creating eco-friendly pest management systems. They can even test how different farming techniques impact the environment.

Circular Economy Virtual Marketplace (Mathematics + Technology + Engineering

---

Students can participate in a virtual marketplace that operates on a circular economy model. They can design businesses that focus on recycling, reusing, and repurposing materials. For example, they could build a virtual company that turns waste into useful products (like turning plastic into furniture or recycled paper into art). They will use mathematics to analyze costs and savings, while using technology to track the lifecycle of materials and minimize waste.

These activities in the metaverse blend STEAM disciplines and focus on fostering the sustainability competence that students need for the future, combining theory with practical, interactive applications in virtual environments.

GAME BASED LEARNING

It is a methodology that uses play as a central element to promote learning and the acquisition of competencies from proposals that can integrate both analogue and digital play.

Analogical play allows the use of pre-existing elements, such as board games or recreational activities with educational objectives. Games can be simulated or carried out in real environments and participation already implies learning from experiences. In this sense, it is important that there is a clear connection for the students between the game and what they learn, so that they are aware of the process. The games should have explicit rules that may have been the result of a previous agreement. Thus, students are involved from the beginning, deciding and negotiating what each player can do and at what time.

Digital games allow the introduction of video games, simulators or serious games from an educational perspective. It is important to distinguish gamification, because unlike Game-Based Learning, does not use the games themselves, but their dynamics. For example, if a

system of assigning points or badges is devised with the aim of increasing student motivation or work by sequencing levels, in the style of video games.

The role of the teacher is especially important in selecting the game according to the educational objectives, guiding the group and adapting the game and its difficulty to the competencies that the group is developing. If the process is too simple or predictable, it can become boring. In the opposite case, if the challenge seems unattainable, it can lead to frustration and abandonment.

When GBL is used, the selection depends on the competencies to be worked on and the game chosen, so it is not possible to define a procedure in a strict sense.

Sometimes the game can favor a negative competitiveness. In this sense, it is convenient to promote processes that favor group work to achieve the objectives, based on collective and not individual successes.

HOW CAN WE APPLY THIS IN THE METAVERSE?

A metaverse learning experience is fundamentally rooted in gamification methodology, as it inherently incorporates key elements of game design to enhance engagement and learning outcomes.

The immersive, interactive nature of the metaverse naturally lends itself to gamified learning by providing a virtual environment where students can explore, experiment, and interact in ways that mirror game mechanics.

This virtual world allows for the seamless integration of gamification elements such as points, badges, leaderboards, and progress tracking, which are core components of gamified learning experiences.

ALL OF THESE LEARNING METHODOLOGIES HAVE PROVEN TO BE SUCCESSFUL IN ACHIEVING COMPETENCIES RELATED TO ENVIRONMENTAL AWARENESS. HOWEVER, IT IS A CHALLENGE TO ADAPT THESE METHODOLOGIES TO A VIRTUAL REALITY ENVIRONMENT IN WHICH NOT ALL OF THEM CAN BE SUCCESSFULLY TRANSLATED AND DEVELOPED, SO IT WILL BE NECESSARY TO DECIDE WHICH OF THEM BEST FIT THE REQUIREMENTS OF A VIRTUAL ENVIRONMENT.

The methods we propose are specific implementations of the broader approaches outlined in

the project. Project-based learning is an example of experiential learning where students gain hands-on experience through practical projects, often in a community setting. Service-learning combines situated and experiential learning by engaging with the community to promote a shift in values and understanding. Learning in nature incorporates experiential elements through direct interaction with the environment, which can lead to changes in beliefs and sustainable practices. Case studies allow for a collaborative approach by analyzing real-world problems and encourage the development of critical thinking skills. Future scenarios encourage creative thinking and reflection and support transformative learning and teamwork. Game-based learning incorporates elements of gamification but goes further by using games as a central learning tool. All the proposed methods are firmly rooted in collaborative approaches, as they are largely based on group work and the exchange of ideas. They are also in line with the principles of transformative (situated) learning, which combines knowledge with real-life experiences and reflection. Therefore, our methods complement and enhance the broader methodological framework described in the project.

6. LEARNING SCENARIOS

6.1. DESCRIPTION OF THE SCENARIO 1

CONTEXT AND PURPOSE OF THE SCENARIO

This scenario has been designed to work on AREA 1 of the EU GreenComp. Area 1 aims at embodying sustainability values to European students, and in order to achieve it, students must develop and acquire the competence of value sustainability, support fairness and promote nature.

The scenario has been specifically designed to ensure that students can work on and develop the above competences.

All the activities in the scenario support or help students in some way to acquire these competences.

SPACIAL AND VISUAL DESCRIPTION

This is an activity that takes place in a travel agency. The scenario should simulate an agency in which the participating students must make all the decisions involved in the preparation of an end-of-course trip.

The scenario will feature an NPC who will guide them in making decisions in preparation for the trip.

The appearance and design of the scenario may be different. As long as it incorporates the elements necessary for students to make the travel-related decisions they need to plan, the agency's design will be considered adequate.

LOCATION AND DISTRIBUTION OF ACTIVITIES

In order for the students to be able to develop the activity in the metaverse, it will be necessary to offer them various elements from which they will have to select the one they consider most appropriate.

In the agency, an NPC will be in charge of summarizing what the activity will consist of. The options will be represented by icons that will float and move around the virtual classroom.

To add a playful note to the activity, the elements should be moving in space, so that it is difficult to select/grasp the desired element.

This process will be repeated for each decision that the NPC proposes to them, and as they

decide the elements, they will be fully defining the trip.

EVALUATION AND PROGRESS TRACKING SYSTEM

In line with the principles of inclusion, the assessment methodology has been designed to ensure fairness and to avoid any form of discrimination. The evaluation process is based on a total maximum score of one hundred points, which are distributed across the different phases of the activity. Students can obtain up to twenty-five points in the first activity, twenty-five points in the second activity, and fifty points in the final activity.

Each decision made by the students carries an associated value according to its level of sustainability. Sustainable choices are rewarded with either five or ten points, while options that have a significant environmental impact do not receive any points.

After each decision, students are provided with immediate feedback in the form of points, allowing them to monitor their progress throughout the experience. At the end of the activity, when the trip has been fully defined, an overall score is assigned based on the total points accumulated during all phases.

The final grading scale establishes three achievement levels. Students who obtain between zero and fifty points must repeat the activity, those scoring between fifty-one and eighty points are considered to have successfully completed it, and those achieving between eighty-one and one hundred points complete the activity with excellence and are awarded a recognition badge.

6.2. DESCRIPTION OF THE SCENARIO 2

CONTEXT AND PURPOSE OF THE SCENARIO

The scenario for TOPIC 2: Embracing complexity in sustainability, consists of an escape room. The scenario for the development of this escape room will be a beehive, so we will be in the presence of a “Beehive escape”. Imprisoned inside a beehive where players engage in climate action-focused decision-making sustainability journey, in order to be able to save and leave the hive.

The European Commission has developed GreenComp as a reference framework on sustainability competences at EU level. It provides a common ground to learners and guidance to educators, providing an agreed definition of what sustainability as a competence entails. Such a shared understanding can act as a catalyst for learning for environmental sustainability by supporting education and training institutions to develop, review and adapt their vision and practices with regard to teaching and learning for sustainability. GreenComp consists of 12

competences organised into four areas.

The Area 2 - Embracing complexity in sustainability - includes the competences: systems thinking; critical thinking and problem framing. This theoretical foundation enables learners to be better equipped to see connections and links between specific issues and environmental change. In this escape room, players engage in sustainability-focused challenges, in order to manage to solve the problem of the decline in bee populations and thus save and leave the hive. The implications of this theme emerge as an ideal framework to explore the competencies of Greencomp Area 2. The activities that will take place in each of the rooms of the beehive are designed to develop the 3 competencies already mentioned, encouraging players to reflect on how human actions impact bees and the environment.

Effectively, bees are essential for the pollination of a wide range of plants, which ensures food production and the maintenance of biodiversity. Without them, many of our food crops, the balance of ecosystems and the production of honey and other products would be compromised. In addition, bees help sustain the global agricultural economy, making their preservation critical to our survival and well-being.

However, scientific data shows that bee populations are facing declines in many parts of the world, and this trend is a cause for great concern. The decline in bees can have devastating effects not only on biodiversity, but also on human food security. To avoid the decrease in bee populations, it is essential to adopt a set of practical actions that seek to preserve their habitat, reduce negative impacts, and promote sustainability.

By the end of the Beehive Scape, participants will have gained a deep understanding of the importance of bees to ecosystems, the threats they face, and the actions needed to protect them. They will have developed systemic thinking, critical thinking and problem framing skills, and will be better able to understand the interdependence between bees and humans, as well as knowing how to act to preserve this species that is essential to life on the planet.

SPACIAL AND VISUAL DESCRIPTION

Bees are disappearing due to several factors. The consequences will be dire. The group's goal is to save a bee colony, restore the balance of the ecosystem and prevent more bees from being lost. They have to solve riddles and find clues that will help restore the environment and

save the bees.

Players entering the hive will have to make their way through the hexagonal rooms. The hive consists of a wooden building, in the shape of a beehive, which players enter through a door that gives them access to an entrance hall;

On each of the two levels there will be two hexagonal-shaped rooms (the shape of the rooms is intended to simulate a honeycomb). Each of the rooms will have a different color, associated with the theme of the challenge that exists in each of them.

At the entrance to the hive and in each of the rooms there will be an NPC bee that will guide players through the tasks to be completed.

1st LEVEL – What if... the bees disappeared?
In the two rooms that make up this level, players will understand the reasons why bees are essential for both ecosystems and humans, playing a crucial role on several levels.

2nd LEVEL - Mission: We have to save the bees!
In the two rooms of this level, players are faced with terrible news: due to several factors, bee are disappearing! This hive and the bees spread throughout the world must be saved. Measures must be taken to prevent the disappearance of bees at all costs, otherwise irreparable imbalances in ecosystems and the world economy will be caused.

LOCATION AND DISTRIBUTION OF ACTIVITIES

The metaverse for Topic 2 is structured as an escape room set inside a digital beehive. Participants are “locked” in the hive and, to exit and save the bees, they must pass through two levels composed of hexagonal rooms and complete a final quiz. Entry occurs via a hall where a bee NPC introduces the mission and the rules of the experience.

Level 1 – What if… the bees disappeared?
Players traverse two hexagonal rooms to understand the essential role of bees. In the yellow room they review organism flashcards and solve four word-based riddles, each linked to a phase of honey production. In the green room they build a forest food web by dragging and correctly placing flashcards onto a large diagram; they then answer a multiple-choice question on the role of bees in maintaining biodiversity. Upon completion, the NPC awards a honey pot matching the room color.

Level 2 – Mission: we have to save the bees!

Players analyse the causes of pollinator decline and select corrective actions. In the gray room they consult information panels on the main threats (climate change, pesticide use, monoculture expansion, habitat destruction) and complete an eight-question quiz. In the pink room they interact with a 3D ecosystem model of fields and beehives: they insert flashcards representing sustainable or unsustainable practices and observe real-time indicators for colony health and field condition, which improve or deteriorate according to their choices. When finished, they receive the corresponding honey pot.

Final quiz

After completing the four rooms, participants take a five-question multiple-choice quiz to verify understanding of key concepts: the ecological importance of bees, the threats they face, and the practices needed to protect them. Passing the quiz allows them to exit the hive and conclude the experience.

EVALUATION AND PROGRESS TRACKING SYSTEM

In line with the principles of inclusion, the assessment methodology has been designed to ensure fairness and to avoid any form of discrimination.

The activity consists of completing four challenges distributed across two levels of the hive, followed by a final quiz. Each challenge must be successfully completed in order to progress to the next room and ultimately exit the hive.

The maximum achievable score is **100 points**, distributed across the different phases of the activity as follows:

- **25 points** for the first activity (yellow and green rooms);
- **25 points** for the second activity (gray and pink rooms);
- **50 points** for the final quiz.

Each decision made by the players has an associated value:

- **2.5 points** if the chosen option is correct;
- **0 points** if the choice has a significant environmental impact.

After each decision, players receive **immediate feedback** in the form of points, allowing them to monitor their progress throughout the experience.

Each room includes a **countdown timer** to encourage focus and time management. Whenever a task is completed successfully, a **reward sound** is played; if the task is not completed correctly, a sound prompts the players to reformulate their response.

At the end of each activity, a **leaderboard** displays the total score obtained by all teams, showing rewards and points earned, in order to encourage participation and engagement.

The **final cumulative score** determines each team's level of achievement according to the following grading scale:

- **0–50 points** → the activity must be repeated;
- **51–80 points** → activity successfully completed;
- **81–100 points** → activity successfully completed with the award of a recognition badge.

This assessment approach ensures a **fair, formative and motivating experience**, encouraging **collaboration, critical thinking, and informed decision-making** while promoting awareness of sustainability and environmental responsibility.

6.3. DESCRIPTION OF THE SCENARIO 3

CONTEXT AND PURPOSE OF THE SCENARIO

This learning scenario is based on **GreenComp Area 3: Envisioning Sustainable Futures**. This scenario focuses on **futures thinking** and the capacity to anticipate how current choices shape tomorrow's world. Students act as sustainability strategists who must decide how societies will grow food and build homes in a climate-conscious future.

Guided by **Professor Solara (NPC)**, they experience two themed arenas that combine creativity, systems thinking, and collaboration. Their actions transform the surrounding environment—green fields and clean skylines appear when sustainable choices are made, while careless ones trigger visible degradation.

The activity develops the GreenComp Area 3 competences:

- **Futures Literacy** – anticipating and shaping desirable futures.
- **Adaptability** – adjusting actions in response to change.
- **Exploratory Thinking** – experimenting with creative, sustainable solutions.

SPACIAL AND VISUAL DESCRIPTION

The environment includes a **floating eco-city** composed of two arenas connected by a central area. This space functions like an interactive "learning hub," equipped with multilingual panels and optional tutorials. The design allows students to return to this area at any time during the activity for clarification or revision.

The main playing zone consists of a large floating platform where the core activities take place.

Students, represented by avatars or characters, navigate this space by identifying and interacting with floating items (e.g. water, fertilizer, building materials).

The layout changes slightly between the two levels of the game:

1. **Level 1 - Agriculture Arena** – a vast garden platform surrounded by rivers and terraces. Here students identify sustainable farming practices (e.g., composting, rainwater collection, crop diversity). Correct actions make the garden bloom; unsustainable choices cause it to wilt.
2. **Level 2 - Construction Arena** – a skyline platform for sorting building materials. Players must distinguish **green** (timber, bamboo, mineral wool) from **red** (PVC, concrete, asphalt) materials. Their decisions visibly change the horizon and green roofs and clean air appear if they succeed.

Between arenas, the central hub serves as a transition space where Professor Solara explains the link between the two systems: food and housing, as pillars of sustainable futures.

LOCATION AND DISTRIBUTION OF ACTIVITIES

In order for the students to carry out the activity in the Metaverse, the environment must provide a variety of visual elements representing different sustainability-related choices. These elements—materials and resources linked to agriculture and construction—will float and move across the virtual space, requiring students to carefully identify and select the most sustainable options.

The scenario unfolds in three stages:

Level 1 – Sustainable Agriculture

- Students collect floating items representing farming practices.
- Sustainable items (compost, rainwater tanks, organic fertilizer, pollinator flowers, ladybug boxes) earn points; unsustainable items (pesticides, plastic mulch, monoculture seeds, diesel pumps) do not.
- Each correct decision enhances biodiversity and soil health in the virtual garden.
  Score: 25 points maximum.

Level 2 – Sustainable Construction

- Teams classify floating building materials into two categories: sustainable (wood,

bamboo, recycled steel, mineral wool, green roofs) or unsustainable (PVC, concrete, asphalt, oil-based paint).

- Each correct classification improves the skyline; errors add smog or decay.
  Score: 25 points maximum.

Final Quiz – Knowledge Check

- A short five-question quiz led by Professor Solara reinforces key concepts.
- Questions test understanding of sustainable farming, green materials, and long-term systems thinking.
  Score: 50 points maximum.

EVALUATION AND PROGRESS TRACKING SYSTEM

Assessment is conducted through a **gamified and formative** system that includes:

- **Point System**:

Student performance is assessed through a formative point-based system with a total of 100 points, distributed across the three stages of the activity:

- 25 points – *Sustainable Agriculture*
- 25 points – *Sustainable Construction*
- 50 points – *Final Knowledge Check (Quiz)*

This positive scoring approach rewards accuracy, collaboration, and sustainable reasoning rather than competition or speed.

- **Quiz**

At the end of the activity, students complete a final knowledge quiz consisting of five questions, each worth 10 points, for a total of 50 points.

The quiz assesses understanding of sustainability principles explored throughout the activity — including sustainable agriculture, eco-friendly construction, and responsible resource use.

6.4. DESCRIPTION OF THE SCENARIO 4

CONTEXT AND PURPOSE OF THE SCENARIO

This scenario has been designed to address the Area 4 of the EU GreenComp Framework, which focuses on Acting for Sustainability. This area includes three essential sustainability

competences:

- Political Agency – the ability to engage with and influence policy-making for sustainability.
- Collective Action – the capacity to participate in group efforts that aim at environmental improvement.
- Individual Initiative – the motivation to act personally and responsibly for a more sustainable future.

The learning activity is designed so that learners practice, experience, and reflect on the three competences of Area 4 of the GreenComp. At both the systemic and personal levels, players engage with complex decision-making processes that simulate real-world sustainability challenges. As they navigate these scenarios, learners are challenged to appreciate how their actions contribute toward a sustainable society and what tools they need to collaborate, and advocate for significant change.

SPACIAL AND VISUAL DESCRIPTION

The learning activity takes place in a large virtual city environment designed to simulate realistic urban spaces where sustainability decisions are made and experienced. The city includes multiple interactive zones:

- **City Square & Town Hall** – center for civic participation and debates.
- **Residential District** – neighborhood for personal decision-making and sustainable upgrades.
- **Environmental Dashboard** – a large visual display showing real-time carbon reduction and energy efficiency as players act.

In Scenario 1, learners navigate around the city and through observation and interaction, collect sustainable civic items, and later on select and defend one sustainability proposal at the City Council Debate. In Scenario 2, they engage with their own digital residence/home and make decisions on how the environmental impact of their home may be minimized.

Spaces are both immersive and dynamic in nature. Depending on the actions that are taken by players, they will witness the visual improvements in the city which includes the addition of bike lanes, installation of solar panels, and improved air quality, or in individual houses such

as the gardens being greener and the installation of energy saving appliances

LOCATION AND DISTRIBUTION OF ACTIVITIES

The scenario unfolds in three stages:

Level 1 – Greening the City (Policy & Collective Action)

- Students begin with a scavenger hunt across the City Square to collect sustainable civic items (solar panels, bike stands, recycling bins, native trees, rainwater barrels).
- In the **City Council Debate**, teams select and defend one proposal before NPC councillors, responding to challenges and negotiating trade-offs.
- Visual outcomes (e.g., new green spaces, cleaner air) depend on the chosen policy and argument quality.

  Score: 25 points maximum.

Level 2 – Leading by Example (Individual Initiative)

- Students receive a €50 000 budget to upgrade a virtual home.
- Upgrades (solar panels, insulation, EVs, compost systems, green roofs, smart sensors) reduce carbon emissions displayed on the dashboard.
- Players must prioritize high-impact actions within budget limits, reinforcing responsible decision-making.

  Score: 25 points maximum.

Final Quiz – Knowledge Check

- Mayor Elara hosts a five-question quiz reviewing lessons on civic action, household choices, and sustainability principles.
- Teams must agree collectively before answering.

  Score: 50 points maximum.

EVALUATION AND PROGRESS TRACKING SYSTEM

The activities of AREA 4 will integrate a scoring and feedback system.

In Scenario 1: Greening the City – From Policy to Action, players will earn points from:

1. Identifying relevant sustainability gaps during the city exploration and scavenger hunt.
2. Based on their ability to convince NPC council members during the debate

phase (Persuasion ratings). How well the proposed policy matches the issues discovered.

3. If visual improvements (e.g., bike lanes, green spaces) appear if the law passes

Feedback will be received immediately from NPCs depending on vote outcome, with guidance for future attempts if unsuccessful.

In Scenario 2: Eco at Home – Sustainable Living by Example, players will receive:

1. A carbon footprint score that updates in real time as sustainable upgrades are made such as installing solar panels, switching to an EV, or composting.
2. Budget management evaluation, tracking how efficiently players use limited resources.
3. Community influence tracking, where players see nearby NPCs adopting similar sustainable actions.

Important to note is that throughout the activity, players are given short feedback messages after key decisions.

7. ASSESSMENT METHODS

After the immersion in the different learning activities simulated in the metaverse, we should implement a method that allows us to assess in a more individual and evidence-based way the extent to which each student is developing and acquiring the competence in sustainability.

In this sense, the metaverse activities, in general, will include a point system, allowing students to earn badges for achieving specific milestones.

When students have completed the activities proposed in each learning scenario, according to the points and badges acquired, they will have an overall idea of how much they have achieved the competences proposed.

However, the exact way in which the activities will be graded, or how students will be able to earn their points throughout the activities, will be defined exactly in each activity.

In addition, after the immersion of the students in the metaverse, it is considered important that the whole group of students have a time to reflect about the experience and have peer discussion on, for example, decision-making strategies, common errors, and key insights. This final session will serve to consolidate students' comprehension of essential sustainability concepts, and also to check the effectiveness of the immersion.

8. PROGRESSION LEVELS

All learning scenarios will consist of two progression levels. The transition from one level to the other can be made in different ways in each scenario, as the activities designed in each scenario will be of a different nature.

In any case, all the exercises to be completed or activities to be performed in the higher level will be of a higher difficulty than in the basic level and in all of them, it will be necessary to compete first the basic level to be able to access the advanced level.

9. LIST OF NEEDED EQUIPMENTS

In order to develop the activity in the classroom in an appropriate way, the following materials are necessary:

Item	Quantity
VR headsets	5
Controllers (2 per headset)	10
Charging cables/docks	10
Wi-Fi Router / Mesh	1 system
PCs (if required)	1 per student
Cleaning kit	2–3 kits
Physical open space	30–40 sqm total
Storage shelves/carts	1–2
Platform accounts	1 per person
Teacher laptop/tablet	1

10. BIBLIOGRAPHY

- Bianchi, G., Pisiotis, U., & Cabrera Giraldez, M. (2022). *GreenComp: The European sustainability competence framework* (M. Bacigalupo & Y. Punie, Eds.). Publications Office of the European Union. https://doi.org/10.2760/094757

- European Commission. (2022). *European sustainability competence framework: Background document*. Publications Office of the European Union. https://doi.org/10.2760/378627

- European Commission. (2022). *GreenComp: Policy background and methodology*. Joint Research Centre. https://joint-research-centre.ec.europa.eu/greencomp-european-sustainability-competence-framework/greencomp-policy-background-and-methodology_en

- European Commission. (2022). *GreenComp conceptual reference model*. Joint Research Centre. https://joint-research-centre.ec.europa.eu/greencomp-european-sustainability-competence-framework/greencomp-conceptual-reference-model_en

- European Commission. (2022). *GreenComp: Developing skills for a sustainable future*. European School Education Platform. https://school-education.ec.europa.eu/en/discover/news/greencomp-developing-skills-sustainable-future
- European Commission. (2024). *GreenComp in practice: Case studies on the use of the European competence framework* (JRC140836). Publications Office of the European Union. https://data.europa.eu/doi/10.2766/053738publications.jrc.ec.europa.eu

- European Commission. (2024). *Learning for sustainability in Europe: Building competences and supporting teachers and schools*. Eurydice Report. https://eurydice.eacea.ec.europa.eu/publications/learning-sustainability-europe-building-competences-and-supporting-teachers-andeurydice.eacea.ec.europa.eu

- European Commission. (2023). *European Education Area Strategic Framework*. Directorate-General for Education, Youth, Sport and Culture. https://wikis.ec.europa.eu/download/attachments/44165726/NC-04-23-794-EN-N.pdfwikis.ec.europa.eu

- European Commission. (2022). *GreenComp: Policy background and methodology*. Joint Research Centre. https://joint-research-centre.ec.europa.eu/greencomp-european-sustainability-competence-framework/greencomp-policy-background-and-methodology_en

- European Commission. (2022). *European sustainability competence framework: Background document*. Publications Office of the European Union. https://data.europa.eu/doi/10.2760/378627

Legal notice

Project Title: CLIMAte change education for secondary schools using MetaVERSE

Project Acronym: CLIMA-VERSE

Grant Agreement No. : 2024-1-SI01-KA220-SCH-000248238

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CMEPIUS (Centre of the Republic of Slovenia for Mobility and European Educational and Training Programmes). Neither the European Union nor the granting authority can be held responsible for them.