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Biophilic Cities: Designing Urban Spaces Inspired by Nature

BIOS4YOU
AR 2.0

BIO-INSPIRED STEM TOPICS FOR ENGAGING YOUNG GENERATIONS
THANKS TO THE USE OF AUGMENTED REALITY

Project Number: KA220-BW-23-30-126516

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TABLE OF CONTENTS

Project Number: KA220-BW-23-30-126516

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Introduction

Urbanization has dramatically changed how humans interact with the natural world. Modern cities, while centers of innovation and culture, often separate people from nature, leading to challenges such as pollution, heat islands, and reduced mental well-being. The concept of biophilic cities aims to bridge this gap by integrating natural systems, materials, and experiences into urban environments, bringing nature back into people's daily lives.

This exercise introduces students to the science and design of biophilic urban planning, where nature becomes a fundamental part of the built environment. Using Augmented Reality (AR), students can explore how cities transform when green roofs, vertical gardens, urban forests, and natural water systems are incorporated into their design. They will visualize how these elements improve air quality, thermal comfort, biodiversity, and mental health, demonstrating that nature is not separate from the city but an essential part of its structure.

Through AR simulations and interactive exploration, students will also learn how biophilic design connects principles from biology, architecture, and environmental science, showing how technology can help create sustainable, livable, and restorative cities. The exercise encourages creativity, systems thinking, and awareness of how urban design can positively shape both the environment and human well-being.

This document consists of the following points:

- Information about AR technology
- How to define AR exercise thanks to the template:
  - General information
  - Pedagogical specifications
  - Technical specifications

Project Number: KA220-BW-23-30-126516

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General information

Name of the exercise:	Biophilic Cities: Designing Urban Spaces Inspired by Nature *This exercise introduces students to the concept of biophilic design, an approach that integrates natural elements, materials, and systems into urban environments to improve human well-being, comfort, and sustainability.*
Description of the exercises:	Through Augmented Reality (AR), students explore how cities can become more nature-centered, reconnecting people with natural processes within built environments. The AR experience allows them to visualize green roofs, vertical gardens, water systems, and biodiversity corridors, showing how these elements support urban ecosystems and human health. Students will analyze examples of biophilic cities worldwide and simulate their own city model in AR by combining natural and built components. By interacting with 3D scenes, they'll discover how design inspired by plants, light, air, and water enhances environmental quality, reduces urban heat, and fosters a sense of harmony between nature and architecture. The exercise connects architecture, environmental science, and social well-being, encouraging students to see urban design as both a technical and ethical field that addresses climate change and promotes healthier lifestyles.
Participants:	This exercise can be conducted by individual students or collaborative groups (3–5 participants). Group work is encouraged to promote teamwork, creativity, and cross-disciplinary thinking between science, art, and design.

Project Number: KA220-BW-23-30-126516

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Participants' age range:	Minimum 15 years old Students should have a basic understanding of environmental science, urbanization, and ecosystem principles.
STEM subject and specific topic:	*STEM Subject:* Architecture, Environmental Science, Urban Design *Specific Topic:* Nature-based urban planning and design solutions (biophilic design, green infrastructure, and urban biodiversity). *Main challenge (stressful aspect) of the topic:* The main challenge in this topic lies in understanding the integration of natural systems into complex urban structures. Students often find it abstract to visualize how nature can coexist with dense city environments and how design choices influence both human health and ecological performance. Another difficulty is grasping the systemic relationships between greenery, water, air quality, and energy use, which are often invisible or difficult to quantify in traditional lessons. *How AR helps simplify the concept:* • **AR models** let students see the transformation of a conventional city into a biophilic one—adding greenery, water systems, and natural materials layer by layer. • **Dynamic overlays** illustrate environmental changes, such as temperature reduction from tree shading or improved air quality due to vegetation. • **Interactive tools** allow learners to design their own **biophilic neighborhoods** by combining nature-based features (green roofs, parks, urban forests). • **Scenario comparison** helps visualize differences between a "concrete city" and a "biophilic city" in terms of energy use, biodiversity, and well-being. • **Gamified exploration** encourages students to experiment with different design strategies and receive feedback on sustainability and livability. *Pedagogical Aim (Learning Outcomes):* By the end of this exercise, students should be able to: 1. Define **biophilic design** and describe its main principles and benefits. 2. Identify nature-based strategies used in urban planning and architecture.

Project Number: KA220-BW-23-30-126516

Gamification process:	3. Analyze the impact of green infrastructure on human well-being and environmental health. 4. Apply the principles of **biophilic cities** to design or improve urban spaces in AR. 5. Reflect on how technology and nature can work together to create **sustainable, livable cities**. • **Interactive design challenge:** Students use AR tools to transform a grey, built-up area into a biophilic cityscape. • **Progress tracking:** Visual indicators show environmental improvements such as increased vegetation cover, air purification, and temperature moderation. • **Scoring system:** Points awarded for integrating biodiversity, renewable energy, and social spaces effectively. • **Reflection task:** Students summarize how biophilic design enhances human health and environmental quality.
Written or graphic description of Augmented info:	The AR content displays a **virtual city model** that students can modify in real time. • **Scene 1:** A dense urban area without greenery. • **Scene 2:** AR elements such as trees, green roofs, and water systems are added. • **Scene 3:** The city transforms into a biophilic environment with improved environmental and social indicators. Students can view **data overlays** showing changes in temperature, air quality, and noise levels as they add natural features
External (or extra) tools required	**AR-compatible tablets or smartphones** (camera + internet connection). **Delightex platform** for AR experience. Optional: • Design worksheet for planning city transformations. • Video resource: “Biophilic Design: The Future of Cities?”
Links (video, images, text online and so on).	Video: Biophilic Design: The Future of Cities? Link: https://youtube.com/shorts/NqCaEFWfafQ?si=R_KJ9JvVIkKcgTPg

Project Number: KA220-BW-23-30-126516

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Pedagogical specifications

Here we will collect information on how to use the exercise in the learning session and the results and benefits of using it, from a pedagogical perspective.

How can this augmented information be used to address a STEAM topic in a more interesting way for students?

Interactive 3D Models

Goal:
Help students visualize and interact with 3D AR models of urban environments, exploring how natural elements, such as vegetation, water systems, and daylight, can be integrated into city design to improve sustainability and well-being.

Use:
Students can zoom in, rotate, and explore detailed before-and-after 3D models of a city. The first model represents a conventional urban landscape dominated by concrete and artificial structures, while the second reveals a biophilic transformation with green roofs, vertical gardens, permeable surfaces, and water corridors. By tapping on specific components (e.g., *green façades*, *urban parks*, *blue infrastructure*), students trigger animations that demonstrate environmental improvements such as reduced air pollution, lower surface temperatures, and increased biodiversity. Interactive overlays display data visualizations, such as CO_2 reduction, temperature drops, and sound absorption, making the environmental and social benefits of biophilic design tangible.

Interactive Buttons

Goal:
Enable students to actively engage with AR models to experiment with urban design scenarios and understand how adding natural features influences the environment and human experience.

Use:
Students can tap interactive buttons to toggle different natural elements, trees, water bodies, or solar shading structures, and observe their impact on the city's climate, air quality, and livability. Buttons allow students to simulate different climatic conditions (e.g., summer vs. winter) or urban density levels to see how design choices affect comfort and sustainability. Each interaction triggers real-time visual feedback, such as changing sky color, shadow density, or environmental data. The "Design Your Biophilic City" mode lets students combine various elements to create their own city model and receive instant feedback on ecological performance and social well-being scores.

Project Number: KA220-BW-23-30-126516

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Possible Classroom Session Plan

Introduction (5–7 mins)
Goal: Introduce students to the concept of biophilic cities and the importance of reconnecting urban life with nature.

- Start with a real-world question: *"What would our cities look and feel like if nature were part of every street and building?"*
- Show a short introductory video (e.g., Biophilic Design: The Future of Cities?– YouTube).
- Discuss how natural systems influence climate, health, and community well-being.

Main Activity – AR Exercise (30-35 mins)
Exploring Biophilic City Design through AR
AR Model Interaction (10–15 mins):

- Students open the Delightex AR app and access an interactive urban model.
- Hands-on Exploration:
  - Rotate and zoom in on different parts of the city.
  - Tap buildings, parks, and waterways to reveal how nature improves comfort and biodiversity.
  - Compare "Before" (conventional city) vs. "After" (biophilic transformation).

Guided Learning Tasks (10–15 mins):

- Watch AR animations showing how trees reduce air temperature, green roofs improve insulation, and daylight supports human health.
- Conduct a virtual experiment: add or remove biophilic elements to observe changes in air quality, noise, and temperature data overlays.
- Gamified Challenge: "Design the Most Livable City." Students build a balanced, biophilic city, earning points for ecological efficiency and human well-being indicators.

Conclusion & Recap (10-15 mins)

Goal: Reinforce learning through discussion and reflection.

Project the AR experience on a shared screen and discuss results. Ask students:

- *Which biophilic features improved the city the most?*
- *How does nature influence how we live, feel, and interact in cities?*
- *Can technology help us design cities that heal rather than harm the environment?*

Reflection Task: Write a short paragraph answering:
"How can integrating natural elements into cities contribute to sustainability and human well-being?"

- Conclude with a brief discussion about how STEAM disciplines, science, technology, engineering, art, and mathematics, collaborate in biophilic urban design to create resilient and restorative cities.

Project Number: KA220-BW-23-30-126516

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Which pedagogical objectives are addressed through this scenario?

Active Engagement

Students actively engage with interactive 3D AR models of urban environments, allowing them to observe, manipulate, and transform virtual cityscapes from concrete-dominated to nature-integrated systems. This hands-on approach encourages curiosity and creative exploration, helping students visualize how biophilic design, through greenery, natural light, and water systems, improves both ecological performance and human well-being. By interacting with animations, pop-ups, and data overlays, students connect theoretical principles of environmental science and architecture with real-time visual simulations, understanding how design decisions affect energy use, temperature, and livability. This direct engagement turns abstract sustainability concepts into tangible experiences, fostering environmental awareness and design thinking.

Critical Thinking

The exercise promotes critical thinking by challenging students to analyze and compare different urban design approaches. Through interactive AR experiments, students observe how the inclusion or absence of biophilic elements changes air quality, temperature, biodiversity, and comfort levels. They are encouraged to reason about cause and effect, evaluating how natural systems interact with the built environment and how these insights can be applied to solve urban challenges such as pollution or the urban heat island effect.

Students must also make design trade-offs, deciding how to balance ecological, social, and spatial factors, which develops their ability to approach complex STEAM problems from multiple perspectives.

Application of Knowledge

Through the AR experience, students apply theoretical knowledge from biology, architecture, physics, and environmental science to real-world contexts. They use AR tools to design or improve virtual urban spaces, translating ecological principles, such as natural ventilation, shading, and biodiversity enhancement, into practical urban design strategies. This process reinforces their understanding of sustainable design principles, demonstrating how integrated systems thinking can produce cities that are resilient, regenerative, and human-centered. By directly applying what they learn in a simulated environment, students experience how STEAM education drives innovation in urban planning and sustainable development.

Multimodal Learning (Visual, Hands-On, Inquiry-Based Learning)

The scenario integrates visual animations, hands-on AR manipulation, and inquiry-based exploration, ensuring accessibility for different learning styles. Students engage visually by observing environmental data overlays; tactilely through direct manipulation of 3D city models; and cognitively through questioning and experimentation. This multimodal experience transforms abstract ideas, such as the impact of vegetation on thermal comfort or air quality, into visible, measurable phenomena.

By combining artistic creativity (design aesthetics) with scientific analysis (environmental data), students experience how biophilic design represents the true intersection of STEAM disciplines, where science and creativity collaborate to create a better world.

Project Number: KA220-BW-23-30-126516

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Which results are expected to be reached with its use?

Enhanced Understanding of Biophilic Design Principles and Urban Sustainability

Students will gain a deeper understanding of how nature-based strategies can transform cities into healthier and more sustainable environments. Through interactive 3D AR simulations, they will visualize the direct impact of natural elements, such as vegetation, water systems, and daylight, on air quality, thermal comfort, and biodiversity.

This immersive experience connects the abstract concepts of environmental science, architecture, and urban ecologyto concrete examples of biophilic city planning.

By engaging with the AR environment, students learn to view cities as living systems where natural and human-made components coexist and support one another, reinforcing their comprehension of holistic, system-based sustainability.

Increased Engagement and Interest in STEAM and Sustainable Design

The visually dynamic and participatory nature of the AR exercise is expected to increase student engagement and motivation in STEAM subjects, particularly in areas connecting science, design, and technology. By exploring how biophilic design integrates biology and engineering into architectural innovation, students develop a greater appreciation for interdisciplinary collaboration in solving environmental and social challenges. The creative freedom to design their own biophilic city encourages imagination and experimentation, while the data-driven feedback promotes scientific inquiry. Overall, the activity fosters curiosity about green technologies, ecological design, and urban innovation, inspiring students to consider future careers in architecture, sustainability, or environmental sciences.

Improved Retention and Recall of Key Concepts

The combination of visual animations, interactive modeling, and gamified challenges supports long-term retention of key concepts such as urban ecology, ecosystem services, and environmental performance metrics. Because students can immediately observe the outcomes of their design choices (e.g., reduced temperature, cleaner air, improved livability), the learning process becomes more memorable and meaningful. This cause-and-effect learning reinforces understanding and recall, ensuring students can explain how biophilic principles work and why they are essential for addressing global environmental issues like climate change and urban resilience.

Increased Confidence in Applying Biophilic and Interdisciplinary Thinking

As students engage with AR simulations and complete guided learning tasks, they will gain confidence in explaining and applying biophilic principles in both scientific and creative contexts. By designing, testing, and refining their own virtual cities, they develop practical problem-solving and design-thinking skills, bridging theory and practice.The exercise empowers students to articulate how STEAM disciplines intersect to promote sustainable living, understanding that successful urban design requires collaboration between science, engineering, art, and human-centered innovation. Ultimately, this confidence prepares students to think critically and act responsibly as future urban citizens and sustainability innovators.

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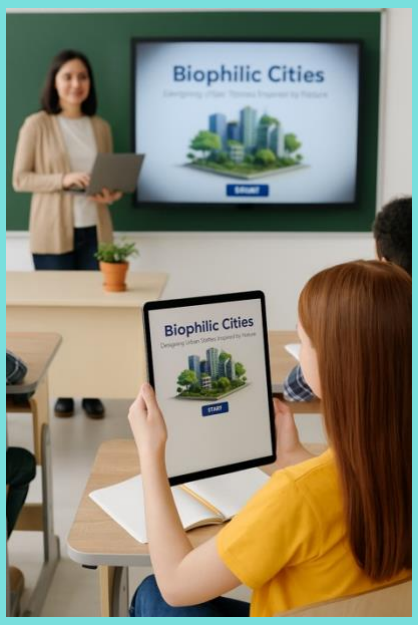
Technical specifications

AR INFORMATION

Technology	**Markerless Augmented Reality (AR)** using the **Delightex platform**.
If it's needed a marker, description of the marker	
Hardware and software needed:	**Hardware:** PC, smartphone, tablet (for accessing AR content), Camera (for AR functionality), Gyroscope (for AR tracking on mobile devices). **Software:** The **Delightex** AR web-based viewer or mobile app, compatible with both **iOS** and **Android**.
Type of Augmented data	• 3D models of urban environments (buildings, streets, parks, rivers, and vegetation) • Animated overlays showing environmental processes (cooling from trees, air purification, natural ventilation) • Pop-up text and icons describing biophilic elements (green roofs, vertical gardens, bioswales, water corridors)

Project Number: KA220-BW-23-30-126516

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Written description of the AR data	• **Environmental data layers** displaying quantitative changes (temperature, CO_2 concentration, humidity, biodiversity index) • **Sound design elements** simulating natural and urban acoustic environments • **Color filters and timeline sliders** to visualize city transformation over time (e.g., from "concrete city" to "biophilic city") When students launch the AR exercise, a **virtual cityscape** appears on their device. The initial scene displays a **dense, concrete-based urban environment** with limited greenery and high pollution levels. A "Start Transformation" button activates the interactive journey through **biophilic design principles**. Students can: • **Zoom and rotate** the model to view different districts. • **Tap on buildings and surfaces** to add natural elements such as trees, rooftop gardens, and water systems. • **Observe real-time environmental changes** through animated overlays (e.g., cooler surface temperature, increased oxygen, noise reduction). • **Trigger pop-ups** that explain the scientific and architectural principles behind each improvement (e.g., "Vegetation lowers heat through evapotranspiration"). • **Use interactive sliders** to test design variations—changing vegetation density, water coverage, or solar orientation. **Additional features:** • **An animated sequence** showing the gradual transformation of a conventional city into a biophilic one, emphasizing the role of vegetation, water, and daylight in enhancing sustainability. • **A design exploration section**, where students can create their own biophilic urban layouts and receive instant visual and numerical feedback on environmental improvements (e.g., air quality, noise reduction, temperature). • **A "Return to Start" button** allowing users to reset the city model and repeat the exercise with different configurations, encouraging experimentation and iterative learning.

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	• **Scenario presets** (e.g., “Hot Climate City,” “Coastal City,” “Dense Urban Center”) to compare how biophilic design strategies adapt to different contexts. • **Reflection prompts** embedded at the end of the AR experience to guide students toward writing short sustainability analyses or visual design notes.
Scene	Five scenes: **Scene 2 – Introducing Biophilic Elements** Students tap icons to add trees, green façades, and rooftop gardens. Animations demonstrate temperature reduction, increased shading, and air filtration. **Scene 3 – Integrating Blue and Green Infrastructure** Students introduce water features such as rain gardens, ponds, and rivers. They observe the impact on humidity, biodiversity, and stormwater management. **Scene 4 – The Biophilic City in Action** The fully transformed city displays improved environmental and social indicators. People interact with natural spaces, and ambient soundscapes become calmer. A prompt appears: *“How does this transformation affect the way people live, feel, and connect with nature?”* **Scene 5 – Reflection and Creative Challenge** Students access a reflection panel and “Design Your Own Biophilic City” challenge. They receive feedback based on sustainability metrics (green area %, air quality index, comfort score).
If Image	-
If Text	**What Is a Biophilic City?** A biophilic city is an urban environment designed to reconnect people with nature by integrating greenery, natural light, water, and biodiversity into everyday spaces. **How Does It Work?** Biophilic design improves environmental performance by reducing heat, filtering air pollutants, and providing habitats for urban wildlife while promoting mental and physical health.

Project Number: KA220-BW-23-30-126516

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Why Is It Important?
As cities grow denser, integrating nature is crucial for achieving climate resilience, ecological balance, and improved quality of life.

What Can Students Learn?
Through this AR experience, students discover how combining architecture, science, and art leads to innovative urban solutions that are both sustainable and restorative.

If video -

If audio -

If 3D model

Delightex

https://edu.delightex.com/NJK-VLA

Project Number: KA220-BW-23-30-126516

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