Co-funded by
the European Union

Panoptes and the Bionic Eye

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

"Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them."

KIT Karlsruher Institut für Technologie · ktu kaunas university of technology · Università degli Studi di Palermo · CEIPES · &duact

Co-funded by
the European Union

TABLE OF CONTENTS

- General Information
- Pedagogical specification
- Technical specification

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

Co-funded by
the European Union

Introduction

The purpose of this document is to create guidelines to help the project staff that are dealing with school children, 14-19 aged, to create and re-adapt exercises using Augmented Reality technology.

To this end, a series of templates have been created that define exercises from a methodological, pedagogical and technological point of view.

A good written description, along with images, videos or sketches of the exercise is very important for experts to understand the idea. This will be part of the “General Information” template.

On the other hand, it will be important to define what STEM topic/subject each exercise is intended for and how AR technology can help students or staff or people interested in it when they use these exercises. In addition, people interested in the exercise can understand the usefulness of augmented information, and it will be necessary to explain the benefits.

During the process of defining the augmented information that each exercise will offer, staff working with teachers will be able to develop innovative ideas that make it easier to learn teaching concepts in an easier way.

All students will be able to view the contents explained by professionals projected in the real world in the form of text, 3D model, image, video, sound... This will help them focus their attention on exercise and more easily assimilate the associated concepts.

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

"Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them."

Co-funded by the European Union

General information

Name of the exercise:	Panoptes and the Bionic Eye
Description of the exercises:	This exercise introduces students to **biomimicry in vision** by exploring how **animal visual systems** inspire **bionic eye technology**. Students will learn about the **visual cortex, sensory mapping, and how engineers use neuroscience to develop retinal prostheses**. Using **Augmented Reality (AR)**, students will interact with **3D models of the human eye, the Panoptes robotic vision system, and the bionic eye implant**. The exercise consists of three stages: 1. **Exploration:** Observing the structure and function of the visual system using AR. 2. **Analysis:** Comparing natural and artificial vision technologies. 3. **Design Task:** Brainstorming future applications of bionic vision.
Participants:	The exercise is designed for individual students or small groups (3-5 members) to encourage collaborative learning and discussion. *Group work is preferred for brainstorming innovative applications*
Participants' age range:	Minimum 15 years old Basic knowledge of **physics, biology**, and **engineering** is required.

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

"Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them."

Co-funded by the European Union

STEM subject and specific topic:	STEM Subject: Biology & Engineering Specific Topic: Animal and human vision, biomimicry, and bionic prosthetics Main challenge (stressful aspect) of the topic: 1. Understanding how vision is processed in the brain and the complexity of artificial vision systems. 2. Many students struggle to connect biological eye function to machine vision. 3. The role of spatial sensitivity and neural processing is difficult to visualize. How AR helps simplify the concept: 4. Interactive 3D models allow students to explore the human eye, Panoptes system, and bionic eye implants. 5. AR animations show how the visual cortex processes signals. 6. Comparing biological and artificial vision helps students understand biomimicry applications. Pedagogical Aim (Learning Outcomes): By the end of this exercise, students should be able to: 7. Explain how vision is processed in the brain. 8. Understand how biomimicry influences bionic eye technology. 9. Interpret experimental data on visual sensitivity mapping. 10. Apply knowledge of vision science to real-world applications.
Gamification process:	**Challenge-based learning**: Students solve real-world challenges (e.g., designing a bionic eye for different environments). **Points and Badges**: Completing sections (exploration, analysis, design) earns students points. **Role-playing**: Students act as bioengineers designing bionic vision solutions.

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

"Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them."

Co-funded by the European Union

Written or graphic description of Augmented info:	**3D AR models** of the human eye, Panoptes robotic vision system, and bionic eye implant. **Interactive animations** demonstrating how the retina and visual cortex process information. **Pop-up text overlays** explaining concepts like light detection, sensory mapping, and artificial vision. **Hands-on AR experiment** where students simulate vision impairment and prosthetic adaptation in a virtual environment.
External (or extra) tools required	**AR-compatible devices** (smartphones, tablets, or AR glasses). **Printable worksheets** for students to document observations and ideas. **Eye models or diagrams** for real-world comparison. **AR software or web-based platform** for interactive exploration.
Links (video, images, text online and so on).	Video: Learning to See Again with a Bionic Eye: https://youtu.be/UnrLaDCTOwA?si=8hfbAW1RjYtBJcQj

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

"Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them."

Co-funded by
the European Union

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?

Augmented Reality (AR) makes the topic of **bionic vision and biomimicry** more engaging by providing interactive, 3D visualizations that allow students to explore vision mechanisms dynamically. The AR technology is used in multiple ways during the session to break down complex vision processing concepts and make them accessible.

Scope of Augmented Information:

- **3D Models:** Students explore high-resolution 3D models of the human eye, the Panoptes robotic vision system, and the bionic eye implant. They can zoom, rotate, and manipulate the structures to better understand their functions.
- **Interactive Animations:** Animated sequences demonstrate how light enters the eye, travels through the retina, and is processed in the brain, helping students visualize an otherwise invisible process.
- **Pop-Up Information Overlays:** Tapping on different parts of the AR models reveals descriptive text explanations, making it easier to grasp key concepts such as retinal function, optic nerve transmission, and neural processing.
- **Videos and Sound Elements:** Integrated videos provide real-world case studies of bionic eye patients, and optional audio narration explains how artificial vision differs from natural vision.

Use of Augmented Information in Different Stages of the Exercise:

1. **Exploration Phase:** Students begin by interacting with AR models of the human eye to understand its structure and function.
2. **Analysis Phase:** They compare the human eye with the Panoptes robotic **system**, seeing the key differences in how natural and artificial vision work.
3. **Design Phase:** Students use AR to explore bionic eye prosthetics, understanding how these devices mimic natural vision, and brainstorm new biomimetic vision enhancements.

By incorporating AR-based interaction, real-world case studies, and 3D visualizations, the exercise transforms a challenging STEM topic into an immersive and engaging learning experience, fostering deep understanding and curiosity in students.

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

"Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them."

Co-funded by
the European Union

Which pedagogical objectives are addressed through this scenario?

This AR exercise promotes **active engagement, critical thinking, and real-world application** of scientific concepts, ensuring an effective and emotional education experience.

1. **Enhancing Conceptual Understanding**
    - Helps students visualize **complex biological and technological processes**.
    - Facilitates **spatial reasoning** by allowing students to interact with 3D anatomical models.
2. **Encouraging Inquiry-Based Learning**
    - Promotes **hands-on exploration** by allowing students to manipulate virtual models.
    - Encourages students to **ask questions and seek solutions** for vision-related challenges.
3. **Developing Problem-Solving Skills**
    - Students analyze and compare **natural and artificial vision**.
    - They develop **creative solutions** for future bionic vision applications.
4. **Fostering Emotional Connection to Learning**
    - Seeing real-world **bionic eye patient success stories** creates empathy and inspiration.
    - Allows students to reflect on the **impact of vision restoration technology**.

By using **Augmented Reality**, the lesson becomes **immersive and experiential**, improving **knowledge retention** and fostering **curiosity in biomimetic engineering**.

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

"Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them."

Co-funded by
the European Union

Which results are expected to be reached with its use?

This exercise aims to achieve learning outcomes that are often difficult to accomplish through **traditional teaching methods** by offering an **interactive, immersive experience** that enhances both **knowledge acquisition and mindset development** for STEM learning.

1. **Improved Understanding of Vision Science:**

- AR allows students to visualize how light is processed in the brain**,** which is difficult to grasp from textbooks alone.
- Students can manipulate 3D anatomical models to reinforce spatial understanding of the eye's structure and function.

2. **Stronger Engagement with STEM Concepts:**

- Traditional learning can make biomedical technology seem abstract**,** but AR makes it tangible and exciting.
- Students are active participants rather than passive learners, which increases motivation and curiosity.

3. **Development of Critical Thinking and Problem-Solving Skills:**

- By comparing natural vs. artificial vision, students learn to analyze and evaluate different scientific approaches.
- The design phase challenges students to apply biomimicry principles to real-world innovation.

4. **Enhancement of Digital and Scientific Literacy:**

- AR fosters technological fluency, preparing students for future STEM careers**.**
- Exposure to bionic eye technology and biomimicry applications encourages students to explore the intersection of biology, engineering, and artificial intelligence**.**

Through Augmented Reality, students will not only gain new scientific knowledge but also develop a growth mindset for STEM learning, where they see innovation and problem-solving as exciting and accessible challenges**.**

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

Co-funded by the European Union

Technical specifications

AR INFORMATION

Technology	**Markerless AR** (no need for a printed marker).
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:** A web-based AR viewer (such as WebXR) or a mobile AR app compatible with iOS and Android.

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

Co-funded by
the European Union

Type of Augmented data	3D models of the human eye, Panoptes robotic vision system, and bionic eye implant. Text overlays explaining vision mechanisms. Animations showing how the brain processes visual input. Interactive elements for zooming, rotating, and manipulating vision models.
Written description of the AR data	After launching the AR experience, students will see a 3D model of the human eye with annotations explaining visual processing. **Interactions:** • Zoom in and rotate to examine the retina, optic nerve, and brain pathways. • Tap on specific areas to trigger explanations on bionic eye implants. • Switch scenes to compare biological vision, robotic vision, and retinal prostheses.
Scene	Three scenes: • **Scene 1:** Human Eye Anatomy – Students explore the eye's structure and function. • **Scene 2:** Panoptes Robotic Vision – Students interact. with a robotic vision system. • **Scene 3:** Bionic Eye Implants – Students examine biomimetic retinal prostheses.
If Image	-

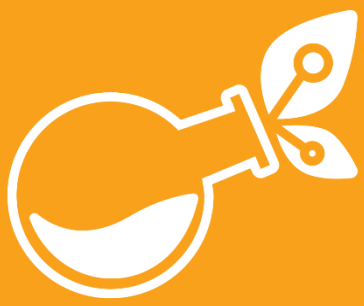
Project Number: KA220-BW-23-30-126516

Co-funded by
the European Union

If Text	The role of the retina in detecting light and converting it into electrical signals. • How the optic nerve transmits visual information to the brain. • The function of the visual cortex in processing images. • Differences between natural vision, robotic vision, and bionic vision. • Real-world applications of bionic eyes and their limitations.
If video	
If audio	-
If 3D model	

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

Co-funded by
the European Union



BIOS4YOU AR 2.0

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