Augmented Reality Technology Green Curriculum

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Introduction

GreenYOU is a project of the Erasmus+ programme implemented in Cyprus, France, Greece, Ireland, Lithuania and Poland, with the aim to develop green skills for young people and provide them with the knowledge and competences needed to keep up with the green transition, combat unemployment and promote a sustainable and climate neutral society.

The aim of GreenYOU project is to build the capacity of youth workers/ organisations for young people to cultivate green skills and key competences with the use of Mobile Augmented Reality and address issues like climate change and unemployment.

The **GreenYOU Augmented Reality Technology Green Curriculum** consistς of 3 sections

1. Augmented Reality tools
2. GreenYOU Augmented Reality Technology Green Curriculum
3. Learning design framework.

The **first part** of **GreenYOU Augmented Reality Technology Green Curriculum** contains a list of available digital tools for Augmented Reality and relevant software that can be used in curricula/lesson plans related to the youth workers' work. In an attempt to map the technological affordances of AR to the corresponding educational objectives this Curriculum includes analytical instructions on the use of those tools along with their affordances and limitations. These should be useful for all the youth workers/institutions that are interested in using Augmented Reality in their curriculum.

In the **second part** of **GreenYOU Augmented Reality Technology Green Curriculum** are included the lesson plans for seven indicative modules with an explicit set of Learning Outcomes (LO), learning methods and material used in each unit.

Finally, in the **last part** of the **GreenYOU curriculum** the learning design framework is provided, in order for the youth worker to create their own curricula/lesson plans, using Mobile Augmented Reality Games to endorse digital and green competencies to young people.

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Augmented Reality

Augmented Reality (AR) is an interactive tool that integrates digital information with the real world. It can also be described as a virtual reality technology where users can interact with virtual objects in the real world and unlike virtual reality (VR) does not create a totally artificial environment.

Those two terms are often confused but there are some notable distinctions between the two. Both technologies are known for their rich experiences that combine an enhanced real world with 3-D visuals and a virtual one. In order to improve the experience, AR overlays the current real-world environment with virtual data or even a virtual world. Virtual reality, on the other hand, transmits users to a completely different environment, that has been digitally designed and produced.

This integration of digital data with the real-world environment is accomplished with the use of computer hardware and software, including apps, consoles, screens and projections.

Nowadays, modern mobile phones are equipped with sensors such as Global Positioning System (GPS), high-resolution cameras as well as rich multimedia features, large memory capacity and powerful processors. In addition, 5G technology, which has better connectivity, can meet the physical needs for augmented reality on mobile devices and offer the Mobile Augmented Reality (MAR) experience. Using the camera on a smart device to take pictures in real time, AR technology enables users to overlay computer-generated objects onto the physical world.

So far, AR has been incorporated in various fields from medicine, the military, engineering design, robotics, manufacturing, maintenance, and repair and can be applied for learning, entertainment, or edutainment by enhancing a user's perception of and interaction with the real world. There are several benefits of AR in education, some of which are listed below:

- Augmented reality (AR) in education significantly boosts student engagement by creating an interactive environment. By overlaying digital content onto the real world, AR enhances learning experiences, such as in history lessons. This interactivity motivates students, facilitates deeper comprehension, and allows them to take ownership of their educational journey, bridging the gap between physical and digital worlds.

- By overlaying virtual elements onto real-world environments, preparing students for future careers and challenges, AR bridges the gap between classroom learning and real-world application

- AR can enhance learning by incorporating gamification elements like challenges, rewards, and progress tracking. This approach promotes intrinsic motivation, increases persistence, and enhances the overall enjoyment of the learning process among students.

- AR can boost significantly student engagement by creating an interactive environment. By overlaying digital content onto the real world, AR enhances learning experiences, such as in history lessons. This interactivity motivates students, facilitates deeper comprehension, and allows them to take ownership of their educational journey, bridging the gap between physical and digital worlds.

- AR can improve knowledge retention by providing a multisensory learning experience. By visualizing complex ideas and forming stronger mental connections, AR enhances information recall compared to traditional methods. By leveraging AR, educators can empower students to retain knowledge effectively and build a solid understanding foundation beyond the classroom.

Digital tools for Mobile Augmented Reality

Seek by iNaturalist

Seek by iNaturalist is an educational AR app that enables users to explore biodiversity by identifying plants, animals, and other organisms in their local environment. With a focus on citizen science, Seek leverages image recognition technology to provide real-time information about the species users encounter, offering detailed insights into local ecosystems. By encouraging users to photograph and identify biodiversity around them, Seek fosters a deeper understanding of ecosystems, biodiversity, and the role of conservation. This makes it a valuable tool for educating youth about environmental awareness and the importance of sustainable practices for protecting natural habitats.

Analytical Instructions on the Use of the Tool

1. **Setup and Calibration**:
   - Download Seek by iNaturalist from the App Store or Google Play, then create an account or log in to iNaturalist to save observations. Ensure camera permissions are enabled for optimal AR functionality.

2. **Installing Applications**:
   - Seek is free to download and available on both iOS and Android. Users can begin identifying organisms immediately without additional purchases or subscriptions.

3. **Using the Interface**:
   - Simply open the app, point the camera at any plant or animal, and Seek will attempt to identify it in real-time. Users can browse observation lists,

participate in seasonal challenges, and explore biodiversity in specific regions. The app's AR features help visualize relationships between species and ecosystems.

4. **Developing Custom Applications**:
    - Seek doesn't support custom development but integrates well with educational workshops or citizen science projects, allowing educators to create local challenges and encourage biodiversity tracking among youth.

Affordances and Limitations

Affordances:

- **Biodiversity Awareness**: Identifies species in real time, educating users on local flora and fauna.
- **Citizen Science Integration:** Allows users to contribute to citizen science, fostering community engagement.
- **Real-World Learning**: Encourages youth to explore natural environments for hands-on experience.
- **No Internet Needed for Basic Use**: Allows identification without data, ideal for remote or outdoor use.

Limitations:

- **Limited Customization:** The app doesn't support development of custom content or AR modules.
- **Accuracy Varies by Region:** Some species may not be accurately identified in less-documented areas.
- **Device Dependent:** Identification quality varies with camera quality, limiting older devices.
- **Requires Stable Lighting**: Identification accuracy can be impacted by low-light or very bright outdoor conditions.

Examples of Methods of AR

- **Overlay Method:** Shows names and details of plants or animals in the real-world environment, making identification accessible for youth.
- **Simulation Method:** Allows users to participate in seasonal "missions," encouraging exploration of changing biodiversity with practical applications of their learning.
- **Annotation Method:** Provides labels and descriptions of species, helping youth understand ecosystem roles and biodiversity.

Recommendations for the Purpose of the Tool

- **Use Case 1: Biodiversity Education**: Youth learn to identify and understand the role of various species in their local ecosystem, fostering environmental appreciation.
- **Use Case 2: Eco-Friendly Practices**: Users explore sustainable interactions with local flora and fauna, learning the importance of conservation.
- **Use Case 3: Citizen Science Projects**: Youth can contribute to biodiversity data, participating in community science efforts.
- **Use Case 4: Nature-Based Challenges**: Educators can use Seek to create challenges around identifying endangered species or invasive plants.
- **Use Case 5: Outdoor Workshops**: Seek is an ideal companion for outdoor learning activities, encouraging hands-on engagement with nature.

Metaverse

Metaverse is an augmented reality (AR) platform designed for creating, sharing, and interacting with immersive AR experiences where users can build interactive experiences using a visual storyboard, combining scenes, commands, and navigation.

These experiences can include puzzles, scavenger hunts, or educational content that incorporates video, clues, or quizzes. The platform also supports gamification, allowing students to engage in problem-solving and creativity.

What sets Metaverse apart is its accessibility for teachers and students, promoting collaboration and content creation without the need for advanced coding knowledge. Its diverse user community contributes to a constantly growing library of experiences.

Analytical Instructions on the Use of the Tool

1. **Setup and Calibration**:
   - Create a free account on Metaverse Studio and download the Metaverse app.
   - Use the visual storyboard to start creating experiences, dragging and connecting scenes.

2. **Installing Applications:**
   - Access the Metaverse app from app stores or the website.
   - Use links, QR codes, or social media to share or join experiences.

3. **Using the Interface**:
   - Interact via tapping the screen, scanning QR codes, or using the app's menu to navigate.
   - The storyboard allows simple, visual creation of interactive content without complex coding.

4. **Developing Custom Applications**:
   - Supported by JavaScript for more advanced functions, users can create arrays or control properties.
   - Tutorials are available, and users can duplicate and modify existing experiences for faster creation.

Affordances and Limitations

Affordances:

- **Collaboration:** Promotes teamwork among students during interactive activities.
- **Gamification:** Engages students through puzzles, scavenger hunts, and competitive tasks.
- **Customizability:** Users can create their own unique experiences from scratch.
- **No Coding Required**: Simple interface allows for non-coders to develop complex interactions.

Limitations:

- **Limited Content**: The quality of user-generated content varies, and teachers must preview content.
- **Age Restriction**: Metaverse Studio requires users to be 13+, which limits access for younger students.

- **Complexity of Features**: Advanced functions like coding may be too difficult for some users.

- **No Backtrack**: Users cannot go backward in experiences unless built in, leading to potential frustration.

Examples of Methods of AR

- **Overlay Method:**
  This method layers virtual information over real-world elements, like a scavenger hunt where clues are overlaid onto real-world landmarks.

- **Simulation Method:**
  Involves recreating an environment in AR, such as a virtual science lab where students can interact with chemical elements.

- **Annotation Method:**
  Provides labels or additional information in AR. For instance, students can explore historical landmarks with virtual annotations that describe key features.

Recommendations for the Purpose of the Tool

- **Gamified Learning**: Ideal for creating interactive scavenger hunts, quizzes, or breakouts to make learning fun and engaging.

- **Collaborative Projects**: Useful for students to work in teams and solve problems or create joint AR experiences.

- **Custom Learning Experiences**: Teachers can create tailor-made lessons or activities, adapting to different learning styles.

- **Student-Created Content**: Students can design their own AR experiences, promoting creativity and ownership of their learning.

- **Professional Development**: Teachers can use Metaverse to create immersive, interactive training sessions for peer learning.

Plantale

Plantale is an innovative tool designed to help users in their gardening and plant care journey. It provides personalized advice on plant care based on the specific needs of various plant species, whether they are indoor or outdoor plants. Through an easy-to-use interface, users can input information about their plants, such as type, environment, and care preferences.

Plantale offers timely reminders for watering, fertilizing, and other essential plant maintenance tasks. Additionally, it provides educational resources on common plant diseases, pests, and how to treat them effectively. Users can track the growth and health of their plants with regular updates and recommendations tailored to the plants' progress. By using Plantale, gardeners of all experience levels can cultivate thriving, healthy plants while enhancing their gardening knowledge. This tool is a valuable resource for both beginners and seasoned gardeners looking to optimize plant care routines.

Analytical Instructions on the Use of the Tool

1. **Setup and Calibration**:

To set up Plantale, begin by downloading the app from the app store (iOS/Android) or web platform. Create a user account, providing basic details like location and gardening preferences. Add plants by selecting from the database or entering them manually, specifying their species, size, and growth stage. Calibrate by inputting the plant's environment, including its location, temperature, and sunlight conditions. Adjust watering schedules and care preferences based on the plant type for accurate reminders.

2. **Installing Applications:**

Plantale can be found on popular app stores. For iOS, go to the App Store, search for "Plantale," and click "Download." For Android, search through Google Play and install the app. Web-based versions can be accessed through the official website by following easy download or sign-up instructions.

3. **Using the Interface:**

The app's interface is designed for intuitive interaction. Users can navigate using simple gestures like swiping to scroll through plant care tips or tapping for more detailed information. Voice commands can be used for certain actions, like adding plants or setting reminders, enhancing user convenience.

4. **Developing Custom Applications:**

Plantale supports custom applications through its open API, compatible with Python and JavaScript. Developers can access documentation on the official website for creating applications that integrate with the tool, such as custom plant tracking systems or enhanced notification features.

Affordances:

- **Personalized Plant Care** – Plantale tailors care recommendations based on plant species, growth stage, and environment.
- **Reminders and Alerts –** Users receive timely notifications for watering, fertilizing, and pest control tasks.

- **Progress Tracking –** The app tracks plant health and growth, offering insights into care adjustments.

- **Educational Resources –** Plantale provides valuable information on plant diseases, pests, and best practices for various species.

Limitations:

- **Limited Plant Database –** Some rare or less common plant species may not be included.

- **Requires Internet Access –** The app may not function optimally without a stable internet connection.

- **Manual Input –** Users need to manually enter environmental details, which may require extra effort.

- **Device Compatibility –** Plantale may not be available on all devices or operating systems.

Examples of Methods of AR:

- **Overlay Method:**

AR overlays plant care instructions directly onto the real-world environment, guiding users through specific tasks like pruning or watering.

- **Simulation Method:**

AR simulates the growth process of plants, showing how changes in care impact their health.

- **Annotation Method:**

AR adds labels and annotations to physical plants, identifying species, growth stages, and care tips directly in the user's field of view.

Recommendations for the Purpose of the Tool

- **Use Case 1: Plant Care for Beginners:** Plantale is ideal for students who want to manage indoor plants without prior experience. By inputting the plant types and their specific care requirements, users receive customized watering schedules, sunlight recommendations, and alerts for plant health. The tool's reminders help students familiarize with the needs of a plant and how to provide consistent care, preventing over or underwatering and promoting healthy plant growth. Beginners can easily track their plants' progress and make adjustments based on real-time feedback.

- **Use Case 2: Outdoor Garden Management as a learning experience:** For seasoned gardeners managing a larger outdoor garden, Plantale offers advanced features like climate-specific advice and detailed tracking of plant growth cycles. Students can input various species and receive tailored care recommendations, including optimal soil conditions, pruning schedules, and pest control tips. The app can also help them understand how an efficient and thriving garden is affected by water deprivation or climate differences.

Assemblr Edu

Assemblr Edu is an augmented reality platform tailored for educational purposes, allowing users to create, explore, and share 3D models and interactive AR content easily. Designed for both beginners and advanced users, it provides pre-made templates and customization options that support various educational activities, from science to history. This tool operates on a mobile or web-based platform,and it is accessible via smartphones, tablets, or computers, making it flexible for use in multiple settings. What sets Assemblr Edu apart is its rich library of ready-to-use AR templates and resources specifically developed for educators, enabling simplified content creation and delivery for youth training.

Analytical Instructions on the Use of the Tool

1. **Setup and Calibration**:
    - Download Assemblr Edu on a compatible device. Create an account or log in, and adjust device camera settings for optimal AR experience. Some adjustments might be needed based on the lighting and space available.
2. **Installing Applications**:
    - Assemblr Edu can be downloaded from the App Store (iOS) or Google Play Store (Android). For the desktop version, access via the Assemblr Edu website.
3. **Using the Interface**:
    - The intuitive interface includes a “Create” button that opens up templates and customizable 3D models. Use touch gestures on mobile (such as drag and rotate) to position models, or mouse commands on the desktop. Users can add text, images, and animations to 3D objects, and use the camera button to project and view models in AR mode.
4. **Developing Custom Applications**:
    - Assemblr Edu supports custom AR content development without coding. However, users with experience in 3D design can integrate external models (e.g., from Blender or Tinkercad) to create unique AR projects.

Affordances and Limitations

Affordances:

- **Accessible Platform:** Available on multiple devices with a web-based option for flexible use.
- **User-Friendly Interface:** No coding skills required, making it suitable for youth and beginners.
- **Extensive Template Library:** Numerous ready-to-use templates for educational purposes.
- **Cross-Platform Sharing:** Easy sharing options for both AR and 3D models in diverse formats.

Limitations:

- **Device Compatibility Issues:** Certain devices may not support advanced AR functionalities.
- **Limited Advanced Customization:** Restricted to basic 3D manipulation, limiting high-end custom AR experiences.
- **Internet Dependence:** Requires internet access for most functions, affecting use in low-connectivity areas.
- **Subscription Costs:** Full access to premium features requires a subscription, which could limit accessibility.

Examples of Methods of AR

- **Overlay Method:** Displays digital 3D objects over the real-world environment through the camera, useful for interactive science models, like anatomy overlays.
- **Simulation Method:** Allows users to explore processes, such as the solar system's orbit, simulating real-life scenarios in AR for visual understanding.
- **Annotation Method:** Adds text and interactive labels to 3D models, such as labeling parts of an engine, helping users explore complex topics in workshops.

Recommendations for the Purpose of the Tool

- **Use Case 1: Environmental Awareness**: Visualize ecosystems or pollution effects, enhancing young people's understanding of sustainability issues.
- **Use Case 2: Soft Skills Development**: Create scenarios that simulate workplace environments, allowing youth to practice communication and problem-solving in AR.
- **Use Case 3: Project-Based Learning**: Encourage youth to create and share their AR projects, fostering collaboration, creativity, and tech fluency.
- **Use Case 4: Sustainable Agriculture and Food Systems**: Enable youth to learn about eco-friendly agriculture and the importance of sustainable food production by exploring sustainable farming practices and concepts through AR simulations.
- **Use Case 5: Renewable Energy Exploration**: Visualize renewable energy sources through AR models, fostering youth's understanding of the mechanics and benefits of energy sources, and how renewable energy contributes to a low-carbon future.

TaleBlazer

TaleBlazer is a location-based augmented reality (AR) tool designed by MIT for creating and playing mobile AR games. TaleBlazer facilitates immersive learning by turning real-world spaces into interactive educational environments. Through role-playing and storytelling, students can explore complex topics like green skills and environmental sustainability, fostering deeper understanding and engagement.

Analytical instructions on the Use of TaleBlazer

1. **Setup and calibration:**
   - Download the TaleBlazer app, enable GPS, use iBeacons if available, and calibrate GPS by moving around.
2. **Installing applications:**
   - Access TaleBlazer on mobile devices by downloading the app and using the web-based editor for game creation.
3. **Using the interface:**
   - Interactions in TaleBlazer involve tapping virtual elements, selecting options, and navigating physical spaces.
4. **Developing custom applications:**

- Use TaleBlazer's blocks-based programming editor to develop customized AR games with environmental concepts.

Affordances and limitations:

Affordances

- **Location-based AR**: Utilizes GPS and iBeacons to create game experiences linked to specific real-world locations.
- **Customizable gameplay**: TaleBlazer's drag-and-drop editor allows students and teachers to design unique AR experiences tailored to specific learning objectives.
- **Cross-platform**: Available on Android and iOS, with a web-based editor that supports most browsers.
- **Educational focus**: Suitable for a range of topics, TaleBlazer supports hands-on learning in subjects such as environmental science, ecology, and sustainable practices.
- **Environmental simulations**: Create scenarios for sustainable resource management or pollution impact, allowing students to explore ecological outcomes.
- **Role-playing for engagement**: Design games where students act as scientists or historical figures, making decisions that influence the storyline.
- **Collaborative learning**: Organize students into groups to create or explore different game segments, enhancing teamwork and knowledge-sharing.
- **Reflection points**: Include quizzes or reflection prompts at AR locations to reinforce learning as students progress.

Limitations

- **GPS dependency**: Requires a strong GPS signal for location accuracy, which can be limited indoors. iBeacons may help but require additional setup and devices.
- **Battery drain**: The AR and GPS functionalities can quickly drain mobile device batteries, making power sources necessary for extended use.
- **Learning curve for advanced features**: While basic game creation is accessible, more complex scenarios may require additional time and practice, particularly for younger or beginner users.

- **Limited for indoor use:** TaleBlazer is best suited for outdoor environments where GPS can function effectively. Indoor use may be challenging without supplemental location-tracking tools.

Examples of methods of AR

- **Overlay method:** Displays digital elements over real-world surroundings, e.g., overlaying information on sustainable practices.
- **Simulation method:** Creates interactive simulations of real-world processes, e.g., simulating the impact of sustainable practices on ecosystems.
- **Annotation method:** Adds digital labels or educational facts to real-world objects, allowing students to explore environmental concepts interactively.

Recommendations for the purpose of the tool:

- **Use case 1: Environmental education:** TaleBlazer is ideal for teaching environmental science. Students can explore natural habitats, track species, or simulate the impact of climate change through location-based AR games.
- **Use case 2: Historical exploration:** In historical sites, students can use TaleBlazer to interact with virtual historical figures or objects, uncovering stories and gaining a deeper understanding of historical events.
- **Use case 3: Museum engagement:** Museums can enhance visitor experiences by integrating AR games, where users unlock additional content or stories about exhibits through the TaleBlazer app.
- **Use case 4: Community learning:** TaleBlazer can be used in community centres or libraries for out-of-school programs where youth design AR games around local themes, promoting civic engagement and learning.
- **Use case 5: STEM learning:** Educators can use TaleBlazer to teach STEM concepts, such as physics or engineering, through interactive role-playing games that simulate scientific experiments or environmental problem-solving.

WWF Free rivers, WWF Forests

WWF Free Rivers is an interactive app that aims to raise awareness of the importance of free-flowing rivers and their connection to ecosystems, wildlife and human communities. Developed by the World Wildlife Fund (WWF), it offers an immersive experience where users can explore river ecosystems, learn about the impacts of human interventions such as dams,

and learn about sustainable water management. Through a combination of storytelling, data visualization, and interactivity, the app highlights the critical role that rivers play in maintaining biodiversity, regulating climate, and sustaining livelihoods. It also advocates for policies and practices that protect these natural waterways to ensure a healthy and balanced environment and the populations that depend on them.

WWF Forests refers to WWF's global initiative to protect forests and promote sustainable forest management. Forests are vital to biodiversity, providing habitat for countless species and providing important resources such as clean air, water and carbon storage. WWF Forests' initiatives focus on combating deforestation, supporting reforestation efforts, and promoting sustainable agriculture and timber harvesting practices. By working with governments, businesses and local communities, WWF works to protect forest habitats, restore degraded lands and promote responsible forestry to ensure forests can thrive for future generations. These efforts are critical to combating climate change, protecting wildlife and safeguarding the livelihoods of the millions of people who depend on forest ecosystems.

Analytical Instructions on the Use of the Tool

1. **Setup and Calibration**:
    - Enable camera permission.

2. **Installing Applications**:
    - Get the applications through app stores.
    - Make the installation steps according to the given instructions.

3. **Using the Interface**:
    - Navigate through app's menu, interact by tapping the screen.
    - The storyboard allows simple, visual creation of interactive content.

4. **Developing Custom Applications**:
    - Tutorials are available for users.

Affordances and Limitations

Affordances:

- **Sustainability Practices**: It promotes responsible and sustainable practices, empowering users to make eco-friendly choices.

- **Data Accessibility**: The app may present real-time data on river conditions, allowing users to see the effects of climate change and human activity on these vital waterways.

- **Interactive Learning**: The app provides users with an engaging platform to explore river ecosystems interactively, helping the development of understanding the importance of free-flowing rivers.

- **Comprehensive Information**: The app offers extensive data and resources on forest conservation, including biodiversity, sustainable practices, and deforestation statistics.

Limitations:

- **Technology Barriers**: Not all users may have access to the necessary technology.

- **Problems with Use**: The user may experience bugs while in the apps, making it irritating to use.

- **Passive Action**: While the app encourages awareness, it may not offer strong avenues for users to take direct action beyond learning and sharing, potentially reducing the tangible impact on conservation efforts.

- **User Engagement**: Some users may find the interactive elements less interesting over time, leading to decreased usage.

Examples of Methods of AR

1. **Overlay Method**: App overlays 3D models of plants and animals over real-life surroundings.

2. **Simulation Method**: Provides a simulated environment where users can interact with things. Users can engage in a simulation where they manage their own virtual forest.

3. **Annotation Method**: Adds and shows the information in AR. Users can tap on their device at specific plant or a person to receive annotations about the living being in that ecosystem.

Recommendations for the Purpose of the Tool

- **Best Practices Guide**: Users can utilize AR technology to create immersive experiences where they are provided with information that contributes to river's/forest's health.

- **Interactive Learning Modules**: Interactive modules that educate users about different forest ecosystems and biodiversity. This could include 3D models of forest types.

- **Sustainable Practices Promotion**: Promoting sustainable forestry practices and encouraging users to adopt eco-friendly behaviors.

- **Virtual Tree Planting Initiatives**: Virtual tree-planting feature where users can create their own forests. This could promote making partnerships with organizations that facilitate real tree planting.

- **Partnerships with Local Organizations**: Promoting eco-friendly activities through app can suggest collaborating with local environmental organizations to create events, clean-up initiatives, or educational workshops.

CoSpaces EDU

CoSpaces Edu is an educational platform that introduces students into VR and AR creation. It is adaptable to any age or subject and allows students to build their own 3D creations, animate them with code and explore them with Virtual and Augmented Reality while equipped with digital skills.

Creating in CoSpaces Edu is a simple drag and drop process using a variety of creation features including a 3D objects, building blocks, multimedia uploads, block-based coding, and other. CoSpaces Edu's visual block-based coding language CoBlocks is a good introduction for young coders to computational thinking.

Analytical Instructions on the Use of the Tool

1. **Setup and Calibration**:
    - From a computer, go to cospaces.io and click Sign up.
    - From a phone or tablet, install the CoSpaces Edu app.

2. **Installing Applications**:
    - The CoSpaces Edu web app works on any computer (including Google Chromebooks). It is recommended using the latest version of Google Chrome, Firefox or Safari.
    - The CoSpaces Edu mobile app for iOS, Android and Microsoft allows you to create and explore your creations on a smartphone or tablet.

3. **Using the Interface**:
    - [Guidance on primary interaction methods, such as gestures and voice commands.]

4. **Developing Custom Applications**:
    - To start creating, go to **CoSpaces** in the left-menu. After exploring the **Welcome CoSpace** to get familiar with the basics click the **Create CoSpace** button to create the first CoSpace. To start the AR mode, play a

CoSpace and click the AR symbol. Move your device to detect a surface. Tap the surface to start projecting.

Affordances and Limitations

Affordances:

- **Coding Skills Development**: The platform supports block-based coding (similar to Scratch) and JavaScript, enabling students to learn and practice coding within a visual and interactive environment. This helps in developing computational thinking and problem-solving skills.
- **Collaborative Learning**: The platform allows multiple users to collaborate on the same project. This promotes teamwork, communication, and collaboration skills as students work together to create and refine their virtual worlds.
- **Interactive Simulations**: Educators can create simulations of real-world scenarios or historical events. Students can explore these simulations to gain a better understanding of complex systems, historical contexts, or scientific processes.
- **STEM Education**: CoSpaces Edu supports the integration of science, technology, engineering, and mathematics (STEM) concepts. Students can simulate scientific phenomena, build virtual machines, or explore mathematical concepts in 3D, making abstract ideas more tangible.

Limitations:

- **Cost Barrier**: While there are free versions, the full suite of features is behind a subscription paywall, which might be prohibitive for some schools and districts.
- **Device Compatibility**: Requires relatively modern devices with sufficient processing power. Older or less powerful devices may struggle with performance.
- **Internet Dependency**: Requires a stable internet connection for most functionalities, which can be a barrier in regions with poor internet access.
- **Complexity for Beginners**: Although designed to be user-friendly, there is still a learning curve for both teachers and students, especially for those unfamiliar with 3D design and coding.

Examples of Methods of AR

1. **Overlay Method**: Allows students to project their own creations onto any plane surface in the real world, by looking through the screen of their device

2. **Simulation Method**: Allows teachers and students to create various types of simulations of subjects studied in class and make it possible to visualize concepts in 3D, such as Real-life simulation where students can create or interact with a virtual and dynamic demonstration of phenomena taken from real-life.

3. **Annotation Method**: Allows users to add informational and interactive elements to their 3D scenes, enhancing educational value and engagement.

Recommendations for the Purpose of the Tool

- **Coding and Computer Science:** Provides an introduction to programming. With the use of CoBlocks (block-based coding) students are introduced to programming concepts. This visual approach makes it easier for beginners to grasp coding logic.

- **Virtual Field Trips:** Exploration of Distant Places with the Use of CoSpaces Edu students can create virtual field trips to places that are not easily accessible. This can provide a broader learning experience without the limitations of geography and cost.

- **STEM Education:** Interactive Science Simulations through the creation of 3D models of scientific concepts like cell structures, chemical reactions, or physics experiments. This helps students visualize and interact with abstract concepts.

- **Geographic Explorations**: By build interactive maps and 3D models of different geographical regions to study topography, climate, and cultural landmarks.

- **Collaborative Projects**: Encourage teamwork by having students collaborate on creating and programming their CoSpaces. This fosters communication, collaboration, and project management skills.

Augmented Reality Technology Green Curriculum

Curriculum is defined as the “inventory of activities related to the design, organisation and planning of an education or training action, including definition of learning objectives, content, methods (including assessment) and material, as well as arrangements for training teachers and trainers”.

This curriculum provides youth workers/trainers with **seven lesson plans** to use as guidelines for the preparation of their lessons and as examples to develop their own lesson plans. The

aim of these lessons is to equip youth with knowledge and advance their skills and key competences, increase their knowledge about climate change issues, and provide them with the necessary tools to contribute to the green transition by the use of their skills and competences

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Module 1: Climate Change - Extreme Weather Events & Agricultural Production

Module/ Lesson plan	**Module 1: Climate Change - Extreme Weather Events & Agricultural Production**			
Workload for learner (hours):	Three hours and 20 minutes			
Learning Outcomes:	• Explain/ Summarize the nature of extreme weather events and their relationship with climate change • Explain the significance and impact of extreme weather events like floods, droughts, and heatwaves on agriculture and livestock production • Examine case studies of applied strategies to mitigate the impact of extreme weather events			
Method/s of assessment:	Quiz, Reflection, Final Assessment			
Content/short description; duration; learning method:	**Units/Subunits**	**Duration**	**Method/s for teaching and learnings:**	**Learning materials (e.g. exercises, data sets)/Equipment Required**
	Introduction to the Module: Introduce learning outcomes and the sequence of learning.	5 min	Lecture	Power-Point
	Pre-Learning Survey: Ask learners to recount any extreme weather events they remember/experienced. Utilizing a brainstorming app, ask learners to plot out examples of the impact this event had on their lives and community.	5 min	Brainstorm app E.g., Kahoot, Miro	Laptop, internet connection, monitor/display If learners have access to smartphones, invite them to the brainstorming board via the QR code displayed on the monitor/display
	Unit 1: Understanding Extreme Weather Events *1.1 Main types of extreme weather events.* ➔ Floods ➔ Fire ➔ Droughts ➔ Storms/Heavy rain ➔ Heatwave *1.2 Connect extreme weather events*	45 min	Presentation OR Group work: Assign one type of extreme weather per group, present to each other Video	Laptop, internet connection, monitor/display Learners access to the internet Youtube video Example 1: https://www.youtube.com/watch?v=eeISzbk9SeE

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	with climate change. Review research on the correlation of extreme weather events and climate change. *1.3 Major trends/figures relating to extreme weather events.* Activity 1: Case Study: The 2003 European Heatwave		Group Discussion Case Study: Review material on the 2003 European Heatwave and discuss its impact	NASA: https://science.nasa.gov/climate-change/extreme-weather/ Infographic: https://nap.nationalacademies.org/visualizations/extreme-weather/ Interactive Map: https://wmo.maps.arcgis.com/apps/webappviewer/index.html?id=5e9a82e52aa3487593fe41b79b2aba00 Analysis: The 2003 European Heatwave https://www.unisdr.org/files/1145_ewheatwave.en.pdf
	Small quiz: 2 multiple choice questions	5 min	Quizlet, Kahoot or something similar	Laptop, internet connection, monitor/display
	Unit 2: Impact *2.1 Impact on Agriculture* Activity 2: Case Studies Group Research activity on the impact on agriculture from: a) Floods b) Drought c) Heatwaves The presenter then reviews an overview of the impact of extreme weather events on agriculture. *2.1.1* Review research on the major food groups impacted and what the consequences could be: ➔ Corn	60 min	Case Study Analysis Group Discussion Lecture	Laptop, internet connection, monitor/display Learners access to the internet Reports to Reference: 1. https://library.wmo.int/viewer/66214/download?file=Statement_2022.pdf&type=pdf&navigator=1 2. https://openknowledge.fao.org/server/api/core/bitstreams/a4fd8ac5-4582-4a66-91b0-55abf642a400/content

	➔ Rice ➔ Wheat ➔ Soybeans *2.2 Impact on livestock* Effects of extreme weather events on livestock *2.3 Impact on human life* Effects of extreme weather events on human life and communities E.g., Recent events such as Hurricane Milton, Hurricane Helene			<u>Resources on 2.1.1</u> 1. https://www.climatecentral.org/climate-matters/climate-change-crops 2. https://climate.nasa.gov/news/3124/global-climate-change-impact-on-crops-expected-within-10-years-nasa-study-finds/ 3. https://www.ers.usda.gov/publications/pub-details/?pubid=107551 4. https://www.csis.org/analysis/climate-change-and-us-agricultural-exports
	Short Written Reflection: Ask learners to reflect on what they learned with a guided reflection question. E.g., How do extreme weather events impact my day to day life?	10 min	Reflective	Blank Paper & Pen
	Unit 3. Solutions 3.1 Strategies to mitigate the impact of extreme weather events on agriculture 3.1.1 Case Studies Activity: Examine case studies on strategies implemented to reduce impact Split learners into groups and assign one case study for them to analyze and identify strategies. 3.3 Scenario. Present students with a scenario of a common agriculture problem related to extreme weather events. Invite learners to come up	60 min	Lecture Group Work Case Study Group Discussion & Group Presentations Scenario Analysis	Laptop, internet connection, monitor/display Learners access to the internet Optional: Printouts of case studies Drought: https://online.ucpress.edu/cse/article/7/1/1233811/197495/Building-Resilience-in-Jamaica-s-Farming Drought: https://toolkit.climate.gov/case-studies/drought-resiliency-planning-

	with solutions and strategies based on what they learned.			prepares-stakeholders-new-conditions Drought/Heat Waves: https://toolkit.climate.gov/case-studies/managing-water-irrigated-agriculture-central-arizona-desert Heatwave: https://toolkit.climate.gov/case-studies/alert-system-helps-strawberry-growers-reduce-costs Flood: https://www.climatehubs.usda.gov/hubs/northeast/topic/farming-floodplain-trade-offs-and-opportunities
	Short MC quiz	10 min	Reflection	
Method for evaluation of course (by students, peer review etc.)	TypeForm/ Google Form evaluation review (Short, only one page)			27
Further reading / Link to Resources	https://climate-adapt.eea.europa.eu/en/countries-regions/countries Book: Regenesis: Feeding the World Without Devouring the Planet, by George Monbiot			

Module 2: Climate Change - Rise of air and water temperatures

Module/ Lesson plan	**Module 2: Climate Change - Rise of air and water temperatures**			
Workload for learner (hours):	3 hours 40 mins			
Learning Outcomes:	- Define climate change and identify key factors contributing to rising air and water temperatures. - Explain the link between human activities and the increase in temperature. - Evaluate potential solutions to combat climate change. - Apply critical thinking to assess current global initiatives			
Method/s of assessment:	Quiz (2 questions/unit) using open interactive and digital platforms such as Kahoot, EdPuzze or Typeform.			
Content/short description; duration; learning method:	**Units/Subunits** (no more than 5 subunits per module)	**Duration**	**Method/s for teaching and learnings:**	**Learning materials (e.g. exercises, data sets)/Equipment Required**
	Introduction to the Module: Overview of climate change and its impact on global temperatures. Brief explanation of rising air and water temperatures.	5 min	Lecture using AR visuals to explain basic climate change concepts.	Visuals with AR support showing temperature rises and graphs
	Preliminary small quiz	5 min	Kahoot	Laptop, tech device and Internet connection
	Unit 1: The Science Behind Climate Change **Activity 1:** Watch a short video on global temperature rise and its causes. **Unit 1.1.** Greenhouse effect (physical explanation). **Unit 1.2.** Human contribution to CO_2 levels. **Unit 1.3.** Long-term impacts on oceans and air.	20 min	-Lecture -YouTube video (5-7 min) -Group discussion on video's main points.	YouTube video (e.g. NASA Earth Science Video), AR simulation tool to show temperature changes

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	Unit 1 quiz	10 min	EdPuzzle	Laptop, tech device and Internet connection
	Unit 2: Consequences of Rising Water Temperatures **Activity 2:** Examine case studies of coral bleaching and melting polar ice caps. **Unit 2.1.** Effects on marine life and coral reefs. **Unit 2.2.** Melting polar ice caps and sea-level rise. **Unit 2.3.** Extreme weather events linked to higher water temperatures.	25 min	Case study analysis: Real-life examples (e.g. Great Barrier Reef). Short video on melting ice caps.	Case studies, AR tool showing changing sea levels over time
	Unit 2 quiz	10 min	Quizizz	Laptop, tech device and Internet connection
	Unit 3: Solutions and Future Outlook **Activity 3:** Develop a plan to reduce global warming in your local area. **Unit 3.1.** Renewable energy sources. **Unit 3.2.** Carbon capture technologies. **Unit 3.3.** Policy changes: Paris Agreement and other international efforts.	30 min	Group presentations Debate on proposed solutions	Worksheets on climate change policy, Interactive AR on renewable energy solutions
	Unit 3 quiz	10 min	Typeform	Laptop, tech device and Internet connection
	Unit 4: Climate Change and Extreme Weather Events **Activity 4:** Watch a simulation of extreme weather events in different climate zones. **Unit 4.1.** The increase in frequency and intensity of hurricanes, floods, and droughts. **Unit 4.2.** Impact on human communities and infrastructure.	30 min	AR simulation showing extreme weather impacts Group discussion on causes and impacts of	Interactive AR tool to simulate hurricanes, floods, and drought patterns.

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	Unit 4.3. Global patterns of extreme weather.		weather patterns.	
	Unit 4 quiz	10 min	Kahoot	Laptop, tech device and Internet connection
	Unit 5: International Efforts and Policy Responses **Activity 5:** Review and debate the effectiveness of global treaties like the Paris Agreement. **Unit 5.1.** The Paris Agreement and its goals. **Unit 5.2.** Other global and national climate policies. **Unit 5.3.** Challenges in policy implementation.	40 min	Research session on climate policies Debate on effectiveness of these policies.	Digital resources (IPCC reports, Paris Agreement summary), AR tool showing policy impacts on global emissions.
	Unit 5 quiz	10 min	EdPuzzle	Laptop, tech device and Internet connection
Method for evaluation of course (by students, peer review etc.)	• By students: Anonymous feedback forms or digital feedback through polls • By peer review: Group presentations will be peer-reviewed based on creativity, feasibility, and impact of solutions proposed.			
Further reading / Link to Resources	• Books: ➢ "The Uninhabitable Earth" by David Wallace-Wells ➢ "This Changes Everything" by Naomi Klein • Articles: ➢ Venturini, A. (2022). Climate change, risk factors and stock returns: A review of the literature. International Review of Financial Analysis, 79, 101934. ➢ Lee, K., Gjersoe, N., O'neill, S., & Barnett, J. (2020). Youth perceptions of climate change: A narrative synthesis. Wiley Interdisciplinary Reviews: Climate Change, 11(3), e641. • Websites: ➢ NASA Climate Change Overview: NASA Climate ➢ Intergovernmental Panel on Climate Change (IPCC): IPCC Reports			

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Module 3: Desertification/ Climate Refugees

Lesson plan	**Module 3: Desertification/ Climate Refugees**			
Workload for learner (hours):	4 hours			
Learning Outcomes:	By the end of this session, learners will be able to:			
Method/s of assessment:				
Content/short description; duration; learning method:	**Topics/Subtopics**	**Duration**	**Method/s for teaching and learnings:**	**Learning materials (e.g. exercises, data sets)/Equipment Required**
	Introduction to the Module: Overview of climate change and its impact on global temperatures. Brief explanation of rising air and water temperatures.	20min	Lecture	Projector and screen for presenting short ppt
	Unit 1: Group brainstorming through guided questions from the lecturer and answers from students through post it notes on whiteboard Brainstorming Effects of climate change– discussion targeted to desertification and climate refugees	30min	Group brainstorming	Whiteboard for brainstorming Post it notes
	Unit 2: Desert ecosystems Students watch the virtual expedition Exploring the Desert from Google Arts & Culture app. Discussion follows about desert ecosystems and the impact on wildlife.	20min	Virtual expedition Group discussion	Laptops or mobile devices with internet connection
	Unit 3: Understanding the desertification's danger Students navigate in small groups the World Atlas of desertification areas of European Committee. Debate follows about land sustainability	50min	Digital map navigation Debate	Laptops or mobile devices with internet connection
	Hands-On AR Activity : Exploring Digital Tools for Desertification/ Climate Refugees	10min	Demonstration of AR tool	Laptops or mobile devices Projector

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	Hands-On AR Activity: Familiarize students with plant's care using Plantale made by the lecturer. Ask them to use this AR simulation tool to present the growth process of a specific plant, showing how changes in care impact their health and which are the potential dangerous scenarios	90min	- Practical activity - Group collaboration	Smartphones with internet connection
	Reflection and Group Discussion	20min	- Group discussion - Reflection quiz on Cahoot	Smartphones with internet connection
Method for evaluation of course:	• - Students: Surveys to gather feedback on course content, structure, and teaching effectiveness. • - Peer Review: Presentations to encourage collaboration and receive peer feedback			
Further reading / Link to Resources:	• - UNESCO (2003). Education kit on combating desertification. Available at: https://unesdoc.unesco.org/ark:/48223/pf0000125816 • Internal Displacement Climate Center (2017). *Displacement in a changing climate*. Available at: https://api.internal-displacement.org/sites/default/files/publications/documents/IDMC_SlowOnsetTypology_final.pdf • UNHCR (2022). Climate Change, Displacement and Human Rights. Available at: https://www.unhcr.org/sites/default/files/legacy-pdf/6242ea7c4.pdf			

Module 4: Greenhouse Gas and Zero Future Emissions

Module/ Lesson plan	**Module 4: Greenhouse Gas and Zero Future Emissions**			
Workload for learner (hours):	Three hours and ten minutes			
Learning Outcomes:	• Define and describe the concept of greenhouse gases (GHGs) and their role in climate change • Evaluate the impact of GHG emissions on ecosystems, economies, and communities, and discuss sustainable pathways for a net-zero future. • Explain the global goal of net-zero emissions and the policies created to help achieve it by 2050 • Analyze the strategies used by countries in their efforts to reduce GHG and transition to renewable energy.			
Method/s of assessment:	Quiz, Reflection, Final Assessment			
Content/short description; duration; learning method:	**Units/Subunits**	**Duration**	**Method/s for teaching and learning:**	**Learning materials (e.g. exercises, data sets)/Equipment Required**
	Introduction to the Module: Introduce learning outcomes and sequence of learning.	5 min	Lecture	PowerPoint
	Unit 1: Understanding Greenhouse Gases (GHGs) *1.1 Types and Sources of GHGs* ➔ Carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and fluorinated gases. ➔ Major sources: fossil fuel combustion, agriculture, industry, and waste management. *1.2 GHGs, The Greenhouse Effect and Climate Change* Review scientific research on the role of GHGs in global warming and the greenhouse effect. ➔ Rising Temperatures ➔ Melting Ice Caps and Glaciers ➔ Extreme Weather Events ➔ Ocean Acidification	45 min	Lecture Group Discussion Group Work Group Presentations	Laptop, monitor/display, access to data charts and infographics 1.1 https://www.epa.gov/ghgemissions/overview-greenhouse-gases https://www.nationalgeographic.com/environment/article/greenhouse-gases 1.2 https://www.unep.org/resources/emissions-gap-report-2022 https://www.ipcc.ch/report/ar6/wg1/

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	1.3 Global Emission Trends and Figures Analyze the major contributors to GHG Emissions. <u>Activity 1:</u> Interactive Chart: Examine data on the world's top GHG emitters. In groups, discuss the changes in emissions over time.			1.3 https://www.wri.org/insights/interactive-chart-shows-changes-worlds-top-10-emitters
	Reflection			
	Unit 2: Impact of GHG Emissions *2.1 GHG Emissions Impact* <u>Activity 2: Group Presentations</u> In groups, research and present to each other the impact of the following ➔ Ecosystems (e.g., biodiversity, coral bleaching) ➔ Human Health (e.g., Heat-related illness, disease spread) ➔ Economies and Communities (e.g., agriculture, displacement) *2.2 Sectoral Analysis* Examine the impact of GHGs across various sectors: transportation, energy, agriculture, and industry. 2.3 Personal Carbon Footprint Discuss about personal carbon footprint and present ways individuals can make personal changes.	60 min	Group Work Group Presentation Lecture	Laptop, internet connection, access to reports and data resources 2.1 Some resources https://sanctuaries.noaa.gov/education/teachers/coral-reef/ https://www.who.int/health-topics/climate-change#tab=tab_1 https://www.fao.org/climate-change/en/ 2.2 https://www.iea.org/reports/world-energy-outlook-2023 2.3 Calculate your carbon footprint: https://www.nature.org/en-us/get-involved/how-to-help/carbon-footprint-calculator/ https://youth.europa.eu/get-involved/sustainable-development/how-

				reduce-my-carbon-footprint_en
	Group Reflection: Ask learners to reflect on how GHG emissions affect their daily lives and brainstorm in groups ways they can reduce their carbon footprint.	10 min	Reflection	N/A
	Unit 3: Net-Zero Future Emissions *3.1 What is Net-Zero* Review definitions of Net-Zero *3.2 Mitigation Strategies* Review global initiatives and policies, such as the Paris Agreement and UN Net-Zero Coalition, focusing on renewable energy and carbon capture technologies. *3.3 National Case Studies* Split learners into groups to analyze strategies implemented by countries to achieve net-zero emissions by 2050. Countries: ➔ Sweden ➔ Norway ➔ Denmark	60 min	Group Work Lecture Case Study Scenario Analysis	Laptop, internet connection, printed case studies https://www.climatewatchdata.org/net-zero-tracker?ap3c=IGbqpDXXiAYPp-YFAGbqpDVKYrpHsAeBFSsKQ_Blg3Q9fXkA8Q Case Studies: https://www.iea.org/countries/sweden https://www.iea.org/reports/norway-2022/executive-summary https://www.iea.org/countries/denmark
	Short Quiz: 2-3 MC questions	10 min	Quiz	
Method for evaluation of course (by students, peer review etc.)	TypeForm/ Google Form evaluation review (Short only one page)			
Further reading / Link to Resources	Book: The New Climate War, by Michael Mann Websites: ● https://eciu.net/netzerotracker ● https://climateactiontracker.org/#			

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Module 5: Green skills

Lesson plan	**Module 5: Green skills**			
Workload for learner (hours):	3 hours 40 min			
Learning Outcomes:	- Understand the importance of green skills in promoting environmental sustainability. - Use digital tools, specifically TaleBlazer, to facilitate green education through immersive AR experiences. - Develop practical digital skills through creating location-based AR projects using TaleBlazer.			
Method/s of assessment:	- Short quizzes to test knowledge and reflection. - Group presentations to assess understanding and application			
Content/short description; duration; learning method:	**Topics/Subtopics**	**Duration**	**Method/s for teaching and learnings:**	**Learning materials (e.g. exercises, data sets)/Equipment Required**
	Introduction to Green Skills	10 min	- Lecture - Group discussions	Whiteboard for brainstorming ideas on green skills
	Preliminary quiz	10 min	- Kahoot or similar quiz platform	Laptops or mobile devices
	Exploring Digital Tools for Green Education Unit 1: Introduction to TaleBlazer	40 min	- Lecture - TaleBlazer demonstration with AR	Projector, smartphones/tablets with TaleBlazer installed
	Hands-On AR Activity with TaleBlazer Guide students in creating a location-based AR game focused on environmental sustainability, such as managing virtual resources sustainably.	60 min	- Practical activity - Group collaboration	TaleBlazer-enabled devices
	Reflection and Group Discussion	20 min	- Group discussion - Reflection quiz	Phones or tablets with internet access
	Group Project – Designing a TaleBlazer-Based Green Skills Project Each group creates a concept for an AR project teaching green skills, such as energy conservation, waste	60 min	- Group project - Peer review	TaleBlazer web editor, paper, pens

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	management, or pollution prevention.			
	Topic Quiz	60 min	- Kahoot or EdPuzzle	Pens, sheets of paper, video equipment, Youtube videos

Method for evaluation of course:	• - Students: Surveys to gather feedback on course content, structure, and teaching effectiveness. • - Peer Review: Presentations to encourage collaboration and receive peer feedback
Further reading / Link to Resources:	• - UNESCO Green Skills for Sustainable Development • - International Labour Organization (ILO) Green Jobs and Skills Report • - How Augmented Reality Can Elevate Environmental Education (Edutopia) • - Integrating Digital Skills into Sustainability Education (Sustainable Educator) • - TaleBlazer Official Documentation and Tutorials • - MIT's TaleBlazer Case Studies

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Module 6: Digital skills – Using digital skills to fight climate change

Lesson plan	**Module 6: Digital skills – Using digital skills to fight climate change**			
Workload for learner (hours):	3 hours 40 miuntes			
Learning Outcomes:	- Understand how digital skills can support climate action. - Explore digital tools and technologies that help monitor and combat climate change. - Developing practical digital skills with practical eco-friendly applications.			
Method/s of assessment:	Short quizzes at the end of each topic to test knowledge and reflect on what they learned.			
Content/short description; duration; learning method:	**Topics/Subtopics**	**Duration**	**Method/s for teaching and learnings:**	**Learning materials (e.g. exercises, data sets)/Equipment Required**
	Introduction to Climate Change: Short introduction to the problem of climate change and its impact on the environment.	10 minutes	- Lecture - Group discussions - YouTube video	Video equipment, Youtube videos, whiteboard
	Preliminary quiz	10 min	- Kahoot	Laptop, tech device and Internet connection
	Topic 1. Climate Change in Digital World Unit 1.1 Ask students to share what they know or believe about climate change and what are the connection to the digital world and tools. Unit 1.2 Definition and explanation of climate change. Unit 1.3 Greenhouse gases and the greenhouse effect. The role of human activities (e.g., fossil fuels, deforestation) and connections to digital tools. Unit 1.4 Impacts on ecosystems, weather patterns, and societies, also	40 minutes	- Lecture - Group discussions - YouTube video	Video equipment, Youtube videos, whiteboard

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	from the point of view of use of digital tools. Unit 1.5 Discussion of how new digital technologies can support pro-environmental initiatives, as well as what digital skills are needed to use them effectively. Unit 1.6 Show a short documentary video to illustrate climate change's real-world effects.			
	Topic 1 quiz	10 min	- Kahoot or standard quiz	Laptop, tech device and Internet connection
	Topic 2. Digital Tools for Climate Research Unit 2.1 Presentation of tools such as applications for monitoring CO2 emissions, climate data mapping (GIS), satellite systems for tracking changes in the environment, and other technologies supporting the analysis of climate change. Unit 2.2 Data analysis, reporting, digital project management. Unit 2.3 Application to green projects (e.g. educational programs, climate data analysis, development of mobile applications for carbon footprint tracking). Unit 2.4 Introduction to the AR tool using the tool's description.	60 minutes	- Presentation of tools - Lecture - AR tool	Phones or tablets with internet access
	Topic 2 quiz	10 min	- Kahoot or EdPuzzle	Laptop, tech device and Internet connection
	Topic 3. Community Engagement and Advocacy Unit 3.1 Understanding the importance of community engagement in climate advocacy to	60 minutes	- Group debate - Group project	Pens, sheets of paper, video equipment, Youtube videos

	develop skills and create effective digital content for awareness and action. Unit 3.2 Local climate issues and the importance of community involvement. Unit 3.3 Examples of successful community engagement initiatives. Unit 3.4 Strategies for effective messaging and audience engagement to create a group project. Students will create an infographic or a social media campaign plan in groups to raise awareness about a local climate issue.			
	Topic 3 quiz	10 min	- Kahoot or EdPuzzle	Laptop, tech device and Internet connection
Method for evaluation of course:	• Students: Surveys at the end of the course to gather learner feedback on course content, structure, and teaching methods. • Peer review: Presentations to help collaborative learning and critical assessment.			
Further reading / Link to Resources:	• Global Climate Dashboard: climate.gov • The Intergovernmental Panel on Climate Change: ipcc.ch - Intergovernmental Panel on Climate Change (IPCC) • National Geographic Education Portal: "Climate Change" - National Geographic Education • Video on Earth planet: Our Planet - Netflix			

Module 7: Green skills and employability

Lesson plan	**Module 7: Green skills and employability**			
Workload for learner (hours):	3 hours and 50 minutes			
Learning Outcomes:	• Define Green Skills: Understand what green skills are and their importance in today's job market. • • Understand the green job market and its opportunities • Explore green career opportunities through an AR simulation created in CoSpaces EDU • Learn how to align their skills and interests with roles in green industries • Be able to create a green-focused resume, LinkedIn profile, and cover letter			
Method/s of assessment:	Quizzes at the end of each topic			
Content/short description; duration; learning method:	**Topics/Subtopics**	**Duration**	**Method/s for teaching and learnings:**	**Learning materials (e.g. exercises, data sets)/Equipment Required**
	Icebreaker Activity: students to share what they know about green jobs or sustainability.	10 minutes	Group chat	Icebreaker cards Whiteboard/flip chart Markers
	Introduction to green skills and green jobs	5 minutes	Lecture	• Smartphones/tablets • Computer/laptop • Internet access • PowerPoint Projector for presentation
	Unit 1. Definition and Importance of Green Skills **Unit 1.1** Definition of green skills and understanding their importance in the context of sustainability • Definition of green skills, real-life examples like waste management, sustainable agriculture, energy efficiency, and eco-friendly innovations **Unit 1.2** Types of Green Skills • Hard skills / Soft skills	40 min	- Lecture - Group discussions - Group Work	• Smartphones/tablets • Computer/laptop • Internet access • PowerPoint Projector for presentation

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	Unit 1.3 Brief introduction to sustainability and green economy **Activity 1**: Identify different types of green skills relevant to various sectors.			
	Unit 1 Quiz	10 minutes	Kahoot! or similar quiz platform	• Smartphones/tablets • Computer/laptop • Internet access
	Unit 2. Green job overview **Unit 2.1** Introduction to green jobs • Definition of Green jobs Sectors Driving Green Jobs with examples **Unit 2.2** Skills and Trends in the Green Economy **Unit 2.3** Identifying Green Job Opportunities **Activity 2**: Exploring Green Job Opportunities Through CoSpaces EDU *Show how to create and use AR scenes in CoSpaces EDU.* *Explain how to import 3D models and integrate them into AR environments. Eg to create a virtual wind turbine, solar panel* *·Log in to CoSpaces EDU and explore existing templates related to green jobs or sustainability* *Participants create a simple AR experience based on a green job or environmental solution (eg simulation of a sustainable city)*	55 minutes	- Lecture - Group discussion - Presentation of AR tool - Group Work	• Smartphones/tablets • Computer/laptop • Internet access • PowerPoint Projector for presentation • CoSpaces EDU Account **EnvironmentalCareer.com** https://environmentalcareer.com/ **Green Jobs Network** https://greenjobs.net/ **LinkedIn**: Use job search filters for "environmental" or sustainability". **Indeed**: Search terms like “green energy,” “environmental,” and “renewable energy”.
	Unit 2 Quiz	10 minutes	Quizizz or similar quiz platform	• Smartphones/tablets • Computer/laptop • Internet access
	Unit 3. Aligning Skills with Green Jobs **Unit 3.1** Leveraging Your Current Experience **Unit 3.2** Identifying Green Skills & Certifications **Unit 3.3** Upskilling and Education Options **Activity 3** Group research on educational options	40 minutes	- Lecture - Group discussions	• Smartphones/tablets • Computer/laptop • Internet access • PowerPoint Projector for presentation http://www.greeneducationfoundation.org/

	Unit 3 Quiz	10 minutes	Kahoot! or similar quiz platform	• Smartphones/tablets • Computer/laptop • Internet access
	Unit 4. Building a Green Personal Brand & Resume **Unit 4.1** Writing a Green-Focused Resume **Activity 4** Crafting a Green-Centric LinkedIn Profile **Unit 4.2** Activity Writing a Green Job Cover Letter **Unit 4.3** Networking & Job Search Strategies in Green Jobs **Unit 4.4** Preparing for Green Job Interviews	40 minutes	- Lecture - Group Discussion - Group Work	• Smartphones/tablets • Computer/laptop • Internet access • PowerPoint Projector for presentation
	Unit 4 Quiz	10 minutes	Quizizz or similar quiz platform	• Smartphones/tablets • Computer/laptop • Internet access
Method for evaluation of course (by students, peer review etc.)	• Evaluation through with limited questions in Google Form for students and for peers			
Further reading / Link to Resources	•Skills for green jobs: 2018 update, European synthesis report. Cedefop reference series 109 Luxembourg: Publications Office of the European Union, 2019. https://www.cedefop.europa.eu/en/publications/3078 •Greening Jobs and Skills: Labour Market Implications of Addressing Climate Change. OECD Local Economic and Employment Development (LEED) Papers 2010/02. https://www.oecd-ilibrary.org/industry-and-services/greening-jobs-and-skills_5kmbjgl8sd0r-en •Promoting Green Jobs: Decent Work in the Transition to Low-Carbon, Green Economies, Kees van der ree 2019. https://journals.openedition.org/poldev/3107 •https://www.greenjobsboard.us/			

Learning design framework

This learning design framework acts as a guide for the youth workers to develop the curricula/lesson plans for the assigned modules, using Mobile Augmented Reality Games to endorse digital and green competencies to young people.

Teaching and learning frameworks are research-based approaches that help trainers align learning goals with learning activities, create appealing and inclusive environments, and integrate assessment into learning. These frameworks can be easily adapted and mixed to serve as conceptual maps for planning or revising courses, curricula, or lessons. Effective teaching and learning frameworks emerge from psychological, cognitive, sociological, and educational research findings that students learn best when they identify and engage with their prior knowledge, have practice and time to build conceptual frameworks, and take charge of their own learning through metacognitive reflection.

These frameworks often require that courses combine learning activities with discussion, active learning and self-reflection. They provide a variety of structured approaches that help students build accurate and relevant knowledge structures as guiding on when and how to apply the knowledge and abilities they acquire. Learning frameworks encourage students to participate as "co-producers" of knowledge by focusing on structures for ongoing student development.

These frameworks facilitate the incorporation of pedagogical best practices into each part of the course while teaching.

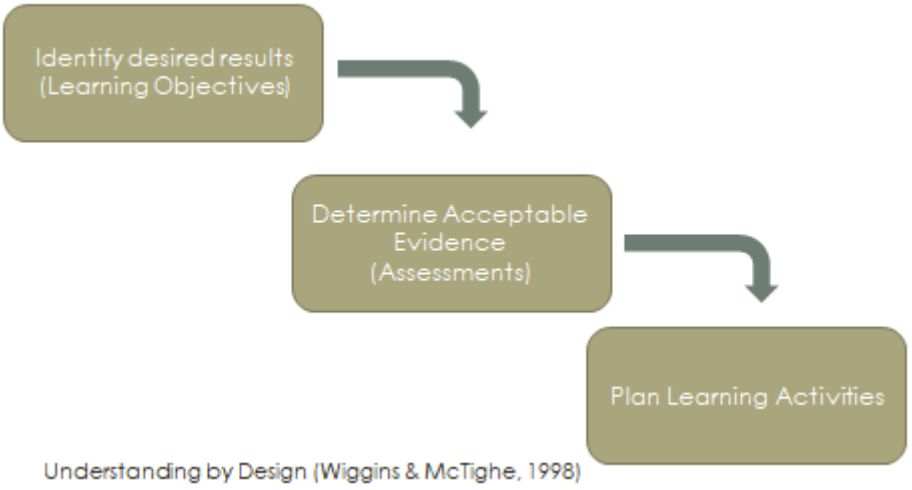
There are various learning design frameworks for a trainer to apply when designing a lesson (eg https://www.montclair.edu/itds/instructional-design/course-design-frameworks/).

In this case we chose to use the **Backward Design Framework**, which is a well-known and accepted approach to learning design and well supported by learning theory.

Backward design is an efficient teaching way to provide guidance for instruction and designing lessons, units, and courses that is focused primarily on student learning and understanding. It is considered to be beneficial to trainers because it innately encourages intentionality during the design process. It continually encourages the trainer to set the purpose of doing something before implementing it into the curriculum.

The benefit of using this method is that it focuses on results we want to achieve. This method also prioritizes “understanding” instead of covering the topic. When we begin the design process with learning goals and learning outcomes, we can make well-reasoned decisions about content and all other aspects of our course—including assignments, grading criteria, and lesson plans.

The three stages of backward design Framework



Stage 1: Identify Desired Results

The process of designing a lesson starts by defining the goals or learning outcomes for each lesson, unit or course. It is the stage where the trainer considers the question in order to establish the curricula priorities:

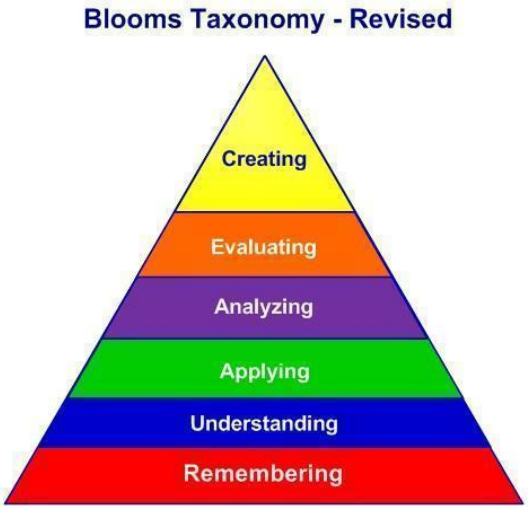
- What should the students know, understand and be able to do after finishing this program?

Trainers may consider writing learning outcomes that cover several cognitive levels as defined by the revised Bloom's Taxonomy.

Bloom's taxonomy of learning is a tool used to write learning outcomes. Benjamin Bloom created Bloom's Taxonomy in 1956, a hierarchical model of the cognitive skills involved in learning. It set the learning objectives for learners and included six levels, namely Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation.

In 2001 this taxonomy was revised by Lorin Anderson and David Krathwohl. This revision introduces six levels of higher order thinking skills that can be carried out via educational activities. The new levels are Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating and are arranged in a hierarchical structure, but not as rigidly as the original one. The revised version introduces the use of verbs instead of nouns in each level.

According to **Revised Bloom's Taxonomy**, the lowest level is "Remembering" which is focusing on students' ability to recollect information, while the highest level, "Creating," is focusing on their ability to combine various pieces of information to create a new concept or product. By designing outcomes that go above the "Remembering" and "Understanding" levels as trainer can promote higher-order thinking.



Blooms Taxonomy Revised (source: https://thepeakperformancecenter.com/educational-learning/thinking/blooms-taxonomy/blooms-taxonomy-revised/)

In Annex II there is a collection of measurable action verbs, for each level using the Revised Bloom's Taxonomy, which can be used when creating the learning goals of the modules. A useful advice at this point is that the goal is not to use different or creative verbs for each objective because that can be confusing to the students. It is better to try and identify the most accurate verb that relates to how you will assess your student's understanding of the goals.

Stage 2: Determine Acceptable Evidence

In order to gather evidence of learning, lessons should be built around two or three types of assessments:

2. Preliminary "diagnostic" assessments to check students' existing knowledge at the start of the course or unit

3. Progress assessments to measure students' understanding along the way, such as pop quizzes, individual reflections or homework assignments.

4. The final assessment at the end of the course or unit.

There is a wide range of assessment methods for the trainer to use in order to ensure that students have attained the goals they have set. The list below contains indicative assessment methods for the learning goals of the course.

- Short-answer quizzes.
- Free-response questions.

- Homework assignments.
- Practice problems.
- Group projects.

The scope of the assessments should correspond to the outcomes and the balance between concepts and skills should be consistent with the stated learning objectives.

Stage 3: Plan Learning Experience and Instruction

The final stage is when trainers start thinking about how they will teach. At this point, learning activities and teaching methods by which you present new information to your students are developed. This way, the trainer will have a better idea of which tactics will be most effective in giving students the tools and knowledge they need to meet the course objectives once the learning objectives and assessment methods have been established.

It is suggested by research that the use of the following questions will organize the thoughts:

- What activities will provide students the needed knowledge and skills?
- What will need to be taught and coached, and how should it best be taught, considering the learning goals?
- What materials and resources are best suited to accomplish these goals?

There are many teaching techniques that can be used in this stage, but our focus is on those that use AR technology. Learning strategies using the AR technology are important in creating a learning environment by using different devices along with collaboration opportunities among students as well as between students and teachers that can offer students with new methods for interactions which and potentially can enhance their learning motivation.

Which learning strategies use Augmented Reality (AR)?

Research has shown that four key learning strategies that use Augmented Reality (AR) are dominant: interactive learning, game-based learning, collaborative learning, and experiential learning.

Interactive learning is learning that requires student participation. Students actively participate in lessons using interactive methods, which improve understanding and recall. This participation can come through class and small group discussions as well as through exploration of the interactive learning materials they're given in a digital classroom. Furthermore, studies show that the interactive learning strategy is better in terms of creating exciting and fun interactions that increases students' motivation.

Next, **game-based learning strategy** is an active learning strategy that refers to the use of certain game principles and their implementation in learning in order to encourage and

enhance learning, practice, and assessment. Game-based learning depends upon determined learning objectives and usually uses a cycle of failure, reflection, and repetition. Research has shown that learning which combines AR and game-based learning strategy has been proven beneficial in learning in the aspects of motivation and interest in the learning activities conducted. GBL is not restricted to digital games but encompasses a wide variety of strategies that include board games, gamification, simulations, and adaptive learning.

Collaborative learning can take place between peers or within larger groups. Peer learning, also known as peer instruction, is a form of collaborative learning where students engage in pairs or small groups to talk about ideas or solve problems together. In this case research have shown that peer instruction allows students to help each other by explaining misunderstandings and clearing up misconceptions.

Experiential learning refers to the learning method that uses experience as a medium for learning. In experiential learning students collaborate and learn from each other in a semi-structured method. Education is meant to involve students in hands-on experiences related to real-life issues, with the instructor facilitating instead of directing student progress. Studies shown that implementing experience-based learning (Experiential Learning) creative thinking was improved. Experiential learning involves a number of steps that provide student with a hands-on, collaborative, and reflective learning opportunity that enables them to thoroughly acquire new skills and knowledge.

Other learning strategies that are used with Augmented Reality are **blended learning**, ubiquitous-learning (u-learning), argumentation-based science learning, mobile learning, and interaction learning. All these learning strategies offer an alternative perspective on technology integration, especially AR that is in line with the quickly evolving modern learning environment that is built around STEM features.

Some links with more information on learning design frameworks and learning strategies:

- https://osf.io/preprints/socarxiv/7qeht
- https://poorvucenter.yale.edu/FacultyResources/Course-Planning
- https://jaymctighe.com/resources/#1521225059546-51d65de1-41c2
- https://learningportal.iiep.unesco.org/en/issue-briefs/improve-learning/curriculum-and-expected-learning-outcomes
- https://mlpp.pressbooks.pub/gamebasedlearning/chapter/chapter-1/
- https://experientiallearninginstitute.org/what-is-experiential-learning/
- https://cft.vanderbilt.edu/guides-sub-pages/understanding-by-design/

Annex – REVISED Bloom's Taxonomy Action Verbs

Definitions	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
Bloom's Definitions	Exhibit memory of previously learned material by recalling facts, terms, basic concepts, and answers.	Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating main ideas. Solve problems to new situations by applying acquired knowledge, facts, techniques and rules in a different way.	Solve problems to new situations by applying acquired knowledge, facts, techniques and rules in a different way.	Examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations.	Present and defend opinions by making judgments about information, validity of ideas, or quality work based on a set off criteria.	Compile information together in a different way by combining elements in a new pattern or proposing alternative solutions.
Verbs	Choose, Define, Find, How, Label, List, Match, Name, Omit, Recall, Relate, Select, Show, Spell, Tell,	Classify, Compare, Contrast, Demonstrate, Explain, Extend, Illustrate, Infer, Interpret, Outline, Relate, Rephrase, Show, Summarize, Translate	Apply, Build, Choose, Construct, Develop, Experiment with, Identify, Interview, Make use of, Model, Organize, Plan, Select, Solve, Utilize	Analyze, Assume, Categorize, Classify, Compare, Contrast, Discover, Dissect, Distinguish, Divide, Examine, Function, Inference, Inspect, List, Simplify, Take Part in, Test for	Agree, Appraise, Assess, Award, Choose, Compare, Conclude, Criticize, Decide, Deduct, Defend, Determine, Disprove, Estimate, Evaluate, Explain, Influence, Interpret, Judge, Justify, Mark, Measure, Perceive, Prioritize, Prove, Rate, Recommend, Rule on, Select, Support, Value	Adapt, Build, Change, Choose, Combine, Compile, Compose, Construct, Create, Design, Develop, Discuss, Elaborate, Estimate, Formulate, , Imagine, Improve, Invent, Make up, Maximize, Minimize, Modify, , Originate, Plan, Predict, Propose, Solution, Solve, Suppose, Test,

Anderson, L. W., & Krathwohl, D. R. (2001). A taxonomy for learning, teaching, and assessing, Abridged Edition. Boston, MA: Allyn and Bacon.

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