

VRinHE

VIRTUAL REALITY IN
HIGHER EDUCATION

**Introduction to AR; terminology, types,
devices, applications in HE education**

Module 1

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Table of Contents

Module description 2
Learning Outcomes 2
Instruments/ Tools/ Supporting Material/ Resources to be used 3
Introduction 4
Unit 1: Relevant terminology..... 5
Unit 2: Types of Augmented reality 7
 2.1 Marker-based AR..... 7
 2.2 Markerless AR 7
Unit 3: Devices for AR..... 8
Unit 4: Applications in higher education 11

Fig. 1: 2D Heat map..... 6
Fig. 2: 3D heat map..... 6
Fig. 3: Mobile AR..... 8
Fig. 4: AR smart glasses..... 9
Fig. 5: AR headset..... 9
Fig. 6: Mixed reality headset..... 10

TABLES	Page
Table 1: Introduction activity	4
Table 2: Development activity	5
Table 3: Hands-on activity	10
Table 4: Assessment activity	11
Table 5: Reflection activity	12

Module description

This module serves as an introduction to the topic of augmented reality (AR). It will be used to familiarize the trainees with the different aspects of the technology, including the relevant terminology, different types of augmented reality, as well as the various devices, which support and are used to display AR content. The final part of the module will be dedicated to the possible applications of the technology in a higher education setting as part of the curriculum, aiding the teaching and learning process.

Spread throughout the module are various activities, which the trainees can perform by themselves or in groups, which will help them solidify their knowledge on the subject and engage in discussions on possible methods and scenarios for implementing augmented reality in higher education.

This is a theoretical module and it will play the role of the first stepping stone towards achieving an initial understanding of the topic of AR, which will then be further developed in the next modules of the training.

Learning Outcomes

With the completion of this module the trainees will be able to:

- Have a good understanding of the concept of augmented reality (AR) and its state-of-the-art;
- Define the terms, which are relevant to the concept of AR;
- List the different types of the AR;
- Have an understanding of the most popular AR systems, applications and tools, available on the market;
- Know the different devices, which can be used for AR;
- Visualize how that technology can be implemented in the higher education setting.

Instruments/ Tools/ Supporting Material/ Resources to be used

Different tools and supporting materials can be used by the trainees throughout the module, including videos, applications, web links, files:

- Video: [The Future of Augmented Reality: 10 Awesome Use Cases](#)
- Video: [DOF VR : AR for Real Estate & Architecture](#)
- Video: [The Future of Augmented Reality - AR in Healthcare](#)
- Application: [CoSpaces Edu app](#);
- File: Crossword_Puzzle

Methodology

This module starts with a short introduction to the concept and state-of-the-art of AR, familiarizing the trainees of what AR is in general terms. After the introduction, the module will be divided into several Units, each of them presenting a particular aspect of augmented reality – the relevant terminology, the different types of AR and the devices, which are used for AR content, as well as some scenarios about how the technology can be applied in the teaching and learning processes in higher education.

There are different learning activities, which are spread throughout the training module, whose purpose can vary: forming a discussion, sharing experiences or reinforcing the learned information. The introduction activity is set as a starting point for all trainees, where they can share their current experience with AR, before going through the module. The development activity will provide the relevant information to the trainees, while the hands-on (practical) activity will allow them to experience AR in real time. The assessment activity is designed to be fun and engaging, while at the same time reflecting on what was learned during the module. At the end of the module, the reflection activity is designed to engage the participants in a discussion on what was learned and possible scenarios on AR implementation in HE curriculum.

Introduction

Augmented reality (AR) is one part of the “technologies of the future”, which also include virtual reality (VR) and mixed reality (MR). These are also known as “immersive technologies”. In a nutshell, they either create a completely new reality (virtual reality) or extend and enrich the existing one (augmented reality). This can be accomplished by immersing the user in a digital environment via applications in different fields and domains.

In the last decade, these types of technologies have advanced a great deal and, while their development is still ongoing, they have reached a certain level of maturity, which allows them to be a useful tool in certain areas, including in education.

The basic definition of augmented reality is that it is a technology, which projects computer-generated elements (text, images, video) on top of the existing environment, thus making it an enhanced version of the real world. It provides the user with additional information and helping him/her perform tasks more efficiently.

Introduction Activity	
What	The first activity in the module foresees each of the trainees to tell about their background and previous experiences (whether professional or personal) with augmented reality.
How	No tools or resources are needed for this activity, since it's meant to provide an insight into the trainees' personal experiences with the technology.
Where	The activity can be conducted in a physical environment, but it can also be adapted for an online or virtual format.
Who	The trainers ask each of the trainees to elaborate on what their previous experience with AR was and what is their opinion of the technology.
Estimated Time	10 minutes

Table 1: Introduction activity

Development activity	
What	The trainers conduct a theoretical introduction into the topic of AR – terminology, types, devices etc.
How	The materials, which the trainers will use for this activity, are a laptop, a projector and a PowerPoint presentation.
Where	The activity can be conducted in a physical environment, but it can also be adapted for an online or virtual format
Who	The trainers will conduct the lesson, while the trainees observe and take notes.
Estimated Time	30 minutes

Table 2: Development activity

Unit 1: Relevant terminology

When talking about augmented reality there are certain terms, which everybody, who is interested in this topic, should be familiar with. This will allow the trainees to be on the same page and they will be able to understand the rest of this module, including the learning activities and tasks, more easily.

When it comes to AR, there are specific terms that the user should be familiar with and must consider, when dealing with this topic. It does not matter if the person is a teacher, student, a learning designer, a technologist or just a casual user – everyone, who is interested in the technology or works in that field professionally, will encounter these terms at one point or another and has to be able to recognize them.

This unit lays out the most used terms regarding augmented reality.

SDK is an abbreviation for Software Development Kit. It is a collection of tools for software development, which come in one package, that can be installed on your device and used for the creation of AR content. There are many different SDKs, that designers use for AR application development. Some of the most ubiquitous examples of such development frameworks are ARCore (Google’s open-source and free to use SDK), ARKit (Apple’s equivalent platform for AR development), as well as Vuforia (leading AR SDK in the industrial sector).

HMD (Head-mounted Display) is a device such as glasses or goggles, which is strapped to the user's head and shows virtual elements, projected on top of the existing environment.

There are two main types of AR - **Marker-based AR**, which relies on image or pattern recognition in order to trigger the augmentation and **Markerless AR**, which allows the user to choose where they would like to place the content. We will talk more about the different types of AR later in this module.

Tracking is a technique used quite often in virtual reality (VR), but it is also present in AR. It allows the device to track the movement of various parts of the user's body. It is mainly used for following the movement and location of the head, hands and eyes.

Heat map is a tool used for analytics. It uses color coding to indicate what parts of the scene people are paying most attention to. These hotspots can be generated based on where the user is gazing or by where the user is within the scene. There are two types of heat maps - 2D (Figure 1) and 3D (Figure 2).

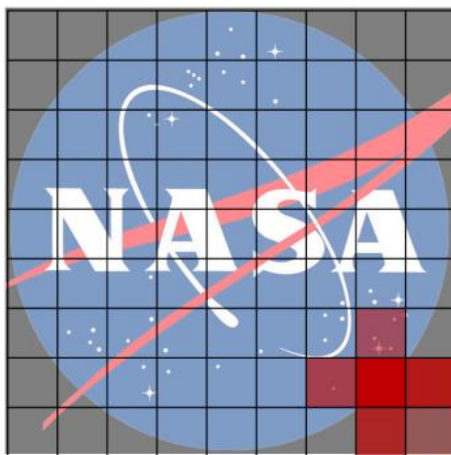


Figure 1: 2D heat map

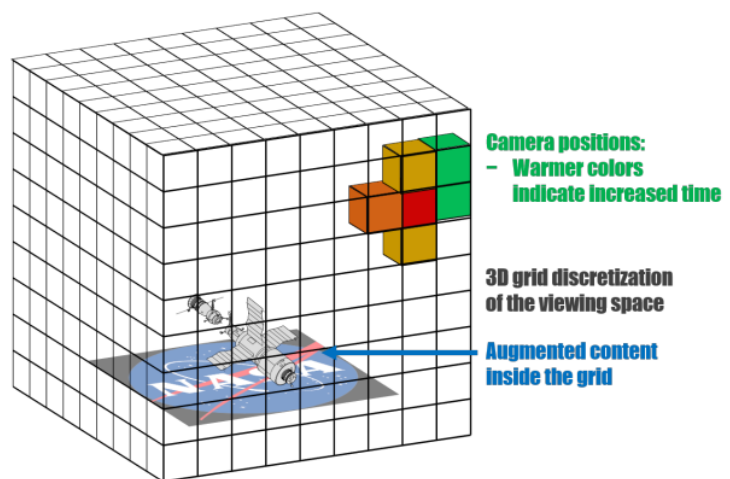


Figure 2: 3D heat map

Source: [Analyzing AR Viewing Experience through Analytics Heat Maps for Augmented Content](#)

Resources: AUGMENTED & VIRTUAL REALITY GLOSSARY:

https://www.iab.com/wp-content/uploads/2018/07/IAB_VR-AR_Glossary_v5b.pdf

Unit 2: Types of Augmented reality

In this unit we will take a look at the different iterations and variations of the AR technology, which can be used in the higher education sector by students, teachers, learning designers, technologists etc.

The two main types of AR are Marker-based AR and Markerless AR, which were briefly mentioned in Unit 1.

2.1 Marker-based AR

This type of AR uses image or pattern recognition in order to function. The camera or HMD scan the environment and when they recognize an object (called “marker”), this will activate the augmented experience, which can be anything: a pop-up text with information on the object, an image, video etc. This type of AR requires an app or similar software with pre-recorded objects for recognition. When the camera stumbles upon such an object, the augmentation is triggered.

An example of a marker-based AR can be seen in [this video](#).

2.2 Markerless AR

The other main variation of AR is called “markerless” because it does not rely on any type recognition in order to work. Instead, it is reliant on smartphone features, such as sensors, camera, processors etc.

Markerless AR can be further divided into:

- Location-based: the augmented experience is triggered when the user is in a specific location. The smartphone has the necessary capabilities (thanks to technologies such as GPS, compass, accelerometer) to detect the location of the user. The virtual objects are mapped to a given location and are displayed when the user is in the same location. You can see an example for a location-based AR in [this video](#).
- Projection-based: also known as “spatial AR”, this method projects light onto a surface. The interaction happens when the user physically touches the projected surface. Projection-based AR is not limited to a specific device and the virtual

elements are integrated directly into the environment. The active area for augmented elements is limited to the zone, which the camera encompasses.

- Superimposition-based AR: in this technology, part of, or the entire original view of any given object, is replaced by an augmented version of the same object.

Resources: Types of AR: <https://digitalpromise.org/initiative/360-story-lab/360-production-guide/investigate/augmented-reality/getting-started-with-ar/types-of-ar/>

Unit 3: Devices for AR

There are different types of devices, which are capable of displaying AR content. They can vary in aspects such as size, comfortability, ease of use and functionality. Depending on the circumstances, users might prefer one or another type of device, but all of them have their applications and use cases.

The first devices to be used for augmented reality content were **smartphones** and later on – **tablets**. They are collectively referred to as “mobile AR”. They use their camera, as well as other sensors, to display digital objects and information contextually in physical space. The physical and digital elements are then shown together on the display.



Figure 3: Mobile AR. Source: [Augmented Reality: Hardware and Definitions](#)

They have a number of advantages – they are ubiquitous, since almost everyone owns a smartphone or a tablet, which makes them a potential user of AR. Also, both devices are capable of installing and using apps, which is how AR content is distributed.

Along with those advantages however, these types of devices also have a number of disadvantages. Their screens are quite small, which is impractical when using them for AR. They are also not good in terms of interactivity with the AR app.

Another class of AR-capable devices are **smart glasses**. They are as lightweight as possible and have a slim form factor, which makes them comfortable to wear, even for extended periods of time. However, precisely because of the small form factor, they offer only limited AR capabilities.



Figure 5: AR smart glasses. Source: [Top 6 Reasons to Buy AR Smart Glasses in 2022](#)

A level above the smart glasses are the **AR headsets**. These are similar to smart glasses. The difference is that AR headsets are bulkier and less comfortable to wear, but they compensate by offering a richer augmented reality experience, since they have features that smart glasses don't have – spatial tracking and 3D mapping of the environment.

However, AR headsets are still very expensive and some of them are actually not even sold to regular consumers, just to business customers and professional users.



Figure 5: AR headset (Microsoft HoloLens 2). Source: [Augmented Reality: Hardware and Definitions](#)

The devices, which offer the most functionality in terms of AR capabilities, are **mixed reality headsets**. They are easier and cheaper to manufacture than pure AR headsets, because they are based on an established technology, similar to that of VR headsets. These devices have built-in cameras, which film the environment and transmit it as a video image to the opaque screens. This creates the illusion of seeing the surrounding world, which can then be augmented and overlaid with digital elements as desired.

Mixed reality headsets have similar form factor to that of VR headsets and are therefore bulky. They provide the best possible AR experience, but they are still very expensive.



Figure 6: Mixed reality headset. Source: [Introducing the Varjo XR-3](#).

Hands-on activity	
What	The trainees will test a mobile AR application, so they can familiarize themselves with the technology first-hand.
How	The trainees will download the CoSpaces Edu application from the Play Store and test out some of the different AR scenarios within it. Everything necessary for this activity is a mobile device and physical space.
Where	The testing of the AR scenarios will be conducted in the classroom.
Who	The teachers will provide guidelines on how to install and use the CoSpaces Edu app. The trainees will get to know the app's interface and try out different scenarios.
Estimated Time	20 minutes

Table 3: Hands-on activity

Unit 4: Applications in higher education

There are different educational fields, where augmented reality can be used as a tool to help and facilitate the learning process. The technology has the potential to turn a regular class or lecture into an engaging learning experience by using gamification and virtual images. Below are only a few examples of possible AR use in higher education fields.

In disciplines such as **architecture and interior design**, AR can help students visualize the different aspects of a building or superimpose different furniture in the room to see how they fit. In **medicine and healthcare**, AR can help students run simulations on how certain procedures should be done and offer them detailed representation of the human body and anatomy. In **engineering**, students can gain access to a detailed layout of a certain machine thanks to AR and learn how to use it, with very little or no interaction with the actual machine itself. AR can also be used when creating engineering designs, as well as in different **scientific fields** for mastering various concepts.

Assessment activity	
What	The trainees have to solve a crossword puzzle, which is composed of the various terms, that were learned in the previous units. The activity intends to evaluate how well the trainees have mastered the AR terminology.
How	The trainers will hand the trainees a printed crossword puzzle, which has to be solved.
Where	The activity can be conducted in a physical environment, but it can also be adapted for an online or virtual format
Who	The teachers give the necessary direction and then play the role of observers, while the trainees carry on with solving the crossword puzzle. After the activity is finished, the trainers will assess everyone's performance.
Estimated Time	10 minutes

Table 4: Assessment activity

Reflection activity	
What	The trainees will reflect upon the learned material and ask clarifying questions if necessary. Then they will go into a discussion about the use of the technology in the field of higher education.
How	No materials will be necessary for this activity.
Where	The activity can be conducted in a physical environment, but it can also be adapted for an online or virtual format
Who	The trainers and trainees will both participate in the discussion and share their experience and opinion.
Estimated Time	20 minutes

Table 5: Reflection activity