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# From Concrete to Nature: Exploring the Difference Between Conventional and Nature-Inspired Buildings



**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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# Introduction

Modern architecture often focuses on function, efficiency, and aesthetics, but nature has been perfecting design for millions of years. By studying natural forms, materials, and processes, architects and engineers can develop innovative, energy-efficient, and adaptive building designs that go beyond traditional construction methods. This concept, known as biomimicry, allows us to learn from nature's strategies to solve human design challenges, such as temperature regulation, water management, and light optimization.

In this exercise, students will use Augmented Reality (AR) through the Delightex platform to compare a conventional building with a nature-inspired building. Through interactive visualization, they will explore how nature-based principles, like self-shading, natural ventilation, and structural efficiency, can create buildings that are both sustainable and aesthetically harmonious.

Students will investigate how these buildings differ in form, material use, environmental response, and energy performance. The immersive AR experience will stimulate curiosity and critical thinking as students discover how biological systems inspire architectural innovation and how mimicking natural mechanisms leads to designs that are not only efficient but also regenerative.

This interdisciplinary activity connects architecture, biology, and environmental science, helping students recognize the potential of bio-inspired design as a path toward a more sustainable and resilient built environment.

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



# General information

<p>Name of the exercise:</p>	<p>From Concrete to Nature: Comparing Conventional and Nature-Inspired Buildings</p> <p><i>This AR-based exercise guides students through a side-by-side comparison of two building types:</i></p> <ol style="list-style-type: none"><li><i>1. A conventional modern building, focused on structure and material efficiency.</i></li><li><i>2. A nature-inspired building, modeled after biological systems and natural principles</i></li></ol>
<p>Description of the exercises:</p>	<p>Using the Delightex AR platform, students explore both 3D models interactively. They can rotate, zoom, and examine how design elements, such as façade geometry, surface texture, ventilation, and lighting strategies, differ between the two. Animated overlays illustrate how nature-inspired solutions mimic processes like photosynthesis, thermoregulation, or self-cleaning.</p> <p>The exercise aims to trigger visual curiosity and analytical thinking, encouraging students to identify the advantages of biomimetic architecture, such as improved energy efficiency, comfort, and environmental harmony.</p>
<p>Participants:</p>	<p>The activity can be conducted individually or in small groups (3–4 students).</p> <p>Collaborative group work is recommended to foster discussion, observation sharing, and idea generation.</p>



Participants' age  
range:

Minimum 14-18 years old

Prior exposure to basic biology and architectural concepts is helpful but not required.

STEM subject and  
specific topic:

*STEM Subject:* Architecture, Biology, Environmental Science

*Specific Topic:* Biomimetic and bio-inspired design principles in architecture, comparing natural and conventional approaches to energy efficiency, structure, and sustainability.

*Main challenge (stressful aspect) of the topic:*

Students often find it abstract to understand how natural principles can be translated into architectural solutions. It can be difficult to visualize how organic forms, natural processes, or biological materials influence real-world building performance. Another challenge is connecting microscopic biological phenomena (e.g., self-cleaning properties of leaves, termite-inspired ventilation systems) with macroscopic building designs and construction materials.

*How AR helps simplify the concept:*

1. **3D visualization** allows students to compare buildings in real-time, side by side.
2. **Animated overlays** illustrate airflow, daylight penetration, and heat exchange to make environmental concepts visible.
3. **Layer toggles** let users explore hidden systems, like structural cores, façades, or ventilation channels, showing how each design responds to external conditions.
4. **Pop-up explanations** connect architectural features to biological analogies (e.g., “*This façade mimics a pinecone’s ability to open and close based on humidity.*”)
5. **Interactive experiments** enable students to adjust variables such as sunlight or wind direction and observe the building’s adaptive response.

*Pedagogical Aim (Learning Outcomes):*

6. By the end of this exercise, students will be able to:
7. Identify key differences between conventional and nature-inspired building designs.
8. Explain how **biological strategies** can be translated into **architectural innovations**.



Gamification  
process:

9. Understand how biomimicry improves **energy efficiency, comfort, and sustainability**.
10. Develop **observation and reasoning skills** by analyzing visible and invisible systems within buildings.
11. Reflect on how **nature can serve as a mentor** for solving modern architectural and environmental challenges.

- **Exploration phase:** Students unlock information points by examining both building models.
- **Comparison mode:** Interactive quiz or challenge asks students to identify which building performs better under certain conditions (e.g., thermal comfort, daylight use).
- **Scoring system:** Points are awarded for correctly identifying nature-inspired features and explaining their benefits.
- **Reflection stage:** Students summarize what makes nature-inspired design unique and propose their own nature-based improvement to the conventional model.

Written or graphic  
description of  
Augmented info:

The AR interface displays two buildings side by side on a shared digital stage:

- The **left model** represents a conventional high-rise building with typical glass façades and mechanical ventilation.
- The **right model** showcases a **nature-inspired structure**—for instance, one inspired by **tree leaves for shading, termite mounds for ventilation, or seashells for strength**.
- Students can rotate and explore both models simultaneously, revealing differences in structure, form, and environmental performance. Animated visual layers highlight energy flow, ventilation paths, and daylight distribution. Pop-up info panels provide concise explanations linking architectural solutions to biological analogies

External (or extra)  
tools required

**AR-compatible tablet or smartphone** with an internet connection

**Delightex AR platform** (browser or app version)

Optional:

- Comparative worksheet for identifying advantages of each building type



Links (video,  
images, text online  
and so on).

- Video: “Wonders of Biomimicry”

**Video:** Wonders of Biomimicry

**Link:** <https://youtube.com/shorts/zttap6V7cIA?si=0KKuSyZZxAC6g29c>



# 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 understand the key differences between conventional and nature-inspired building through immersive, side-by-side AR models that reveal how nature's strategies can solve architectural challenges.

### **Use:**

Students can rotate, zoom, and explore two contrasting 3D building models: A conventional building, showcasing standard materials, rigid geometry, and mechanical systems; A nature-inspired building, modeled after natural forms such as tree canopies, honeycombs, or termite mounds. By tapping specific areas (e.g., façade, roof, or ventilation system), students trigger animated overlays that show how each design responds to light, temperature, and airflow. Interactive pop-ups explain biological analogies, for instance, how a termite mound's passive cooling inspired natural ventilation systems or how leaf venation patterns inform energy-efficient façade structures. This visual and interactive comparison helps students connect biology, engineering, and architecture in a tangible, engaging way.

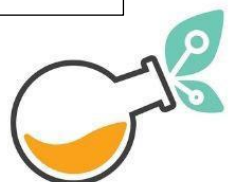
## **Interactive Buttons**

### **Goal:**

Enable students to experiment with design choices and discover how biomimetic principles improve performance compared to conventional solutions.

### **Use:**

Students use interactive buttons to: Switch between "Conventional" and "Nature-Inspired" modes, Activate environmental simulations, such as sunlight exposure, temperature changes, and wind flow, View real-time performance metrics (e.g., interior temperature, light levels, energy demand). As they interact, visual indicators (e.g., airflow arrows, heat maps) update to demonstrate environmental improvements. Students can toggle material types, façade geometries, or ventilation methods, allowing them to explore how natural principles lead to adaptive, resource-efficient designs. A "Biomimicry Explorer" mode encourages curiosity by revealing short scientific facts about each nature-inspired concept (e.g., "This design mimics the lotus leaf's self-cleaning property"). Progress tracking ensures students move from observation to analysis to design reflection, embodying a complete STEAM learning cycle.



## Possible Classroom Session Plan

Introduction (5–7 mins)

Goal: Introduce students to the concept of biomimicry and its application in building design.

- Start with a question: “*Why are natural structures, like shells, leaves, and termite mounds, so efficient compared to many human-made ones?*”
- Show a short video (e.g., *How Nature Inspires Sustainable Architecture*).
- Discuss examples of architecture inspired by nature (e.g., Eastgate Centre in Zimbabwe, Eden Project in the UK).

### Main Activity – AR Exercise (30-35 mins)

Exploring Conventional vs. Nature-Inspired Buildings with AR

AR Model Interaction (10–15 mins):

- Students open the Delightex AR app and access the two comparative models.
- Hands-on Exploration:
  - Rotate and inspect both models.
  - Tap to reveal pop-up explanations and animations (e.g., airflow, solar shading, self-cleaning).
  - Observe how each design behaves under simulated conditions such as wind or sunlight.

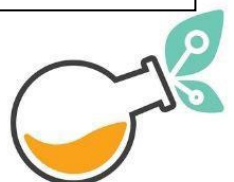
Guided Learning Tasks (10–15 mins):

- Watch animations demonstrating how biomimetic designs reduce energy use or improve comfort.
- Conduct a virtual experiment: simulate a heatwave or intense sunlight and observe which building adapts better.
- Gamified Challenge: “Design Smarter”, students select nature-inspired features to retrofit the conventional building, earning points for efficiency and comfort improvements.

### Conclusion & Recap (10-15 mins)

Goal: Reinforce learning through comparison and reflection.

- Project the AR experience on a shared screen.
- Discuss as a class:
  - *What were the key differences between the two building types?*
  - *How does nature solve problems differently from traditional engineering?*
  - *Can architecture learn efficiency and adaptability from biological systems?*
- Reflection Task: Students write a short answer to:  
“*Which natural system or organism do you think could inspire the buildings of the future, and why?*”
- Conclude with a short discussion on how STEAM integration, biology, engineering, art, and technology can lead to innovative and sustainable building design.



## Which pedagogical objectives are addressed through this scenario?

### Active Engagement

Students actively engage with interactive 3D AR models that allow them to observe, rotate, and compare conventional and nature-inspired buildings. This hands-on experience stimulates curiosity by letting students *see and test* how nature-inspired architecture adapts to environmental factors such as light, wind, and temperature. By directly interacting with dynamic models, students connect biological principles (like self-shading, ventilation, and material adaptation) with architectural applications, making abstract concepts about sustainability and biomimicry visible and concrete. The interactive nature of the activity ensures continuous attention and exploration, fostering motivation through discovery-based learning.

### Critical Thinking

The exercise promotes critical thinking by encouraging students to analyze how and why nature-inspired buildings outperform conventional ones. As they compare both models, students must interpret visual data, like airflow patterns, heat maps, or energy consumption indicators, and reason about the cause-effect relationships behind each outcome. They are guided to evaluate design efficiency, environmental responsiveness, and material logic, asking:

- *What biological strategy is being mimicked here?*
- *Why does this natural solution perform better?*
- *How could we adapt this for human architecture?*

By reasoning through these questions, students learn to apply systems thinking, understanding how **form, function, and environment** are interrelated.

### Application of Knowledge

Through the AR simulation, students apply knowledge from biology, physics, and architecture to interpret and improve building designs. They translate natural mechanisms, such as thermoregulation, hydrophobic surfaces, or load distribution, into architectural concepts like passive cooling, self-cleaning façades, and lightweight structural systems. This application phase helps bridge theory and practice, showing how STEAM fields intersect in real-world innovation. Students also practice comparative analysis and design-based problem solving, skills that are critical for understanding how sustainable design can draw inspiration from natural systems.

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

The scenario supports multimodal learning, combining visual observation, tactile exploration, and inquiry-based investigation. Students see how environmental data changes visually, manipulate digital models to explore design alternatives, and question how biological insights can be translated into architectural solutions. This integration of visual and interactive content enhances understanding for both analytical and creative learners. By linking science, art, and technology, students experience firsthand how design thinking and biological inspiration merge to address environmental and architectural challenges.



## Which results are expected to be reached with its use?

### **Enhanced Understanding of Biomimetic Architecture and Environmental Design**

Students will develop a deeper understanding of how natural systems inspire architectural innovation. By comparing conventional and nature-inspired buildings in AR, they will clearly visualize how biological forms and processes, such as passive cooling (termite mounds), self-cleaning (lotus leaves), or light diffusion (tree canopies, translate into architectural features that improve energy performance and comfort. This immersive comparison allows students to link scientific principles (biology, physics, and material science) with architectural practice, reinforcing their comprehension of how nature can inform human design. The AR experience transforms abstract sustainability ideas into visible, tangible examples, helping students see how adaptive, efficient, and regenerative design principles can be applied to the built environment.

### **Increased Engagement and Interest in STEAM and Sustainable Architecture**

The interactive and exploratory nature of the exercise increases students' motivation and engagement in STEAM learning. By interacting with 3D models and animated overlays, students experience real-time cause-and-effect feedback, seeing how a small design change can impact energy use or comfort. The comparison between "conventional" and "nature-inspired" modes fosters curiosity and a sense of discovery, motivating learners to explore how biological intelligence and technology can shape the future of sustainable cities. This process encourages an interdisciplinary mindset, where science, engineering, art, and environmental awareness converge in a single learning experience.

### **Improved Retention and Recall of Key Concepts**

The combination of visual models, interactive experimentation, and data-driven exploration helps students retain and recall core ideas about biomimicry and design innovation.

By directly observing environmental responses, such as heat reduction, airflow optimization, or self-cleaning properties, students build lasting conceptual connections between natural mechanisms and architectural functions. The multimodal learning approach ensures that both analytical and visual learners can remember key relationships between form, function, and performance, leading to stronger comprehension of sustainability concepts.

### **Increased Confidence in Applying Nature-Based and Interdisciplinary Thinking**

As students explore and experiment within the AR environment, they gain confidence in explaining how biological principles can inform design and in proposing their own solutions to architectural problems. Through guided reflection and comparison, they practice analytical reasoning and creative problem-solving, bridging knowledge from biology and architecture into practical innovation. The activity empowers students to think critically and independently, recognizing that nature is not just an inspiration but a mentor for sustainable design.

By the end of the exercise, learners will be able to confidently articulate the advantages of biomimetic buildings, justify their environmental benefits, and envision how such principles could shape future architecture.



# Technical specifications

## AR INFORMATION

### Technology

**Markerless Augmented Reality (AR) using the Delightex platform.**

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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

- **Two 3D building models:** one **conventional** and one **nature-inspired**.
- **Animated overlays** visualizing environmental factors—such as heat, airflow, and daylight—affecting each building.
- **Pop-up text panels** explaining biological analogies and architectural responses.



Written description  
of the AR data

- **Interactive layers** showing internal systems (e.g., ventilation, energy use, water collection).
- **Comparison dashboard** displaying performance indicators (temperature, energy demand, airflow efficiency).
- **Audio effects** simulating environmental context (wind, sunlight intensity, ambient sound).
- Upon launching the AR experience, students see two side-by-side 3D models floating above a virtual baseplate.
- The left model depicts a conventional high-rise building with glass façades, sealed windows, and mechanical cooling systems.
- The right model represents a nature-inspired building, with organic shapes, porous façades, and adaptive ventilation channels modeled after biological systems.
- Students interact with both models by:
  - Rotating and zooming to explore structural details.
  - Tapping different parts of each building to reveal explanatory pop-ups (e.g., “Conventional façade traps heat,” “Nature-inspired façade mimics leaf shading to reduce glare”).
- Activating animations that visualize environmental behavior such as heat exchange, airflow, or light distribution.
- Switching between views (“structure,” “environment,” “materials”) to compare how each building performs under various conditions.
- Data overlays show live performance metrics, allowing learners to visually assess improvements in energy efficiency, comfort, and adaptability.
- **Additional features:**
  - **An animated transformation sequence** demonstrating how conventional building elements can evolve into nature-inspired ones, step by step (e.g., rigid façade → porous leaf-inspired façade → dynamic shading system).
  - **A “Bio-Analogy Explorer” panel**, linking architectural features to real-world organisms (e.g., termite mounds, lotus leaves, tree canopies).
  - **A comparative performance dashboard**, displaying side-by-side data such as:
    - Internal temperature (°C)
    - Energy use (kWh/m<sup>2</sup>)
    - Daylight factor (%)
    - Air exchange rate (ACH)



- A **“Return to Start” button**, allowing users to reset the comparison and repeat experiments with new environmental settings (e.g., change sun angle, wind direction, or climate type).
- **Interactive learning prompts**, asking questions like: *“Which design performs best in hot climates?”* or *“How can we learn from natural forms to improve this structure?”*
- Reflection interface **at the end, where students can record or export short notes summarizing their insights**

Scene

Four scenes:

### **Scene 1 – Introduction: The Conventional Building**

Students observe the conventional model first, noting straight lines, uniform materials, and high energy use. Visual indicators show heat accumulation and poor ventilation.

### **Scene 2 – The Nature-Inspired Building**

The AR view transitions to the organic model. Animated overlays highlight adaptive ventilation, self-shading elements, and natural materials. Pop-ups explain how each component is biologically inspired.

### **Scene 3 – Comparison Mode**

Both buildings appear side by side. Students toggle overlays showing **heat maps, airflow, and daylight analysis**, discovering clear performance differences.

### **Scene 4 – Transformation and Reflection**

An animation shows how conventional features can be redesigned using biomimetic strategies.

A reflection question appears: *“What can humans learn from nature’s architecture to create sustainable buildings?”*

If Image

-

If Text

### **What Are Nature-Inspired Buildings?**

Nature-inspired buildings use biological principles and natural processes to solve design challenges. They mimic how organisms regulate temperature, manage water, and use materials efficiently.

### **How Do They Differ from Conventional Ones?**

Conventional buildings rely heavily on mechanical systems for



comfort, while nature-inspired buildings adapt passively, just like living organisms, to their environment.

### **Why Are They Important?**

They reduce energy consumption, increase comfort, and minimize environmental impact while reconnecting people with nature.

### **What Can Students Learn?**

How architecture and biology intersect, and how nature's intelligence can inspire innovation, efficiency, and sustainability in human design.

If video

-

If audio

-

If 3D model



Delightex

<https://edu.delightex.com/WGV-URV>





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