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## A DEBATE ABOUT EMERGING IMMERSIVE TECHNOLOGIES IN THE CONTEXT OF “HIGHER EDUCATION 4.0”

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### ABSTRACT

Higher education system plays a key role in research, innovation, employability and entrepreneurship. Never before has higher education been under so much pressure to rethink and transform itself. Ensuring quality education and training in the digital age depends not only on having enough technology, but also on how it is used, on preparing and supporting teaching staff to apply technology effectively in the learning process. **PURPOSE:** In this context, the article aims to discuss the concept of emerging immersive technologies for higher education. **METHODS:** To achieve the purpose, the article describes and analyses the recent trends and developments of “*European Digital Education Area*” and the concept of “*Emerging Immersive Technologies*”. **RESULTS:** This study provides an analysis and discussion the potential of emerging immersive technologies to improve higher education institutions (HEIs); however, new technologies alone are not enough to address the challenges of teaching and learning today.

**Key words:** higher education, digital education, emerging technologies, immersive technologies in education,

### INTRODUCTION

Over the past decade, and especially during the last global pandemic, the topic of emerging technologies in education systems has risen dramatically. It has been almost three years since the COVID-19 pandemic first disrupted traditional education and learning process, forcing educational institutions to examine its impact. Moreover, the use of emerging technologies as a means of delivering educational services seems to have challenged the notion of learning space and expanded the educational context beyond the traditional classroom. Digital transformation is having an increasing impact on educational institutions, including students and teachers, as now the technology is an important part of interaction,

learning, assessment, acquisition of specialised knowledge and lifelong learning. Therefore, Industry 4.0 is driving new technological opportunities as emerging technologies are increasingly being disseminated and used in the field of Education 4.0 and Science 4.0.

Thus, the purpose of this study was: 1) first, to describe the recent trends and developments in European Digital Education Area and; 2) second, to explore the role of emerging immersive technologies in promoting uptake in higher education. The study looked at key emerging technologies and in particular “immersive technologies” that can be transferred to and used by the education sector. The results of this study are contained in the review of a number of different technological aspects that need to be aligned and adapted to unlock the educational benefits of emerging immersive technologies in the context of Higher Education 4.0.

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## LITERATURE BACKGROUND

### 1. The development of an European digital education ecosystem

The European Commission has published its annual Education and Training Monitor 2022, which reports on progress towards the EU-level targets that are part of the strategic framework for European cooperation towards the European Education Area and beyond (2021-2030). It presents the Commission's annual analysis of the development of education and training systems across the EU. The country reports of the Education and Training Monitor reflect current and ongoing policy developments at all levels of education in the 27 EU Member States (1).

#### European Education Area

The European Education Area (EEA) initiative structures cooperation between Member States and stakeholders to build more sustainable and inclusive national education systems, removing barriers to learning and improving access to quality education for all. Indeed, the priority theme is Digital Education, with the EU promoting the development of an effective European ecosystem for digital education and working to improve citizens' competences and skills in relation to the digital transition (2).

#### European Digital Education

The Digital Education Action Plan (2021-2027) is the EU's renewed policy initiative to support the sustainable and effective adaptation of the Union's education and training systems to the digital age (3). The two priority areas of the plan are: First, fostering the development of a high-performing digital education ecosystem; and Second, improving the digital skills and competences needed for digital transformation. Therefore, the Action Plan sets itself objectives such as (4):

- to address the challenges and opportunities of the COVID-19 pandemic, which has led to an unprecedented use of technology for education and learning purposes;
- to propose a long-term strategic vision for high quality, inclusive and accessible European digital education;
- to strive for stronger cooperation at EU level in the field of digital education and stress the importance of working together across sectors to bring education into the digital age;

- to present opportunities, including improving the quality and quantity of digital learning, supporting the digitisation of teaching methods and pedagogy, and providing the infrastructure needed for inclusive and sustainable distance learning.

Therefore, the Digital Education Plan 2021-2027, based on the 2018-2020 Five-Year Plan, includes the following priority areas: 1) better use of digital technologies for teaching and learning; 2) development of digital competences and skills; and 3) improving education through better data analysis and prediction.

### 2. The Important Role of an Emerging Immersive Technology

New technologies are changing society by inventing new, unsuspected things and doing them in new, unsuspected ways (5). Indeed, they have a vitally important role to play in any digital transformation processes. The introduction of new technologies can have the following, such as:

- Initial productivity slowdown and delayed productivity payoff from the new technologies
- Destruction of human capital (as many old skills are no longer wanted)
- Technological unemployment (temporary but serious)
- Widening disparities in the distribution of income, which tends to be temporary until the supply of labor catches up to the new mix of skill requirements
- Big changes in regional patterns of industrial location (globalization)
- Big changes in required education
- Big changes in infrastructure (e.g., the information highway)
- Big changes in rules and regulations (intellectual property, antimonopoly, etc.)
- Big changes in the way we live and interact with each other

#### Conceptual defining and types

The definition of "immersion" is a broad and fluid concept, but in general it can be taken to mean that the user simply feels like part of a simulated "universe". An immersive digital environment can be a model of reality, but it can also be a complete fantasy user interface or abstraction, as long as the user of the environment is immersed in it. The success with

which an immersive digital environment can truly immerse the user depends on many factors, such as: *3D computer graphics, surround sound, etc.* New technologies are currently being developed and refined that will bring even more realistic effects to the user's environment such as wind, water, seat vibrations and ambient lighting (6).

The term “immersive technology” describes the process of creating, displaying and interacting with applications, content and experiences in a new way. It refers to a technology that attempts to “emulate” a replicated physical world through the means of a digital or simulated world by creating an ambient sensory experience, thereby creating a sense of immersion. Immersive Technology is the integration of virtual content with the physical, real environment in a way that allows the user to naturally engage with the mixed reality. By combining realities in immersive and haptic technologies (haptic technologies) such as “3D touch” or “kinesthetic interaction”, immersive technologies transform digital experiences. What's more, by bringing together sight, touch and sound, users can feel themselves as part of a simulated artificial environment. Creating these experiences requires state-of-the-art hardware and specialized software (6, 7).

In fact, the concept of “immersive technology” emerged more than half a century ago when the first prototype for immersive human-computer interaction (8). But in recent decades, scholars have had different views regarding the definition of immersive technology (9). For example, Slater (2009) views immersive technology as technology that provides users with a high quality or volume of sensory information (10). These researchers focused on the quality and quantity of sensory information received by users. On the other hand, Lee, Chung, and Lee (2012) perceived immersive technology as a technology that makes the boundary between the real world and the virtual world blurred, creating a sense of immersion (11). These scholars highlight the immersive nature of the technology.

Trending realities in immersive technology – VR, AR and MR

#### *Virtual reality - VR*

Virtual reality is a simulated experience that can be both similar and completely different from the real world at that moment. The roots of VR

lie in a combination of 3-D still images, computer games, computer-aided instruction, equipment simulators, etc. Some VR setups show immersive environments through head-mounted displays that replace or supplement the notion of the real world (6, 7). VR creates an entirely virtual world while allowing users to experience an extremely realistic environment that is a type of illusion with the effect of visual, auditory, interactive, and other sensory-stimulating elements. Its main feature is that users interact only in the virtual world without light sources or real-world interactions.

#### *Augmented Reality - AR*

Augmented reality is the technology that expands the physical world by adding layers of digital information to it. Unlike VR, AR does not create an entirely artificial environment to replace the real one with a virtual one. AR appears in a direct view of an existing environment and adds sounds, videos, and graphics to it. In other words, AR is a real-world view of the physical environment with superimposed computer-generated images, thus changing the perception of reality. Therefore, AR is an enhanced technology that originated from VR, which is about augmenting virtual objects to the real environment (6,7). The term “augmented reality” itself was coined in 1990 and one of the first commercial uses was in television and the military. With the rise of the internet and smart phones, AR is rolling out its second wave and is nowadays mostly associated with the interactive concept. 3D models are projected directly onto physical things or merged together in real time, various AR applications are influencing our habits, social life and entertainment industry. AR apps typically link digital animation to a special “marker” or use GPS in phones to determine location. Zooming happens in real time and in the context of the environment.

#### *Mixed Reality - MR*

Mixed Reality is a combination of VR and AR, here the digital content enables the appreciation of the environment in a 3D way. Subsequently, the digital objects generated by MR technologies can be realized in the physical world (6, 7). As mentioned, VR takes users to an alternative world by offering interactive possibilities. Whereas MR with a blend of VR and AR is changing the way users create, connect and collaborate with a new holographic

experience. MR is therefore the better choice for industries trying to improve their operational efficiency using holographic experiences.

Nowadays, many organizations want to use different types of “immersive experiences” including augmented reality, virtual reality, and mixed reality. But MR has become a common goal for many industries because of its distinctive capabilities compared to other immersive experiences. MR is able to produce applications with the best combination of physical and digital world. That is why many organizations are investing in developing MR applications to provide a digital experience to their users. The main MR devices available in the market are Microsoft HoloLens and ODG headsets.

### 3. A brief overview of emerging immersive technology in education

Successful education and learning has traditionally been based on the relationship between students and their teachers, but the COVID-19 pandemic has made this interaction truly challenging. Therefore, for the past few years, students around the world have had to conduct lessons asynchronously (a.k.a. “independent learning”) using new technologies (6, 12).

In today's digital world, immersion plays a special role. Due to the ability of AR and VR to provide connectivity through digital environments, these tools have suddenly become particularly necessary in for the delivery of education and training (17).

It can be argued that the education industry has the opportunity to benefit from immersive technology as it manages to touch the different

senses of the human being who in the role of a learner. Traditional multimedia systems used in education have primarily addressed only two senses using audio and visual communication channels. But there are five human senses, therefore there is a huge potential on the topic of “learning effectiveness”. In education, AR allows students to visualize text and interactive elements in lectures. Moreover, emerging immersive technologies allow olfactory and haptic media to be used. For example, App “Google Expeditions” allows students to go on “field trips” without leaving the classroom (6, 13-16).

Immersive technologies in education, such as instructional AR and VR, create or mimic the physical world through digital simulation, providing the student with a unique way to experience and understand related concepts. AR and VR also integrate virtual content with the physical environment, allowing the student to engage with MR (16, 17). Therefore, it should be viewed with optimism when technologies such as AR and VR help bridge the gaps in education. These technologies actually offer a range of services to help successfully transform distance learning into a more immersive experience.

### RESULTS AND DISCUSSION

New technologies continue to emerge and transform today's higher education. The digital transformation of higher education system will leverage data and emerging technologies to create powerful new experiences for university teachers and students (17). Technology is already immersed in HEIs. The following table provides some aspect for the future of emerging technologies in higher education:

**Table 1.** *Enabling Ecosystem on Higher Education 4.0 driven by Industrial Revolution 4.0*

	Type	Direction	Description
1	Mobile Devices	First point of access to the Internet	Mobile devices provide ubiquitous connectivity and an array of applications and services that impact almost every facet of Malaysia higher education environment and opens up a huge range of activities that were previously inaccessible.
2	IoT Platforms	Bridge between the devices' sensors and the data networks	Internet of Things (IoT) platforms which is positioned to revolutionize the entire Malaysia higher education value chain by providing an unprecedented level of connectedness and functionality.
3	Location Detection Technologies	Detect its current location to control events and information	Location is detected through the use of various sensors and methods of calculating geographical location such as through GPS technology. MOHE can add value by enhancing

			products and services offered by institutions with location detection technologies.
4	Advanced Human-Machine Interfaces	Method of teaching and learning for modelling and simulation of the real situation.	Advanced Human-Machine-Interface is considered as an interface that allows humans to interact with the machine. This method can be deployed to games for education, simulation based training applications and intelligent tutoring systems.
5	3D Printing	An effective way to enrich learning in virtually any discipline.	Nothing conveys an idea better than holding it in your hand. An excellent match for STEM curriculum projects at undergraduate and graduate levels. 3D Printing can be used with virtually all types of 3D CAD software.
6	Smart Sensors	Towards smart education environment	A smart sensor is a device that takes input from the physical environment and uses built-in compute resources to perform predefined functions upon detection of specific input and then process data before passing it on.
7	Authentication & Fraud Detection	Secure all digital transactions.	The ability to learn about the latest trends in fraud, either internally through sophisticated data analysis or through external sources. Using up-to-date fraud information, MOHE can rapidly respond to new types of fraud and makes changes to their systems.
8	Big Data Analytics & Advanced Algorithms	Faster, better decision making	With the speed of business analytics tools, combined with the ability to analyze new sources of data, organizations are able to analyze information immediately – and make decisions based on what they have learned.
9	Augmented Reality/Wearables	Bridging the gap between the virtual and physical worlds	Augment changes the way we see, imagine, and learn about the world around us. The augmented reality (AR) app and platform enables students and teachers to visualize 3D models in the real environment, in real time, and at scale.
10	OMNI Channel Customer Interaction	Continuous experience across different channels	An omni-channel platform for higher education puts postsecondary institutions in line with the needs and demands of their students – the majority of whom are digital natives – and helps them soar into the digital age.
11	Cloud Computing	Delivery of computing services	The cloud computing is connected to the internet and allows for remote access to services, apps, and stored data.
12	Cyber-Physical Systems	Cyber and physical components deeply inter-point	A cyber-physical system is characterized by a physical asset, such as a machine, and its digital twin; basically a software model that mimics the behavior of the physical asset.

Source: Prepared by the author of this study based on the literature review

If we deepen the discussion on the impact of emerging immersive technologies on Higher Education 4.0, we will come to the conclusion that the logic of the education system needs to be reversed. Therefore, the system must adapt to the learner, not the learner to the system. This is the essence of personalization. Some relevant and important questions in this context may be: *How will the lecturers teach/students learn?; What will the lecturers teach (method, content)?; How will the learning space look like?; What are the role of the lecturers/students?; What are the attributes of the students/lecturers?*

## CONCLUSION

In conclusion, immersive reality technologies, including VR, AR and MR, promise to allow learners to immerse themselves in simulated environments and experience the interaction between physical and virtual objects. The study shows that immersive technology can effectively support the process of teaching complex theories, concepts through object visualization and further used for technology education. Simulated objects can be picked up, viewed from all sides, navigated around, heard, smelled, touched, picked up and explored in many sensory ways. Indeed, educational applications of the technology are encompassed

in almost all areas of science and practice; however, the main limitation of all these effects lies in the emerging technology that supports them. Finally, immersive technology is a type of emerging technology and has the potential to improve HEIs.

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