XR FOR PED

# SHOULD VIRTUAL LEARNING BECOME A REALITY?

## Policy issues and best practice for applying immersive technologies in European education


GREEN PAPER

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Staatlich anerkannte, private Fachhochschule des Mittelstands (FHM)

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European Network for Transfer and Exploitation of EU Project Results

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Co-funded by the Erasmus+ Programme of the European Union

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Mixed Realities for Pedagogues

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# IMPRINT

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Co-funded by the Erasmus+ Programme of the European Union

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein. Project number: 2020-1-SI01-KA226-HE-093633

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# ABBREVIATIONS

| | |
|---|---|
| 2D | two-dimension |
| 3D | three-dimension |
| ADHC | attention deficit hyperactivity disorder |
| AI | artificial intelligence |
| API | application programming interface |
| AR | augmented reality |
| BIM | building information modelling |
| C-19 | coronavirus disease 2019 |
| DOF | degrees of freedom (3/three or 6/six DOF) |
| EC | European Commission |
| EDIHs | European Digital Innovation Hubs |
| EdTech | technology-supported education |
| EFL | English as a foreign language |
| EPUB | electronic publication |
| EQAVET | European Quality Assurance Reference Framework |
| EQF | European Qualification Framework |
| EU | European Union |
| H2020 | Horizon 2020 (EU Framework Programme) |
| HE | higher education |
| HEI | higher education institution |
| HMD | head-mounted display |
| HPC | high performance computing |
| HR(D) | human resources (development) |
| HVET | higher vocational education and training |
| ICL | intercultural learning |
| ICT | information and communication technologies |
| IFC | industry foundation classes |
| IoT | internet of things |
| IEEA | Institute of Electrical and Electronics Engineers |
| IT | information technologies |
| LIDAR | light detection and ranging |

| | |
|---|---|
| KUL | Katholic University Leuven |
| MOOC | massive open online course |
| MR | mixed reality |
| OER | open educational resources |
| PC | Personal computer |
| SME | small and medium-sized enterprise |
| STEM | science, technology, engineering, mathematics |
| SVR | social virtual reality |
| US | United States |
| VET | vocational education and training |
| VR | virtual reality |
| XR | extended reality |

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# EDITORS‘ NOTE

— Mitja Kranjčan, Michael Schwaiger —

# Immersive learning

## Is technology ready for it? ... and are we?

This policy paper is one of the main outcomes of the EU project *Mixed Realities for Pedagogues - XRforPED* (www.xr4ped.eu) which was funded by the *Erasmus+ Programme (https://www.eacea.ec.europa.eu/grants/2021-2027/erasmus_en)*[1]. It was produced at the end of the project and collects the experiences and lessons learnt during the project work to share them with a wider public for the benefit of all. Above all, it is addressed to educational policy makers and stakeholders. With our lessons learnt, suggestions and recommendations, we would like to inspire and encourage them to undertake further developments in the field of digital learning in general, and in the field of immersive learning in particular. With this paper, we would like not only to initiate further developments at the level of education policy, but above all to make it clear that it is mostly not the political will or the motivation of teachers or learners that is lacking - but rather the comprehensive equipping with digital infrastructure, hardware and software as well as the comprehensive training of teachers and the provision of IT specialists that is required. Europe needs major investment in its digital systems, especially those related to education, to keep pace with global developments. This may certainly be expensive and cost a lot of money at present - but it will be much more expensive if Europe loses out in this area and falls behind its main competitors in America and Asia.

However, as a start, let us look back at how this project came about in the first place. The idea to the XRforPED project arose from two different observations:

First of all, this project was conceived against the backdrop of the first massive Corona wave that spread to Europe in spring 2020. Most educational institutions were closed for months, yet somehow classes had to continue. This meant that large areas of teaching as well as communication with colleagues and parents had to be carried out remotely and digitally. Many of Europe's teachers, trainers and lecturers had their first experience with digital learning and communication platforms, document archives or data collection and assessment tools. When our project started in June 2021, we wanted to learn about the educators' experiences with lockdown-related distance and digital learning, what media and tools they mainly used and to what extent this has influenced their attitudes towards digital learning in general. These are crucial questions, not only because educators played a key role in maintaining social and professional life during the COVID-19 pandemic, but without their support, enthusiasm and competencies, a comprehensive and rapid digitisation of our society would be more difficult to achieve. Of course, particularly children will grow up anyway as digital natives without help from teachers, but it is still necessary to provide them with the appropriate digital knowledge and skills that will enable them to successfully enter the world of work and participate meaningfully in social and political life. It is much more the educators who need professional training in digital learning and teaching. It was also an interesting issue which we were collecting data about.

The second reason was that immersive technologies (virtual reality/VR, augmented reality/AR, mixed reality/MR, extended reality/XR)[2] are becoming more and more established in our lives. While for a long time they have existed exclusively in the fields of leisure and entertainment, their potential has now been discovered for many other areas, including education.

The history of XR in education and learning in Europe dates back to the early 2000s, when the first VR and AR applications began to emerge in the education sector. These applications were primarily focused on providing a visual and interactive experience to help students better understand complex concepts and ideas. During subsequent years, XR technology continued to gain traction in Europe's education systems. In 2016, Finland became the first country to introduce VR headsets in its schools, with the aim of enhancing learning and promoting digital literacy. Other European countries soon followed suit, and meanwhile there is growing number of apps introducing XR technology in education systems.

In recent years, the COVID-19 pandemic has accelerated the adoption of XR in education and learning in Europe. With the shift to remote and hybrid learning, XR has provided a way for students to engage in immersive and interactive learning experiences from their homes. The outlook for XR in education and learning in Europe is promising, with the technology expected to play an increasingly important role in the years to come. Many experts enthusiastic about immersive technologies predict that XR technologies will be widely used in education and training by 2025, with the potential to transform the way we learn and work.

Above all, they point to the potential and benefits of XR in education, such as:

☺ Real-world experience: XR technologies can provide students with simulated real-world experiences that can help prepare them for future careers and real-world situations.
☺ Immersive learning: XR technologies can provide a highly engaging and immersive learning experience, allowing students to explore and interact with virtual objects and environments that are otherwise inaccessible or difficult to experience in the real world.
☺ Flexibility: XR technologies can be used in a variety of educational settings, from traditional classrooms to online learning environments, making it easier for educators to deliver high-quality educational experiences to students regardless of location.
☺ Personalization: XR technologies can be tailored to individual student needs, allowing for personalized learning experiences that are tailored to each student's unique learning style and pace.
☺ Enhanced retention: XR technologies can help students retain information better by providing them with a more memorable and engaging learning experience.
☺ Increased safety: many apps allow training in situations or with machines that could be very dangerous in the real world. This not only helps to prevent serious accidents and injuries, but also avoids damage to machines.
☺ Repeatability: in XR, the same tasks can be repeated or learned over and over again; one can interrupt tasks and continue them at other times and places.
☺ Protected learning space: especially virtual spaces allow people to practice and learn alone; many people are shy in groups or feel uncomfortable performing in the presence of others, especially if there is something they do not know yet. VR makes it possible to perform in front of a virtual audience and still be alone.
☺ Cost-effectiveness: XR technologies can reduce the costs associated with traditional hands-on learning experiences, such as field trips or laboratory experiments, by providing virtual alternatives that are less expensive and more accessible.
☺ Improved collaboration: XR technologies can facilitate collaboration and teamwork among students, allowing them to work together on projects and assignments in a virtual environment.

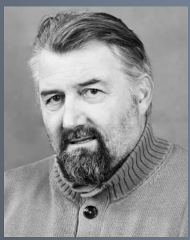
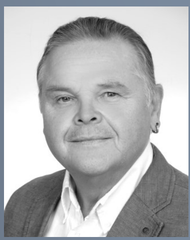
However, there are also educators who have a less positive view of the importance of XR in education. They are mainly concerned with the disadvantages and barriers to immersive learning and put forward the following arguments:

☹ Costs: Although costs have dropped considerably in recent years (e.g., one can purchase a good-quality stand-alone VR device for 300-400 Euro, and many apps are free or cost only a few Euro), some institutions still may not have the resources to invest in them. This can limit the availability of immersive learning experiences to only certain students or schools.
☹ Accessibility: Some students may have physical or sensory disabilities that make it difficult for them to engage with immersive learning technologies. It is important to ensure that these technologies are accessible to all students.
☹ Technical issues: Immersive learning technologies can still be complex and may require specialized knowledge to set up and operate. Technical issues, such as glitches or malfunctions, can disrupt the learning experience and require skilled technicians to resolve.
☹ Content limitations: The content available for immersive learning experiences may be limited or not aligned with the curriculum. It is important to ensure that the content is educational, age-appropriate, and aligned with learning objectives.
☹ Over-reliance on technology: Immersive learning should not replace traditional teaching methods, but rather be used as a complementary tool. Over-reliance on technology can lead to a reduction in critical thinking and problem-solving skills.
☹ Safety concerns: Immersive learning experiences can create a sense of presence or immersion, which can be both beneficial and potentially dangerous. Students need to be taught how to use the technology safely and appropriately.
☹ Ethical considerations: Immersive learning technologies can raise ethical concerns around data privacy, surveillance, and the potential for addiction or overuse.
☹ Pedagogical challenges: Immersive technologies can also present pedagogical challenges for educators. For example, it can be difficult to design learning experiences that effectively integrate im-

mersive technologies with traditional teaching methods. Additionally, some educators may not have the necessary technical skills to effectively use immersive technologies in the classroom.

In our project group we are aware of both the topicality of the issue and the controversial discussion among educators. Above all, we also know that most educators may have heard of immersive technologies, but have never used them themselves - and certainly not in the classroom. We think it is highly appropriate for educators to learn about immersive technologies in a timely manner and to find out whether or not, in which areas and under which conditions immersive learning makes sense and can be used in teaching, especially. Therefore, a further goal of our project was to find out to what extent trainers and teachers are aware of immersive technologies and whether or not they have experience and/or interest in using them in the classroom.

Regardless of what educators decide, whether they will quickly embrace and actively use these new technologies or remain sceptical and not see much benefit in immersive learning - the important thing is that the XRforPED project will give them important insights and knowledge about immersive learning and teaching and enable them to form their own opinions about it.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[1] *Funded by the Slovene National Agency CMEPIUS under the project number 2020-1-SI01-KA226-HE-093633.*

[2] *With regard to terminology, there are a variety of different approaches which we do not wish to go into in depth; we consider the following basic differentiation to be sufficient:*

- *Virtual reality (VR) refers to a simulated experience that can be similar to or completely different from the real world. It is typically achieved by wearing a headset that fully immerses the user in a virtual environment, often using motion-tracking technology to allow the user to interact with objects in that environment.*
- *Augmented reality (AR) overlays virtual objects onto the real world. AR typically involves using a smartphone or tablet camera to display virtual objects or information on top of the physical world. For example, an AR app might allow you to see how a piece of furniture would look in your living room before you buy it.*
- *Mixed reality (MR) combines elements of both VR and AR to create a seamless blend between the real world and virtual objects. MR typically uses advanced technologies such as depth-sensing cameras, which can track the user's movements and adjust the virtual environment in real-time to create a more convincing and interactive experience.*
- *Extended reality (XR) is an umbrella term that encompasses all of these technologies, as well as others such as haptic feedback and 360-degree video. XR is typically used to describe any technology that creates a sense of immersion and presence beyond what is possible with traditional screens and displays.*

# KEYNOTES

# XR/VR/AR:

## Perspectives for teachers' education

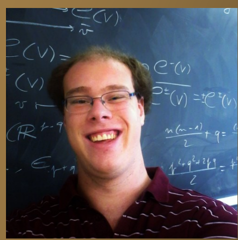
TRANSFORM 4EUROPE

In recent decades, we have witnessed rapid technoligical developments, which became even more important during the Covid-19 pandemic, especially in education. Educators had to rapidly shift from traditional face-to-face teaching to online teaching. This transition was not always smooth and different issues emerged. For instance, many researchers explored educators' digital skills, finding that many teachers lack basic knowledge and digital literacy.

XR/VR/AR technologies are used in various domains, including in education. In particular, these technologies are often used in classrooms to enhance students' meaningful learning. Through manipulation and immersive learning, it is expected that students retain more information and deepen their learning. Despite the positive effects that this kind of technology might have on students' learning and understanding of the teaching material, educators seem to have little knowledge about how to implement XR/VR/AR technologies. In particular, from a pilot survey, it emerged that the majority of teachers did not have any experience with it and had not used it in their regular classes. Although believing that the usage of this kind of technology might be efficient and engaging, educators expressed their concerns about not having enough knowledge about how to this technology works and how to use it effectively in their classes. From the survey results, we concluded that there is a real need to educate our educators. In particular, educators and prospective teachers need to acquire basic knowledge about XR/VR/AR technology and the skills that will allow them to effectively and confidently use these technologies within their regular pedagogical activities.

Our goal was therefore to look at how XR/VR/AR can help in pedagogy. Even though XR was originally used for games, it has now started to be implemented in different areas of learning and developing new skills. Apps in XR that contribute to learning allow us to be everywhere else in the world but still be in our rooms. Let us think about a history lesson on ancient Greece and, at the same time, actually being there. Would it not be useful for students not only to hear but to experience history? Or geography, or even physics, biology, or anatomy. XR technology has a wide range of usages within education. It can be applied in primary schools, high schools, and higher education and it can also help people with disabilities and special needs to learn and overcome the struggles of everyday life. In the past, these technologies were not so accessible and were very expensive. But with the growth of XR and virtual technology development, it has become more affordable and many companies have started to produce their own headsets, so that they can nowadays be bought at a fair price for an amazing experience. The Covid-19 epidemic caused people to stay in their homes, unable to socialize or learn in person. By combining XR/VR/AR technology and distance learning we can achieve greater things.

The main aim of the project was therefore to develop specific learning modules, comprised of theoretical lessons and practical workshops, seminars, and tutorials, that might help educators to obtain an overview and practical knowledge about the implementation of XR/VR/AR technologies in education. Through collaboration with partners, a multifaceted course was developed. Hopefully, the course will provide educators with all the knowledge they need to use this kind of technology in their classes.



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# The new frontiers of education:

## Eight key principles

In today's rapidly evolving world, education is at the forefront of innovation and transformation. The New Frontiers of Education brings together eight key principles that underline the importance of innovative approaches, technologies and trends in education. These principles shape the transformative potential of education and contribute to improving learning experiences and outcomes:

**Integrating Edutainment:** The principle of integrating Edutainment recognizes the power of combining education and entertainment. The use of entertainment elements such as games, videos and multimedia makes learning more enjoyable, interesting and effective.

**Integrating Game-based learning:** Game-based learning exploits the motivation and engagement inherent in games to facilitate learning. By incorporating game elements, learners actively participate, problem-solve, think critically and collaborate, leading to meaningful and immersive learning experiences.

**Using gamification:** In gamification, game mechanics such as scoring systems, leaderboards and badges are used in non-game contexts such as education. This principle motivates learners, increases their engagement and fosters a sense of achievement by complementing educational activities with game-like elements.

**Use of immersive technologies:** Immersive technologies, including virtual reality (VR) and augmented reality (AR), offer interactive and experiential learning opportunities. These technologies, which immerse learners in a virtual environment or overlay digital content with the real world, increase engagement and enable new ways of exploring educational material.

**Use a constructivist approach towards learning**: Constructivist learning emphasises active participation, engagement and the construction of knowledge through practical experiences. This approach encourages learners to explore, discover, and connect new knowledge to existing understanding and create their own meaning, fostering deep learning and critical thinking skills.

**Problem-based learning** focuses on solving real-world problems, which promotes critical thinking, problem-solving skills and collaboration. By presenting students with authentic and complex problems, it encourages them to explore, analyse and apply knowledge, preparing them for real-life challenges.

**Personalised learning experiences**: personalised learning adapts lessons and learning experiences to the needs, interests and abilities of the individual learner. This principle uses technology and data to provide personalised learning paths, resources and assessments that empower learners, fostering autonomy and suit different learning styles.

**Developing digital literacy and citizenship**: Digital literacy and citizenship are key principles in the digital age. Learners need the skills to navigate digital information, to critically assess its credibility and to participate responsibly and ethically in the digital world. This principle equips learners with the necessary competences to use technology effectively, to evaluate digital content and to participate responsibly in a global society.

These eight key principles are the foundations of the new frontiers of education. They promote critical thinking, problem-solving, and collaboration skills essential for success in the 21st Century.

It is crucial to provide educators with the necessary resources, training and support to effectively embrace these new frontiers.

By embracing the new frontiers of education, we can create inclusive, dynamic, and learner-centred environments that prepare students for the challenges and opportunities of the future. Together, let us embark on this exciting journey of educational transformation and unlock the full potential of our students.


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# Immersive competences

## in a context of people performance solutions

Today digital based learning and digital based literacy need to be related to the general possibilities of immersive teaching and learning in Europe, as extended reality has enormous complexity and also connectivity to so many other digital learning methods. Our individual experience with learning by extended realities has informed me about new concepts dealing with alternative forms of learning and training with some innovative perspectives concerning professional, political or institutional issues and approaches.

Therefore, it can be said that immersive competences result from very complex learning environments. The complexity arises from the digital technologies and their application in 3D contexts or other extended reality technical frameworks. This represents a critical point, being the question of the current costs of these learning environments. But it is to be expected that the costs for extended realities will decrease in the future. But only then will extended technologies be a permanent solution allowing for very new digital based approaches necessary for effective immersive learning in schools and HEIs.

Furthermore, it can be clearly observed that extended realities have high potential for stimulating students in their daily learning processes and procedures because digital learning environments are highly capable of connecting to the living environment of students in schools and universities, as well as of vocational students. The daily usage of digital media makes it easier for students to use and apply extended reality technologies. They already use media that influences their everyday lives and can therefore fall back on existing life and behavioural patterns. Living and learning can therefore be unified with the digital context of extended realities.

XR technology is the umbrella term used for virtual reality (VR), augmented reality (AR), and mixed reality (MR), as well as for the future realities that immersive technologies might create. Therefore, XR must cover the full spectrum of real and virtual environments concerning teaching and learning. Against this background XR technology must be easy to use for both the instructor and the student. This is partially achieved through increasing the standardization of interfaces and functionality. Furthermore, XR technology must enable pedagogy that is not available through existing instructional methods. What we need are more constructive learning methods! Last but not least the time needed by the students for all extended realities is very important in the conception of time-on-task. Like other technologies applied in blended learning, XR promotes increased engagement for students interacting with educational content. And like other developing technologies, XR promotes self-directed learning through the concept of self-transformation and experiential learning. At the heart of the requirements for trainers and education institutions must be an adequate pedagogical concept and sufficient resources to engage deeply with immersive technologies.

Of course, immersive technologies can contribute to the progressive importance of digitalized education, for learning and teaching in different digital settings. This affirmation is based on the relevant knowledge of the main forms of immersive technologies and also on the correct use of key technical terms. And, of course, it will also become more important to be aware of all possible barriers in order to continue the use of virtual reality technologies within educational settings. With extended reality technologies we have more possibilities for motivating and stimulating all processes of development concerning learners' interests.


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# Europe should lead on immersive education technology

The future of computing will be immersive. New technologies are replacing the current, somewhat crude VR and AR headsets and are overtaking smartphone and 2D screen-based computing experiences.

Radical developments are giving us a glimpse of the future. In 2019, Oculus Quest created a new category for VR HMD (Head-Mounted Displays) - the powerful 6DOF (degrees of freedom) standalone. Data suggests that this category is very different from the wired PC VR. People are spending considerably more time in VR and return to consume content more often.

In terms of AR/MR we will see the big wave hit during the next five years as behemoths like Meta Platforms (Facebook) and Apple are positioning themselves to fight over the new immersive market. These companies employ thousands of people who are constantly looking to find exciting new ways of defying the constraints of the physical world and, I am sure, they will deliver us something amazing in a couple of years.

Withing Nordic XR solution providers, we are seeing a major shift of enterprise segment attitudes because of 1) technological development and 2) the urgent need to find productivity gains in a sustainable way. In many ways, sustaining this momentum is critical for the future of Europe.

In order to realise their goals, enterprises require capable and educated people. Major long-term trends and the current situation are driving the need for more effective ways of preparing people to enter the workforce. Thus, improving our education system is critical, as it needs to be able to evolve and help enterprises take advantage of these emerging technologies.

Currently the majority of investment activity as well as major leading companies investing in this sector are in the USA and China. The next five years will be very formative in the sense that the big race for the next computing platform will be fully on. We hope to see European companies taking the initiative and displaying leadership in both developing hardware and platform solutions to enable the immersive future. As the platform game is still on, we should be active in creating alternatives to the largest players Microsoft, Huawei, Apple and Facebook who are playing a long game and who are inching towards the same type of dominance that they have today with cloud platforms.

European Union activities are critical in creating such an environment that can facilitate the emergence of world-class technology companies that can actually compete in the global platform game. Cross-country collaboration on major technology development efforts creates the basis for a more unified sector that can take on the challenges posed by both the East and the West. We believe that the next Horizon effort should focus major resources at projects that help to take the European XR sector forward.

It is clear that during the next five years European higher education institutions have the opportunity to accelerate the diffusion of this technology. The XRforPED project has created a curriculum that can be used as a first step for participating in the development of the immersive future in Europe. Being amongst the first to adopt these technologies will give us the key to not only more effective and engaging education, but also to unlocking the expected productivity gains that will be the basis for ensuring Europe's prosperity in the 2020s and beyond.

The future is unfolding in front of our eyes as technologies converge in unexpected ways. Immersive technologies will help us address the largest challenges of our generation by transforming the ways we experience the world and giving us the tools to make our world smaller, in a positive way.


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Co-funded by the Erasmus+ Programme of the European Union

# XR in engineering curriculum

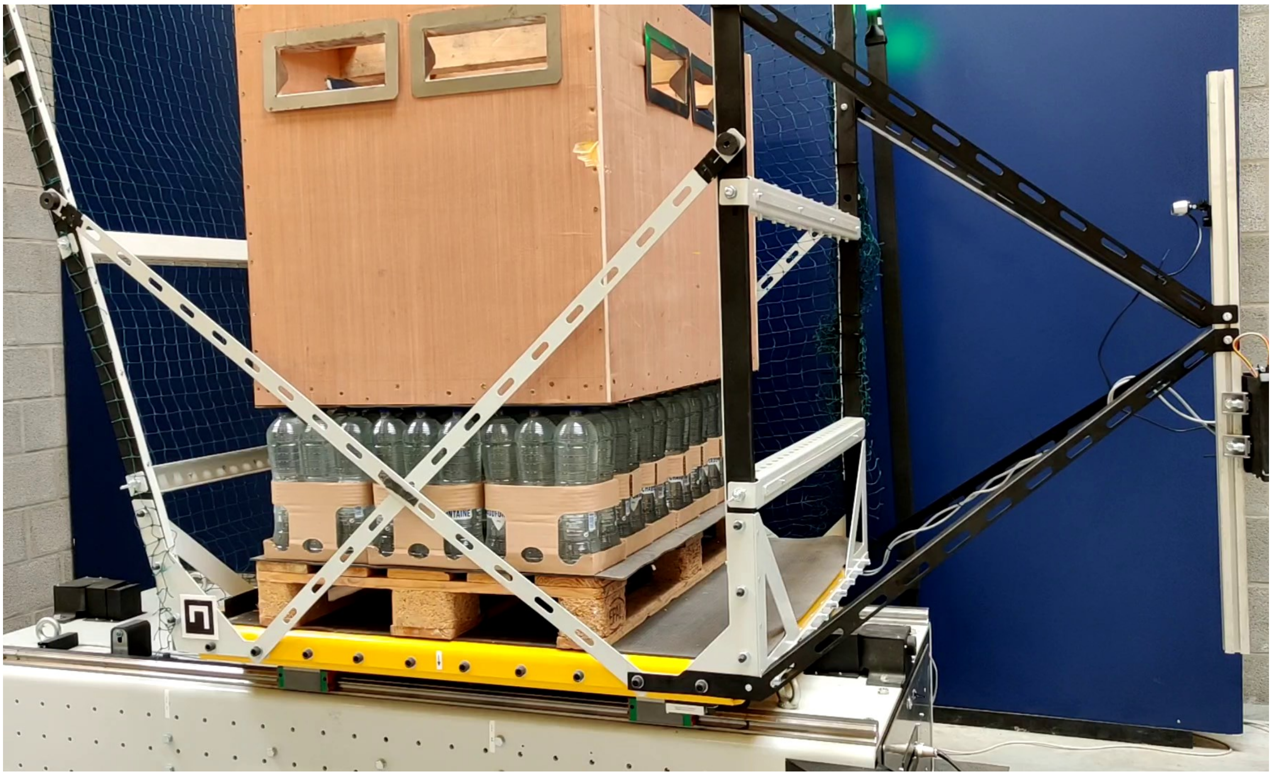
KU LEUVEN

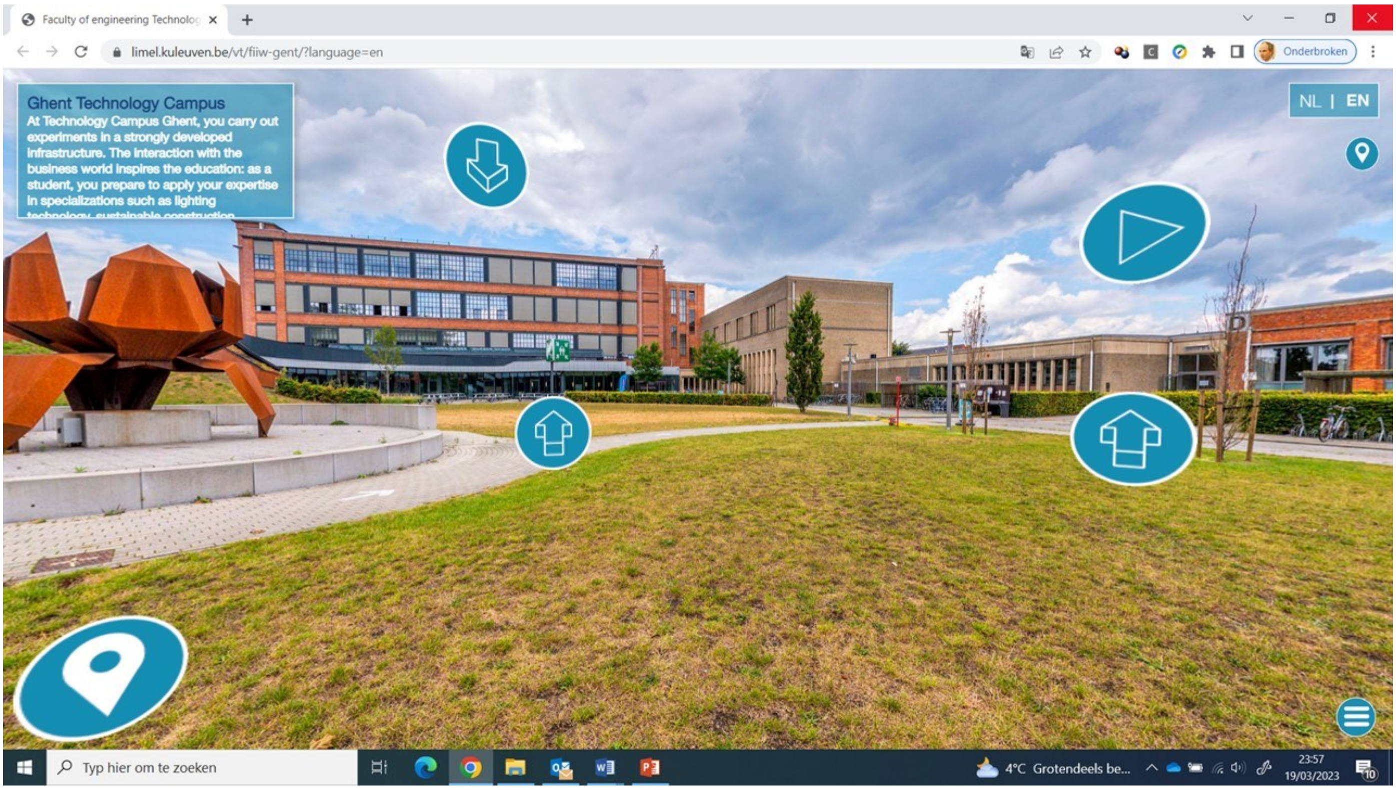
In recent years, KU Leuven 's Technology campus in Ghent has been involved in several XR projects. The initial motivation to get involved in these projects about XR technology was twofold. Firstly we always want to discover and exploit new technologies in order to know their benefits and to experience their opportunities for education. Secondly we already knew there are large opportunities for using XR technologies in the area of logistics, which is our main research domain within the Mechanical department.

Although the adoption of XR technology in industry has been progressing rather slowly, our job as an educational institution is to explore the possibilities and limitations of this technology, find meaningful applications and transfer this knowledge to our students and to the working sphere. Today, we can already report some concrete achievements.

The Production Management course (6ECTS) has a substantial part about Lean Management. It is clear that many lean companies can make further great leaps forward by also making their product design process more efficient. On 22nd June 2022, the KU Leuven Lean Learning Academy organised an Open Access Day about Lean Design. The course was enriched by a Lean Design game and a separate lecture and demo on the use of XR in new product design. From now on, this will be part of Lean Management classes.

One of our researchers, Jannes Roman, has developed and built a machine for testing the stability of palletised goods during e.g. an emergency stop or an evasive manoeuvre during lorry transport. The machine has been designed in SolidWorks. After installing an extra SolidWorks add-on, he managed to create a file that can be viewed through VR glasses. The file allows for virtually looking inside the machine and checking manufacturability, safety, ergonomics and maintainability. From now on, these checks can be performed and discussed with all stakeholders before a new machine is built. This allows for finding many design improvements during the early stages of new product development and






reduces the number of physical prototypes that need to be made.

At KU Leuven, the faculty of Architecture and the faculty of Engineering Technology have launched a joint course called ‘creative makers’ in which interdisciplinary teams of master students develop creative solutions for problems in society using state of the art technology like Internet of Things (IoT) devices, cloud computing, LIDAR scanning,… and also AR/VR technology. We have equipped a room with state-of-the-art XR hardware and software to bring this technology to our students and researchers.

Furthermore, in the centre of Ghent the Winter Circus, a historic building where circus animals used to hibernate, has been renovated and will now be used as a meeting point for organisations fostering entrepreneurship, creativity and state-of-the-art technology. KU Leuven participates in this initiative and will exploit a dedicated room to demo XR technology and applications to visitors.

And yes, KU Leuven has also created a virtual tour of all campuses using 360° photos: https://limel.kuleuven.be/vt/fiiw-gent/?language=en. Each tour uses info buttons for those who want to know more about a location and arrows to guide you to another building or laboratory. The web application gives an impression of the green spaces and the buildings on the campuses and the modern equipment in the laboratories.

In conclusion, we can state that the XR4Ped project has allowed us to further introduce XR technologies into our organisation, into education and into our research activities. KU Leuven is committed to constantly investing in the exploration of new technologies and implementing them whenever useful.

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# MATHESIS:

## Attracting students' interest in Mathematics and improving their skills, comprehension and performance with the use of a virtual reality educational platform

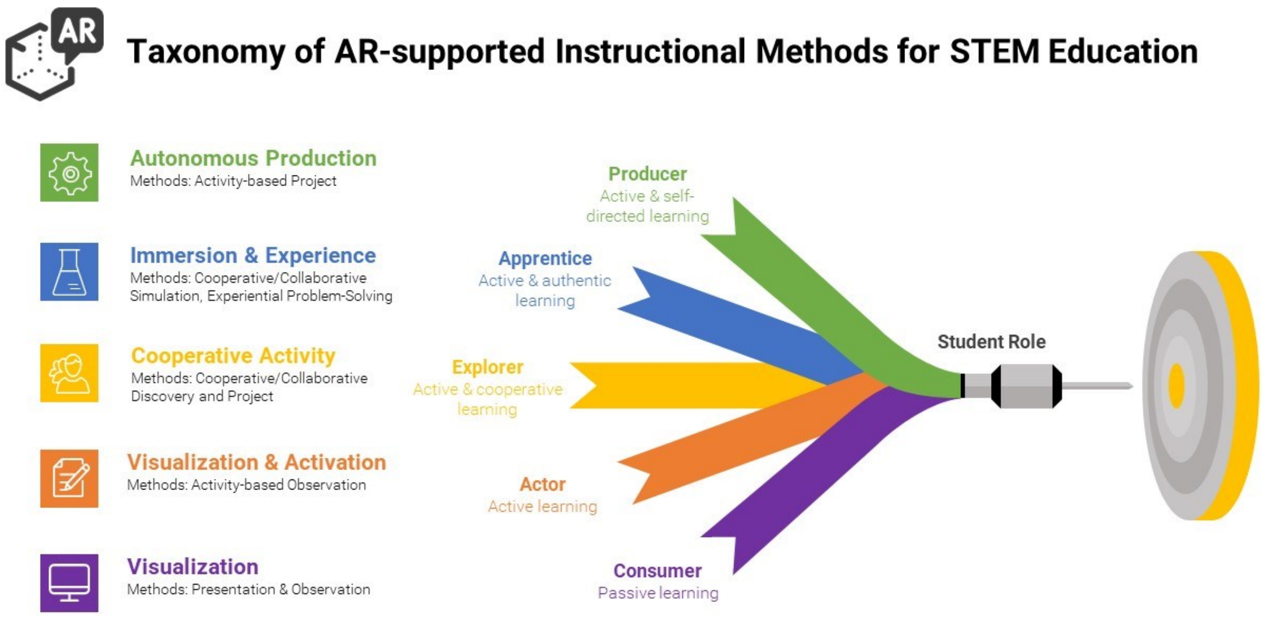
**The MATHESIS project addresses the challenges associated with traditional mathematics education and proposes a new approach to teaching and learning mathematics that is engaging, interactive, and immersive.**

Mathematics is a critical subject in modern education, forming the foundation for numerous fields and careers. However, traditional approaches to teaching mathematics can be challenging for some students, leading to disengagement and limited success. In this spirit, by considering taxonomies for learning using XR technologies (Mystakidis et al., 2022), the aim of the MATHESIS project (https://projectmathesis.eu/) is twofold: on the one hand, to provide educators and instructional designers with a comprehensive framework for integrating Virtual Reality (VR) into mathematics education and, on the other hand, to offer learners a series of VR-based modules that visualise mathematical concepts and problems in a more interactive and engaging way.

**Observations & Discoveries**

The key-findings of this pilot research study (Christopoulos et al., 2023) are as follows:

- **No evidence of immersion explaining increases in mathematical skills.** Most studies interested in Game-Based Learning (GBL) assume that immersion/flow is the mechanism that explains the effects of GBL. The results of this current study contrast with the wider literature findings indicating that there is no direct association between them.
- **GBL in VR might particularly increase mathematical fluency.** By providing a play-based VR environment that stimulates rapid responses, creativity, strategy and direct feedback can foster a deeper understanding of mathematical principles which, in turn, helps students to develop fluency in different situations.
- **No gender differences related to performance are identified.** The fact that the effect of GBL on performance was not affected by gender means that it can be used with equal success for boys and girls.
- **Correlations between learning strategies and**




Source: Mystakidis, S., Christopoulos, A., & Pellas, N. (2022). A systematic mapping review of augmented reality applications to support STEM learning in higher education. *Education and Information Technologies, 27*(2), 1883–1927. https://doi.org/10.1007/s10639-021-10682-1


**performance.** The fact that negative correlations were identified between *rehearsal and planning* and the performance outcomes is justified after considering that learners with greater mathematical difficulties feel more need to practice. With respect to *monitoring, regulation and help seeking*, it might be that students were unable to correctly reflect on how frequently they had actually used these strategies.

**Implications**

- **Pupils' mathematical ability increases by introducing GBL approaches.** The large effect that was obtained after integrating the pilot programme, on a completely voluntary basis over only a 4-week period, makes GBL a great addition to traditional learning programmes which usually show smaller effects.
- **Mini-games are effective for short-term engagement but might not be as efficient for sustained practice.** Even though we could not confirm any effect on engagement and on the presence of mathematical improvements, a possible explanation might be students' willingness or fatigue to continue playing certain games over longer periods of time (Christopoulos et al., 2022).

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# Poppr:

## The future of XR in education and how to best support its implementation

poppr

In recent years, the education sector has experienced a paradigm shift in the way students learn and retain information. The advent of e-learning platforms, online courses, and digital tools has made learning more engaging and interactive than ever before. However, one technology is disrupting the education industry and is promising to revolutionize the way we learn: Extended Reality (XR).

We must ask ourselves if the traditional way of teaching and learning, through books and educational films, is still the most effective method for capturing students' attention. Considering that we now spend 80% of our daytime in front of all kinds of screens, why not make learning more interactive and enjoyable by using Extended Reality? It is difficult to find someone who is not interested in discovering what lies behind a VR headset, as this new technology is genuinely exciting!

XR has the potential to transform the educational and professional sector by making learning more immersive and interactive. XR can help students understand complex concepts by allowing them to visualize abstract ideas. Creating informative and engaging lessons and hands-on training is a challenging balancing act, but XR can make this possible. For instance, medical students can use XR to simulate surgical procedures and better understand the anatomy of the human body.

In professional settings, the use of XR can also be very beneficial in increasing knowledge retention. For instance, a proof-of-concept safety training in VR for the energy supplier Engie required technical staff to go through a range of safety best practices and find potential hazards in a one-on-one replica of their real workplace, created thanks to photogrammetry. In this case, the use of gamification increased learning retention significantly.

Moreover, XR can help students explore historical events and places that are not accessible in real life. Students can use XR to travel back in

time and experience historical events first-hand, which can help them develop a deeper understanding of history and culture. Modern storytelling techniques and cutting-edge technology like AR can unlock interactive guides at certain points of interest like museums, statues or historical sites, making the experience more memorable.

XR can also help students with special needs, such as those with autism or ADHD, by providing a more engaging and sensory-rich learning experience. XR has already proven to help students with autism develop social skills by simulating social situations in a safe and controlled environment.

To fully realize the potential of XR in education, it is essential to integrate it into curricula. This means using XR to enhance learning outcomes across all subjects, from maths and science to history and literature. By integrating XR into curricula, we can provide students with a more engaging and immersive learning experience that improves their retention of knowledge and understanding of concepts. We can also provide more opportunities to learn about this exciting technology, which is here to stay and will create a lot of job opportunities in the future.

Local authorities and policymakers play an important role in supporting the adoption of XR technologies in education. They can provide funding and resources for XR training programs, in all possible forms, and make it available to all age groups and socio-economic backgrounds to learn through XR. They can also work to build partnerships and collaborations between schools, educators, and technology companies to ensure that the use of XR technologies is integrated effectively into curricula and is aligned with educational standards and objectives.



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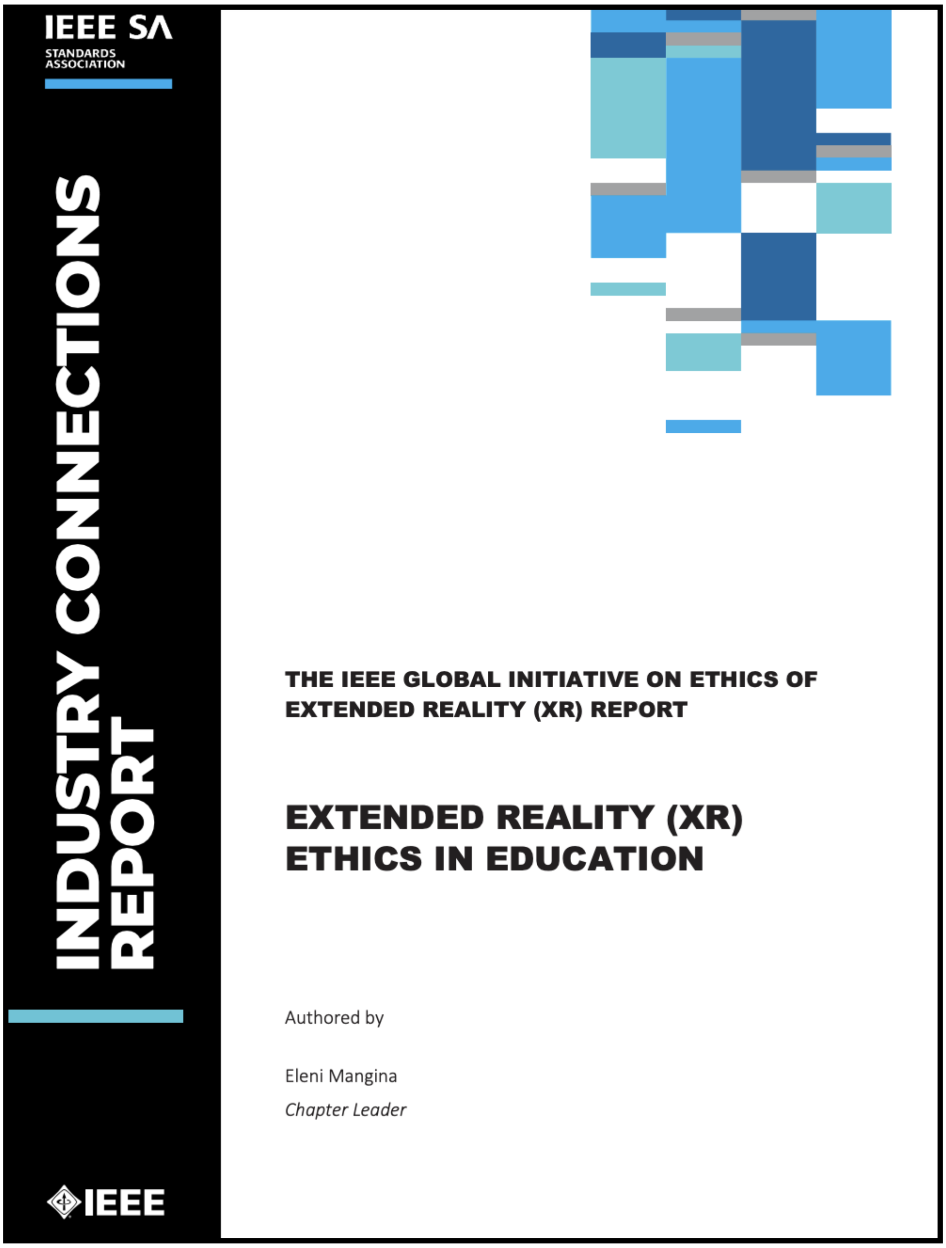
# XR ethics in Education:

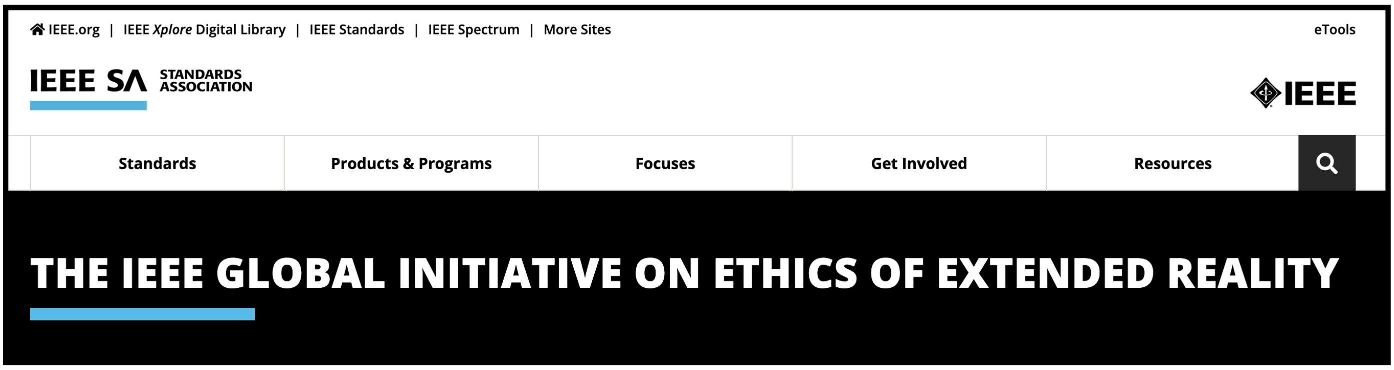
## Challenges and recommendations

I am the vice-chair of the IEEE Global Initiative on XR Ethics and the executive editor and author of the IEEE White paper on XR Ethics in Education. Immersive technologies (XR) in education offer a number of opportunities (e.g., facilitating Authentic Learning Experiences; empowering learners as creative designers and makers; integrating immersive storytelling in learning; integrating immersive learning in STEM; fostering collaboration with Social VR and other XR technologies; cultivating immersive and blended-reality learning spaces and laboratories; developing the capabilities of the future workforce), but convergence with artificial intelligence (AI) can have a profound impact upon ethical considerations for applications at all levels. Utilizing AI in XR can reshape human experience and social interactions in education, but one of the barriers for adoption is the lack of policy on XR ethics for education. Ethics XR for education is a broad topic that needs to be present within the different levels of education.

Policies and recommendations for Digital Learning 2020 exist and they relate to reporting on practice in early learning and care; primary and post-primary contexts, with minimum reference to the prospect of XR educational systems. The focus within practices of digital learning for adoption of ethically XR systems should include:

- XR Digital Strategy for Schools
- XR Digital Teaching and Learning Frame work
- Ethically approved XR Teaching and Learning methodology;
- XR technologies to ethically encourage active and collaborative learning;
- XR technologies to ethically create new knowledge, content, and 3D artifacts;
- XR technologies sup porting effective teaching and learning assessment strategies.






Although within the current educational system spectrum there are predefined factors for the progression of an individual student, specific factors must be considered depending on the level of education at which the XR technology is to be adopted:

- Impact of educational policies and resources for the adoption of XR in education
- Definition of educational equality and equity within XR in education
- Level of impact of XR towards the contribution to the quality and equity of student performance
- The structure of differentiation within education systems and the applicability of XR within those systems
- Decentralization of ethically approved XR educational systems

Potential challenges are as follows:

- Equity: Will XR Educational systems increase the educational divide?
- Acceptance: What level of readiness do stakeholders have for XR technology adoption?
- Safety: What is safe use of software
- in terms of both physical health and mental health and data analytics within XR education? And what unintended consequences may arise?
- Privacy: How do students retain control over their biometric and psychometric data within an educational context when using XR technology? How can students be assured that their use of XR technology will not prejudice opportunities for advancement?

In summary, the activities to be found in XR educational systems should include the following:

- Maintain ethical standards of practice in educational teaching, learning, and research.
- Protect human subjects from harm.
- Ensure that the practice of fully informed consent from all individuals is observed.
- Ensure that ethics requirements adhere to the ethical national legislations and directives for the utilization of XR at educational levels.
- Establish an External Ethics Advisory Board at each educational level for policy reform, with specific roles and responsibilities.
- Provide reassurance to the public and policy regulation bodies that all the above are done.

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# Immersive competencies

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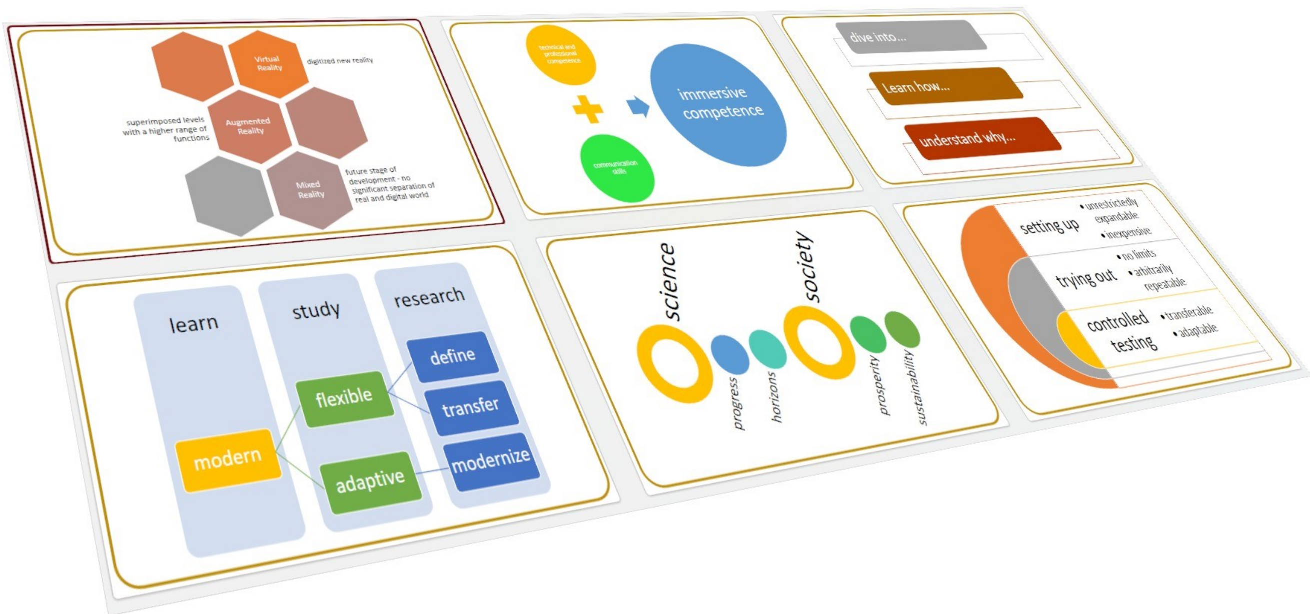
Learning, studying, researching - the basic principles of knowledge acquisition and knowledge transfer have always been strengthened, promoted or even redefined by new technical and technological influences. Dialogue-oriented concepts are currently in focus, with a trend towards transdisciplinarity.[1] Reflexivity, i.e. introspection and the recognition of effects, is a central element. In the real world, the transfer of learning is supported by language and the intensive use of digitized media and content (digital formats to be mentioned here: *.doc, *.pdf, *.ppt and *.mp3). The schools of cognitivism and constructivism have developed corresponding theoretical foundations that underline the advantages of the respective methodology.[2] All approaches are now facing radical change or at least fundamental expansion. The advancement in terms of digitization now enables immersion, or even better a complete experience of all senses, in a digitized real world. The partially or completely digitized world opens up possibilities that, beyond the real laws of nature, redefine movement in space, the presentation of events and the associated communication channels and interfaces. Boundaries are shifting, all senses can be activated at the same time and lead to a new reality that can be experienced.

The scenarios for setting up and trying out controlled testing have opened up new possibilities in knowledge transfer and in the stimulation of learning.[3] The cognitive stimuli experience a proverbial firework and promote types of learning at highly individual levels that were previously not apparent and therefore unattainable. Manipulations of the object, the environment, the feeding in of knowledge sources of any kind and time composition are parameters that are developing in the direction of a new practical relevance and a different clarification of the benefit (of components or content). In the process of experiencing and absorbing something new, the momentum of decoupling from everyday experiences becomes exciting. That is whole the point of immersive learning. Situations are created anew and can also be redefined in the respective (digital-real) context.[4]

The advantages lie in a higher or better activation of visualization, the ability to remember and the retrieval behavior of mentally stored information.[5] Synapses are reconnected using immersive learning methods and learning environ-



ments. Immersive competencies result from the synergetic linking of driving self-interest, the availability of IT infrastructure and a new communication structure between those involved. Feedback, multi-level integration and pushing the boundaries of what is physically possible manifest experiencing and learning in an immersive environment. This is the basis for future learning.

[1]Adopted from Sheniger, E. [2014], p. 135-140.
[2]Adopted from Meier, R. [2006], p. 84.
[3]Adopted from Aguirrezabal, P., Gomez, Judit [2020], p. 29-30.
[4]Adopted from Meier, R. [2006], p. 83.
[5]Adopted from Ripken, Ch., Sacher, O. [2020], p. 35.

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# Five key insights

## for successful VR adoption in HEIs

Tampere University

VR has the potential to transform how we learn and collaborate. However, embedding the use of VR into organisational practices requires much effort. Here is a short summary of five key insights that HEIs could consider when adopting the use of VR in education.

1. Standalone head-mounted display (HMD)

Standalone HMDs (i.e., all-in-one VR system that does not require a PC) is the game changer. These headsets offer superior usability and prices (about the same as a mid-range mobile phone), and they outperform older generation HMDs in many ways ((for example, Meta Quest 2 supports many advanced features, such as hand tracking). In educational use, multiple standalone HMDs can be managed via hardware racks that enable centralised charging, sanitation, and software installation and updates. Doing without PCs and cables also saves physical space that is needed for the safe and comfortable use of VR.

2. Quality over quantity

Our brains treat VR as real, even though we know that it is not. For some people, VR may feel too overwhelming or uncomfortable. Poor user experience drives people away from VR. VR adoption depends on the quality of VR and the possibility of individuals trying out VR at their own speed. Fortunately, VR technology is much better than it used to be. VR developers are just starting to master building user experiences that do not only feel real in terms of sensory stimuli but which are psychologically engaging.

3. Social virtual reality (SVR)

The most important content in VR is other people. Avatar-based interaction in SVR enables rich remote communication in a shared 3D space. SVR software that includes tools for presentations and brainstorming, such as file sharing, whiteboards, and laser pointers, substitute a physical classroom with a virtual one, but without any geographical boundaries. In SVR, natural

3D space and spatial sound enables multiple small group brainstorming sessions simultaneously. Avatars are our digital representations; with the gaze, gestures, and posture they foster effective turn-taking and dialogue.

4. Recognising the complexity

If you can simulate everything, what should you simulate? Because everything is possible in VR, this creates a significant design problem for VR solutions. What information should be presented to a user? What are the specific interactions? Who are the individuals communicating with each other? For example, in a virtual building, an architect works with a different layer of information than a construction engineer or a marketing person. Every user group also requires a different set of tools and interactions. Similarly, both information and interactions should be customised depending upon who is communicating with whom. However, more details within the simulation lead to increased costs and decreased scalability.

5. Educating the educators

In general, HEIs currently do not possess much knowledge of VR. Therefore, educating the educators about VR and its potential is critical. Most European countries have an active base of VR enthusiasts, developers and research groups who are willing to work with educational VR. Unfortunately, collaboration between these initiatives tends to be low. Building cross-disciplinary projects focusing on both technological and human factors is essential in building VR related know-how in HEIs. Fields that study sociotechnical systems, such as information systems science, hold a particularly interesting position in bridging this gap.

In summary, our insights suggest that successful VR adoption in HEIs emphasise standalone HMDs, high-quality VR, and focus on social interaction. There is also a need to map out the complexities of VR development in the cross-disciplinary context.

The first fully virtual university might not be that far away, after all.


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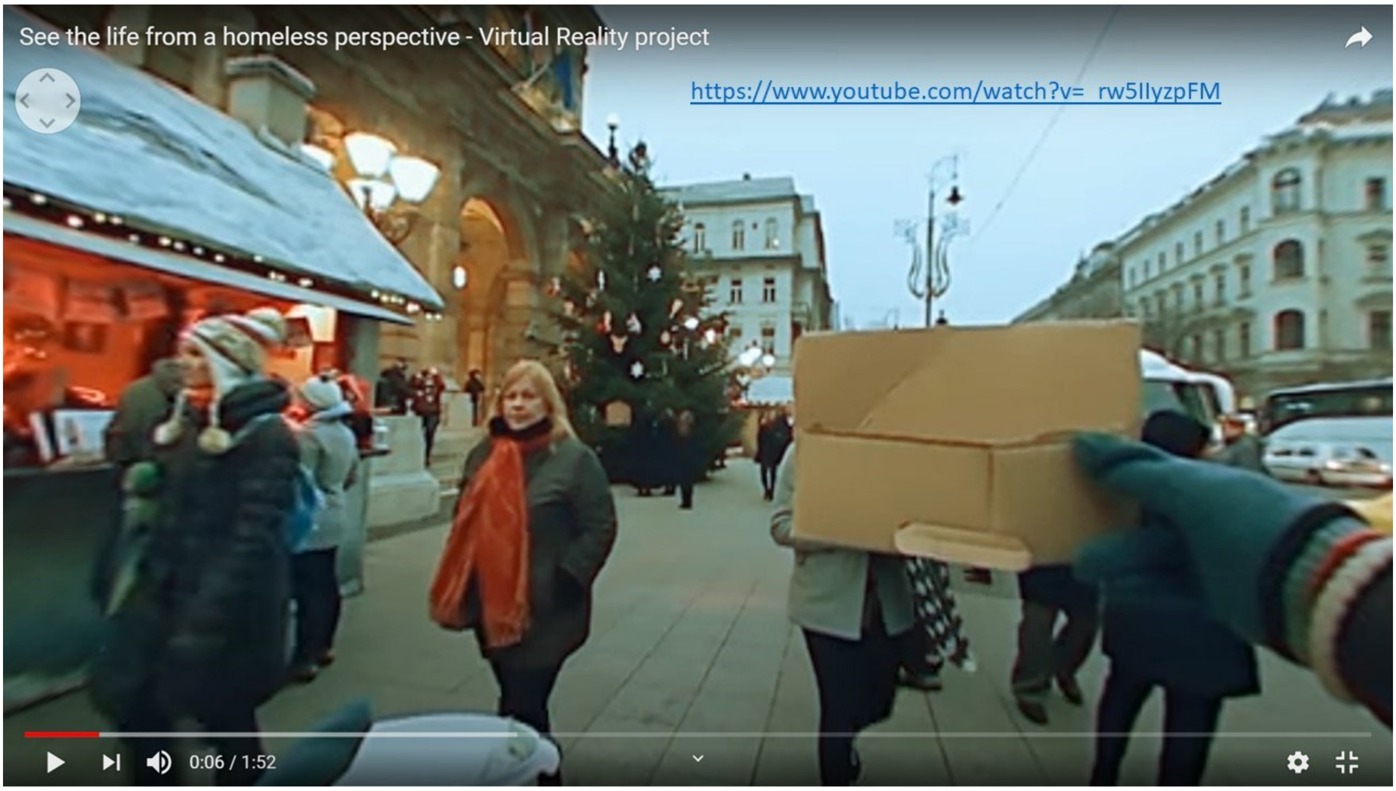
# The educational power of VR

The US market researcher Zion Market Research expects the global eLearning VR market to grow by 42.9% every year for the next 8 years. This means the market will grow from $60 million in 2018 to around $1478 million by the end of 2027. The International Data Corporation is expecting even 98.8% growth of VR in higher education in the coming years. Why is VR booming at this moment? Of course, there is the rapid evolution of VR that has led to performant but affordable hardware and software today. But at the same time, education is rapidly discovering the specific opportunities this technology offers for enhanced learning. This text gives an overview of some unique features of VR, useful in education.

The first time you use VR, you will be overwhelmed by its ability to immerse you in another world and by the fact that your brain treats it as real. The immersive experience is further enhanced by the head mounted display that enables a learner to stay focussed on the topic. This is a learning solution for those students who are prone to distraction. Moreover, sets like ClassVR (www.classvr.com), with a number of headsets and monitoring software, allow teachers to follow up where students are looking at using head tracking technology. Teachers can also upload their own resources (such as 360° photos or videos) or they can make them using e.g. Google Expeditions.

To help fully understand a subject, with one click, you can switch between an egocentric view, where you are controlling the events like a pilot or machine operator and the exocentric view where you are watching the events. Students can choose where to look at and where to go. They do not have to “stick with the group” like with school excursions. Therefore, they can direct their own flow of information according to their own way of learning. Physical school trips are organised only a few times a year. With VR, students can visit the whole world or even the universe, every day. In an app like Google Earth VR you can teleport yourself to another place and look around with just a few clicks. Some locations are out of reach for school trips, like an active volcano, the aurora borealis in the very north or the top of high mountains. With VR such locations are within reach. Teachers can visit museums virtually with their students without restrictions of opening hours and minimal




safety distance and without losing time in long queues. In some museums, VR is used to go back in time and let visitors experience how life was in the past. In Cologne, Germany, people can visit the Time Ride Museum. There, they can sit in an old tram and have a virtual ride through Cologne in around 1910. In this and many other virtual expeditions, VR offers a high level of situated learning. That means that students not only learn about the topic but at the same time they gain impressions of other aspects of life in the surrounding environment. VR not only allows you to look at the virtual environment but also offers possibilities to interact with that environment. Nowadays, machine designers develop digital twins of their designs in order to allow training of operators in executing maintenance tasks or in making operating decisions under different circumstances (like e.g. flight simulator training). VR training with these virtual twins can be organised in a virtual space. Participants just need to log-in to this virtual space. They do not need to move physically to the training location. They can practice as many times as they like and thus costs can be saved.

In social VR, the immersive feature of VR is used to foster empathy in many different situations. In the Stanford University app Becoming Homeless, people can experience how it feels to lose your job, to be forced to sell your possessions to pay the bills, to become homeless and to have to beg for money. VR has great potential in social sciences because it can generate the impression of remote presence. This is the immersive experience of a real place, including real-time remote interaction with the people there. E.g. in Belgium, children with a long-term illness can use the BedNet app to have a virtual presence in their classroom from their hospital bed and to communicate in real time with the teacher and the group.

VR is not the solution for every pedagogical problem, but it can add value in many learning situations, enhancing motivation, enthusiasm and last but not least creating a higher retention rate.

So, try VR. Think about its potential to bring your lessons to a higher level and to overcome the barriers you feel.

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# Learning XR technologies:

## Embracing immersive learning for school students

In recent years, XR technologies have become increasingly prominent in educational settings across Europe. As a professional with 15 years of experience working with emerging media technologies, I have witnessed the transformative potential of these tools for enhancing pedagogical practices. Today, I would like to address the importance of incorporating immersive learning experiences in schools, focusing on the challenges, opportunities, and policy-level improvements needed to ensure their effective integration.

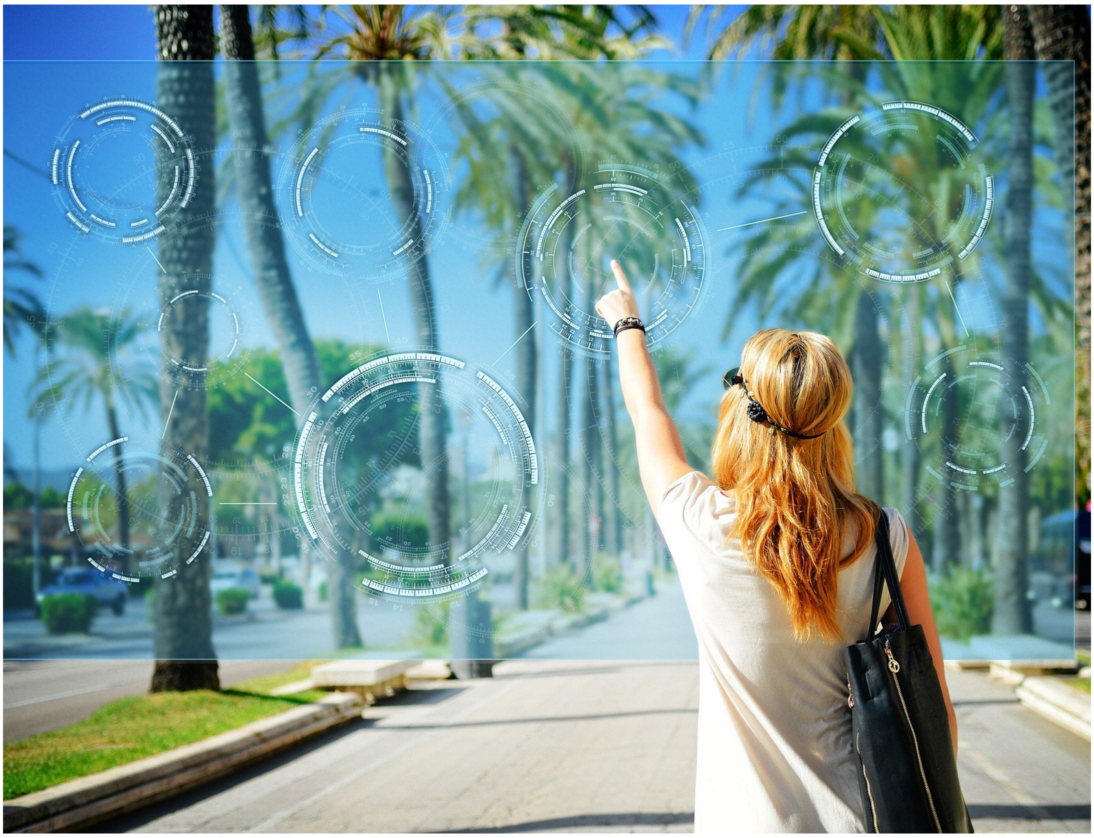
Immersive learning refers to educational experiences that leverage XR technologies to create highly engaging, interactive, and immersive environments. These technologies have been successfully applied in various fields, from vocational training to higher education. However, their potential for students remains largely untapped. Introducing XR technologies at an early age can foster essential 21st Century skills, such as critical thinking, creativity, collaboration, and digital literacy, while providing a highly engaging and stimulating learning environment.

Here are some concrete examples of XR technologies suitable for elementary school students:

Virtual Field Trips: VR can be used to take students on virtual field trips to various locations around the world, such as museums, historical sites, or even outer space.

Interactive Learning Modules: AR-enhanced learning modules can be developed to help stu-

dents understand complex topics and visualize abstract concepts.



Storytelling and Creative Expression: Mixed reality tools can be employed to encourage students to create their own stories, plays, or artistic expressions.

Despite the benefits, there are several challenges that must be addressed to effectively integrate XR technologies in schools. These challenges include the possible high costs of equipment and a lack of teacher training and resources. To overcome these challenges, we should advocate for funding initiatives to support the development of affordable XR solutions and provide training programs to empower educators to effectively leverage these tools in the classroom.

One notable opportunity for immersive learning in education lies in enhancing accessibility and fostering a deeper understanding of accessibility issues. XR technologies can facilitate inclusive education by providing personalized learning experiences, overcoming physical, social, or cognitive barriers, and adapting to students' diverse needs.

XR technologies can serve as a powerful tool to teach students about accessibility issues and promote empathy. By simulating various disabilities and challenges that people face in their everyday lives, immersive experiences can help students develop a better understanding of the importance of inclusivity and accessible design.

To fully embrace the potential of immersive learning in schools, it is crucial to address the necessary improvements and changes at the policy level. Policymakers should prioritize the development of digital infrastructure and the provision of resources for schools to adopt XR technologies. Additionally, curriculum guidelines should be updated to include immersive learning methodologies and digital literacy skills.

In conclusion, XR technologies hold immense promise for enhancing the way we teach and learn. By addressing the challenges and focusing on the opportunities presented by immersive learning, we can create a more engaging, inclusive, and future-ready educational experience for our students. It is our responsibility as educators, policymakers, and stakeholders to work together and pave the way for a new era of immersive learning in Europe.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# "Before Corona, I thought digitalisation in education is evil!"[1]

E.N.T.E.R. European Network for Transfer and Exploitation of EU Project Results

## European survey on the impact of C-19 pandemic on the use and acceptance of digital teaching in European education systems with a special focus on immersive learning.

### Introduction

Before we could start developing specific learning and information content and materials within the XRforPED project, we needed to be certain concerning some key questions about our project theme.

These included, for example, what impact have the lockdowns and other Corona restrictions had on digital teaching in different educational sectors, whether teachers experienced this positively and could their e-teaching skills be increased - or not! Within this context, it was important for us to know what development processes different educational institutions have recently gone through with regard to e-learning and whether we will encounter an open and positive attitude amongst education managers and educators or will we see reluctance and scepticism.

Another set of questions that needed to be addressed concerned prior knowledge and skills already acquired in VR, AR, MR and XR. It was difficult for us to assess whether these technologies had already been used in class, whether positive or negative experiences had resulted and whether there was any interest in them at all.

In order to answer these questions, the project group conducted two Europe-wide studies with different methodological approaches and set-ups, instruments and target groups:

The first was an online-based standardised questionnaire (with largely closed questions) in which 324 teachers and trainers gave us feedback about their experiences of using digital methods and tools within the context of Corona, about their opinions and attitudes towards the digitisation of pedagogy in general and immersive technologies in particular.

In the second one, 21 coordinators of EU projects on immersive learning were asked in semi-standardised interviews (semi-open and open questions) about their experiences of project work, what opportunities and risks they see for pedagogy and what advice they have for the orientation of the XRforPED training programme. In addition to the interviews, the results and outcomes of these projects were analysed with regard to their use for the XRforPED project.

The data collection phases of both studies lasted from autumn 2021 to spring 2022. The results were published in two reports at www.xr4ped.eu and formed the basis for the development of our training programme for students of pedagogy and educational sciences.

For this education policy paper, we have selected the results of the online-survey because of their high relevance for education managers and educators across Europe.

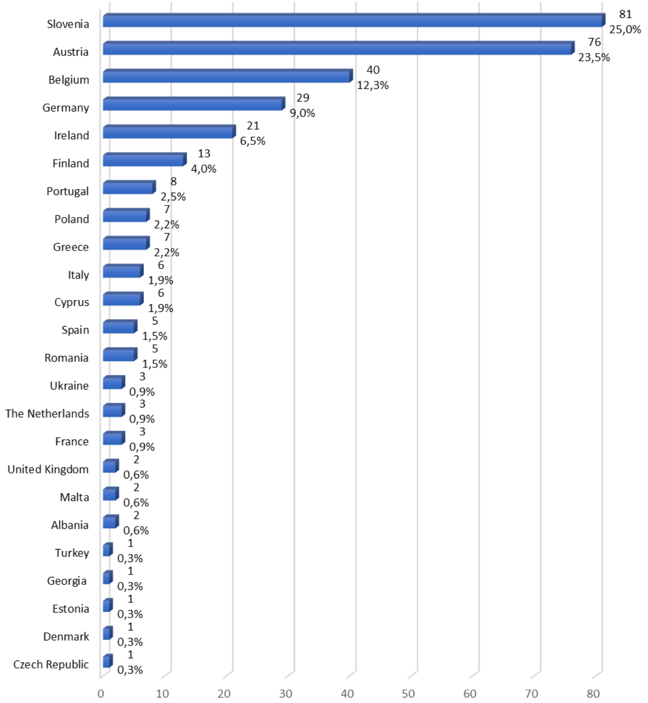
### Results and findings of the online-survey

**1.The sample and its pedagogic education and experience**

1.1 Countries

From the total of 324 people who took part in our survey, Slovenia accounted for the largest share with 81 (25.0%) responses, followed by Austria 76 (23.5%), Belgium 40 (12.3%), Germany 29 (9.0%), Ireland 21 (6.5%) and Finland 13 (4.0%); among the responses from other

Fig. 1.1 Countries (N=324)

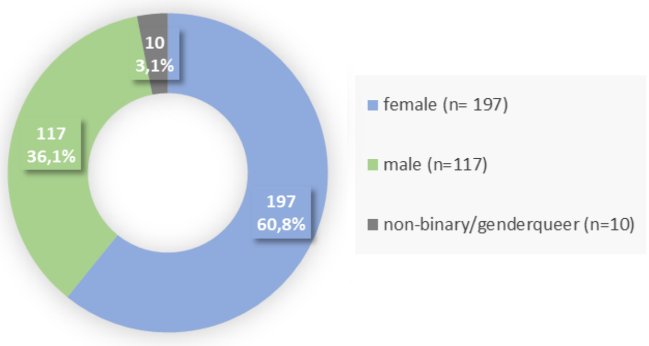



EU countries, Portugal was strongest with 8 (2.5%) persons, followed by Poland and Greece with 7 (2.2%) each, Italy and Cyprus with 6 (1.9%) each and Spain and Romania with 5 (1.6%); there were 3 or fewer responses from a further 22 countries, 4 of them outside the EU. As Fig.1.1 shows, our overall sample represents pedagogues from 24 European countries, including 20 EU Members States.

### 1.2 Gender split

In terms of gender, 197 (60,8%) women, 117 (36,1%) men and 10 (3,1%) non-binary/genderqueer persons participated in the online survey.

Fig. 1.2 Gender (N=324)

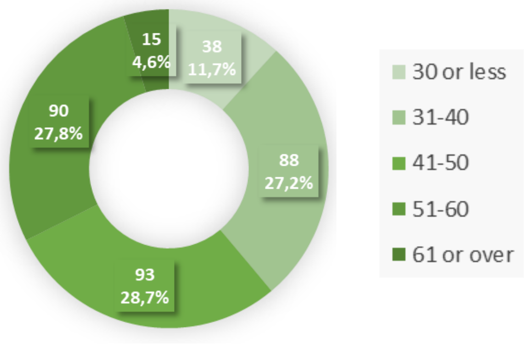



This is not entirely surprising because women are somewhat overrepresented in the education sector, especially at the primary and secondary levels of education as well as in socio-educational areas, which are all important areas for our project work. In general, gender issues do not play a major role in the sense of our study, therefore we also did not gender-sample the evaluation of the responses.

### 1.3 Age

The groups representing the three decades from 30-60 years are almost equally represented; the groups with younger and older respondents are smaller, which is explained by the fact that teachers and trainers usually start working in their mid-twenties and stop in their early to mid-sixties.

Fig. 1.3 Age (N=324)

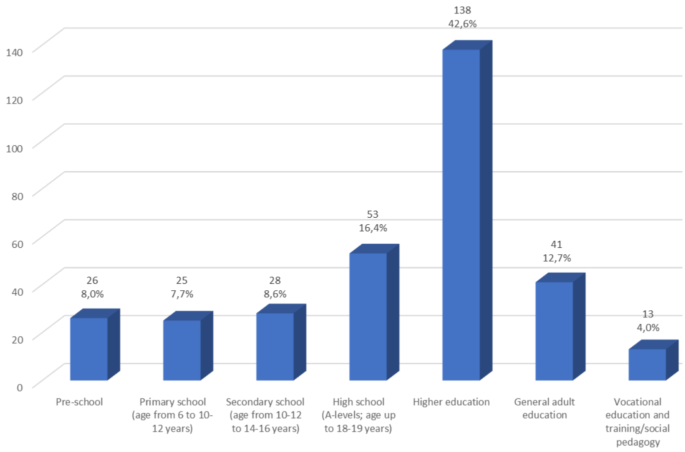



With regards to the reliability of the data gained by our survey, the sample was very well selected. It fully represents the real age ratios amongst educators and no single age group dominates. This is important because age is a crucial factor concerning the knowledge, acceptance and use of digital methods and tools. IT literacy decreases amongst higher age groups and is acquired circumstantially by older persons, while younger persons simply grow up with it. By having a balanced representation of all age groups in the sample, the results of the survey should also be balanced and not be distorted by one or the other age group.

### 1.4 Area/level of main teaching activity

In terms of areas/levels of educational activity, the sample is less balanced; with 138 (42.6%) respondents, higher education is clearly dominant and the other educational areas follow far behind with high schools (16.5%), adult general education (12.7%), secondary schools (8.6%), preschools (8.0%), primary schools (7.7%), and vocational training institutions (4.0%). This is explained by the fact that 4 higher education institutions are represented in the partnership and we generally focus on higher education. This is not a methodological problem in principle, but we must always be aware of it when looking at and evaluating the survey results, that the higher education sector is more dominant in this raw data.

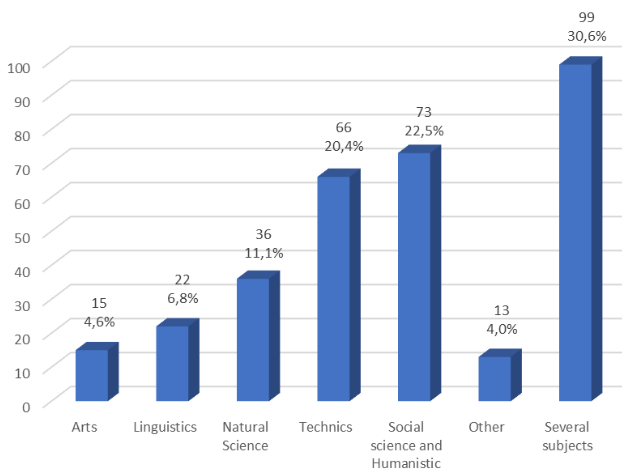
Fig. 1.4 Area/level of main teaching activity (N=324)




## 1.5 Main subjects/fields of teaching

There also seems to be no over-dominance with regard to content areas and subjects that would lead to serious distortions of the results. The most frequent single discipline is social sciences and humanities with 73 (22.5%) respondents, closely followed by technical fields with 66 (20.4%); then come natural sciences (36; 11.1%), languages (22; 6.8%), arts (15; 4.5%) as well as 13 (4.0%) persons teaching other fields/subjects; the sample's largest group, however, is those 99 (30.6%) educators who teach several subjects/fields. It can be concluded that also in this respect, the sample was very balanced and representative of a wide range of educational fields.

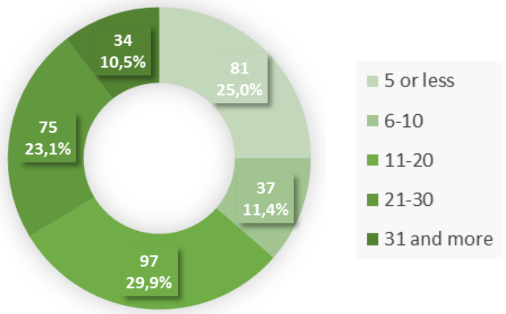
Fig. 1.5 Main subjects/fields of teaching (N=324)




## 1.6 Years working as teacher/trainer

The distribution of work experience (Fig. 1.6) is quite similar to the distribution of age (Fig. 1.3) - a positive correlation that is not very surprising. Regarding the quality of data, this means that they are widely based on many years of professional and life experience. At the same time, data, opinions and experiences of younger people who are only at the beginning of their professional careers are also included to an extent that roughly corresponds to their statistical share in the real group of teachers and trainers.

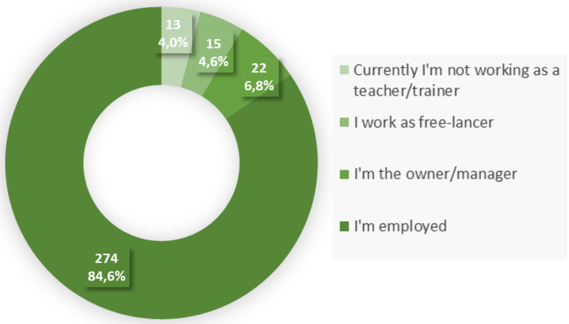
Fig. 1.6 Years working as teacher/trainer (N=324)




## 1.7 Link to educational institutes

Upon knowing how old and experienced our respondents are and what areas and subjects they teach, it was interesting to see how they are linked to the educational institutions in which they are teaching, so we asked them exactly that.

Fig. 1.7 Link to educational institutes (N=324)




13 (4.0%) persons are trainers or teachers but were not working in this profession at the time of the survey (e.g., because they were unemployed, on parental leave or taking a sabbatical), 15 (4.6%) work as free-lancers and 22 (6.8%) are the owners or managers of an educational institution; with 274 (84.6%) the

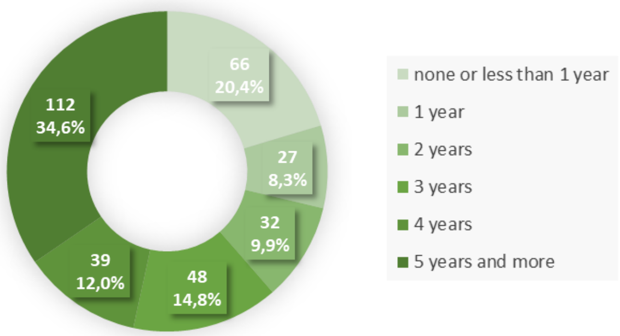
majority of the survey participants are educators employed by an educational institution.

This finding is not surprising and is in line with the information given in 1.4 - if people work mainly in schools, vocational schools and colleges, they are usually employed by these educational institutions, at least in the countries that participated in the study. This means that the respondents have a good inside perspective into the educational standards and philosophy of their employers and can therefore also well judge how things stand with digitalisation in general and immersive technologies in the classroom.

### 1.8 Years of professional education/training in pedagogy

The fact that people work as trainers or teachers does not mean that these people are also good pedagogues who know exactly how to guarantee knowledge transfer - regardless of the professional content - in the best possible way. A very good indicator of pedagogical expertise is the amount of professional pedagogical training someone has received themselves. Of course, someone with pedagogical training is not automatically a good trainer or teacher, but a certain level of expertise and skills in pedagogical methodology and didactics should be guaranteed by this.

Fig. 1.8 Years of professional education/training in pedagogy (N=324)



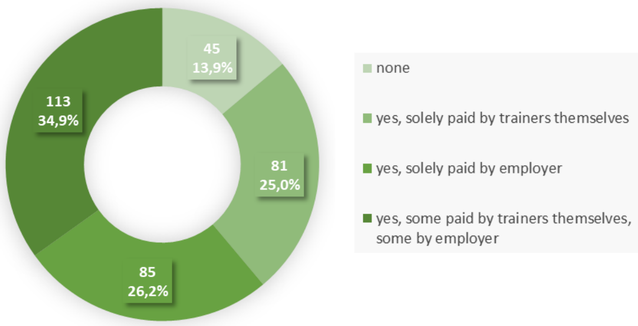

The individuals in the sample represent thoroughly well-trained teachers and trainers who not only have life and work experience, but also comprehensive theoretical knowledge and practical training: 79.6% have at least 1 year of professional pedagogical training, and 60.4% have at least 3 years or more! Only 20.4% have no pedagogical training or one that lasted less than 1 year.

This statement is very important because we assume that trainers and teachers are primarily shaped by the professional training in their methodological and didactic orientation. This means that if certain methods and tools are not taught in the pedagogical training, then they have a hard time finding their way into the classroom. Whether digital methods and instruments have found their way into the pedagogical training of the sample will be clarified in the next question.

### 1.9 Continuous education/training in pedagogy

It is very positively surprising that 86.1% of the respondents stated that they regularly(!) participate in further pedagogical training measures. This is therefore quite promising: firstly, because it is a very high result; secondly, because it seems to ensure that teachers and trainers for the most part come regularly into contact with pedagogical innovations and should be sufficiently trained in their use.

Fig. 1.9 Regular continuous education/training in pedagogy (N=324)

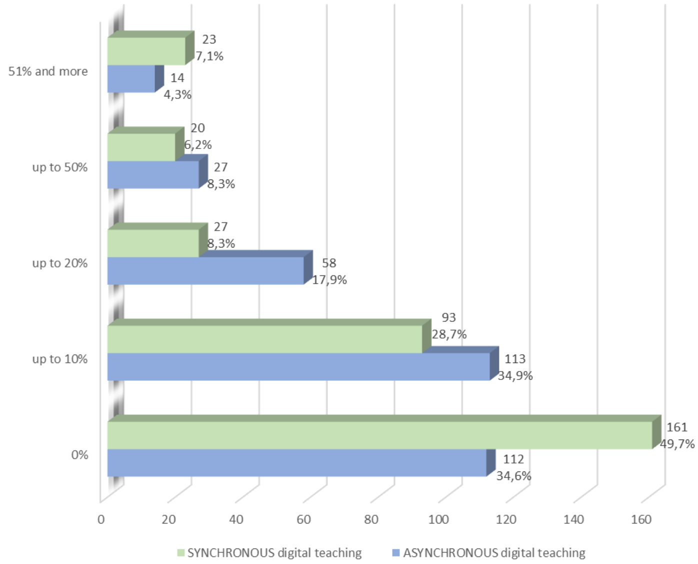



Our study shows that the majority of teachers have completed thorough basic pedagogical education of several years and receive further postgraduate training on a regular basis. From a quantitative point of view, there seem to be sufficient measures to ensure high pedagogic quality amongst trainers and teachers. However, this training will only have a lasting positive impact on teaching if they are of a corresponding quality and intensity. In order to be able to check these two factors, instruments must be chosen other than simply an online survey. What we were able to find out from the respondents, however, is to what extent the training measures already dealt with the teaching of digital learning methods and skills before Corona.

### 1.10 Prior to C-19 pandemic: Your pedagogical training in synchronous/asynchronous teaching

For the reasons mentioned above, we asked the educators what percentages of their overall training roughly dealt with synchronous or asynchronous digital forms of teaching. With 49.7%, pretty much half of them said they have had no training at all in asynchronous digital learning, and 34.6% said that they have had no training in synchronous learning. The second largest group is made up of those who were trained in digital learning for at least up to 10% of their pedagogical training (28.7% asynchronous; 34.9% synchronous), followed by those who were trained in digital learning for up to 20% of the time (8.3% asynchronous, 17.9% synchronous). For those with over 20% of the training time focussed on digital learning, the outcome shows 13.3% was spent on asynchronous learning and 12.6% on synchronous learning.

Fig. 1.10 Continuous education/training (synchronous/asynchronous) in prior to C-19 pandemic (N=324)




From this data we see that the pedagogical training of trainers and teachers is extensive and continues long after graduation, but that the content overwhelmingly does not deal with digital learning and teaching and up to 50% of trainers receive no training at all in this area. It is therefore not surprising that the digitalisation of teaching, largely enforced by C-19, has posed major problems for teachers and trainers in almost all EU countries. Within a very short period of time, they had to make a change for which they were hardly prepared in terms of methods and approaches. They were therefore forced to jump into the cold waters of online teaching and to do what is methodically considered to be very sustainable: learning by doing!

## 2. Digital teaching during the C-19 pandemic

### 2.1 The Impact of C-19 on the quantitative use of learning methods and tools in the classroom

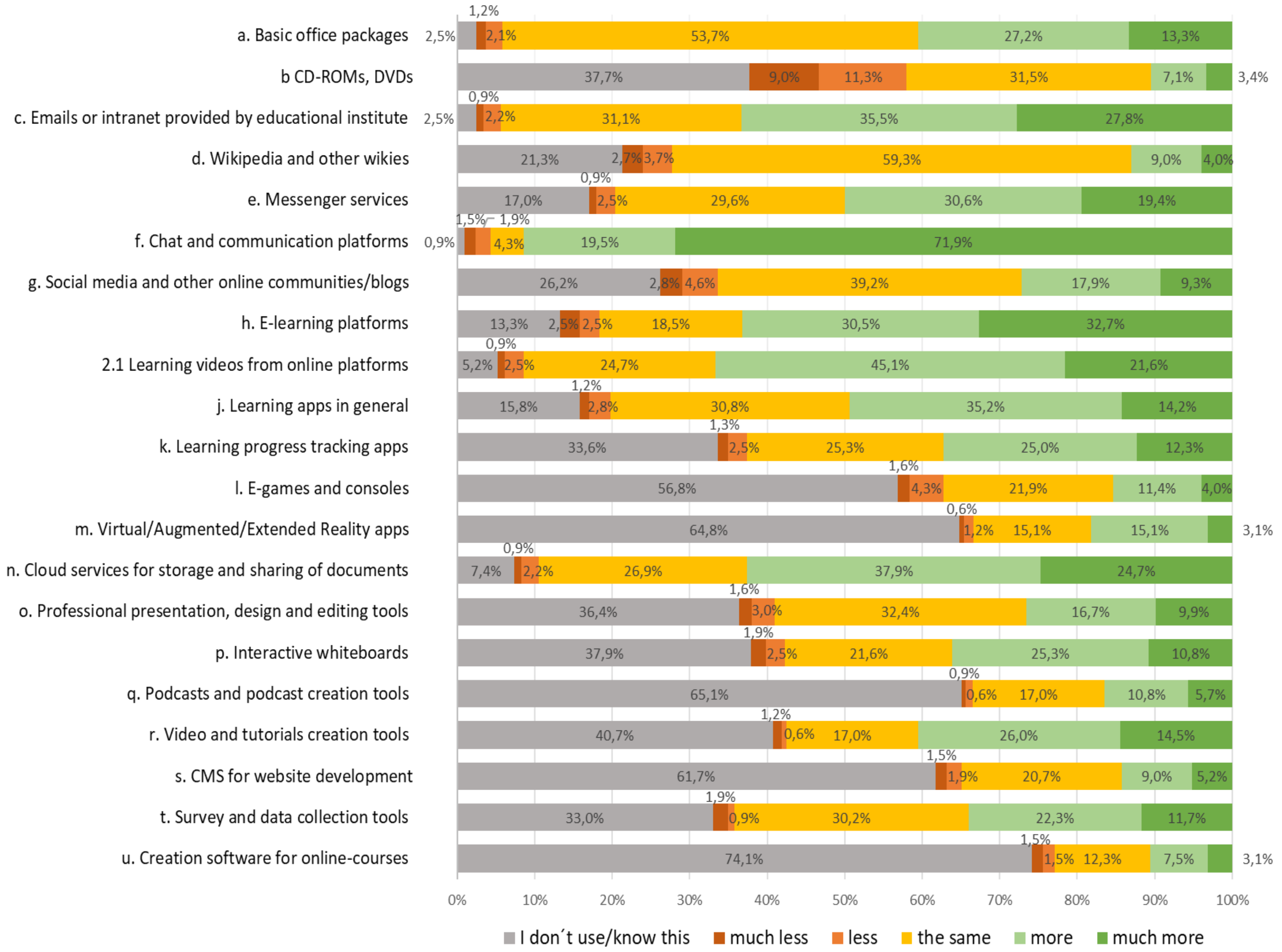
Many studies state that the impact of C-19 has led to teaching becoming more digital at all levels and in all institutions across Europe. In our survey, we asked educators to indicate to what extent they used 21 different methods and tools during Corona.

The light and dark green parts in the bars show how many teachers and trainers used the teaching/learning methods and tools in question more often with the appearance of Corona than beforehand; the orange parts of the bars indicate the proportion of teachers for whom the use of digital methods and tools did not really change much. The light and dark brown areas indicate when the use of digitalisation reduced; the grey areas highlight when methods and instruments were either unknown or not used at all. From the first spot, it can be seen that Corona had a promoting influence on the awareness and use of digital methods and instruments.

Looking at the details, it is noticeable that the use of communication (f) and learning (h) platforms in teaching were the digital success story of the Corona period, but other areas such as emails/intranets (c), messenger services (e), learning videos (i) and cloud services for storage and sharing of documents (n) have also experienced a real boom. Some of the items seem to have been very widespread even before Corona, such as basic office packages (a), Wikipedia and other wikies (d) or social media and online communities/blogs (g). The only area where there has been a decline seems to have been with CD-ROMs/DVDs (b), but this is not really a surprise and is very likely related to the fact that these methods and tools are considered technically outdated and have generally lost their relevance.

The fact that some of the methods and techniques (especially those in the second half of the diagram) were used neither before nor during Corona is certainly due to the fact that they are generally very specific and hardly known to the wider population, the technical and instrumental effort is high and the levels of prior knowledge and application skills required are very high. All these preconditions seem to be a hindrance to their use in the classroom; in addition, not all digital methods

Fig. 2.1 Impact of C-19 on the quantitative use of learning methods and tools in the classroom (N=324)

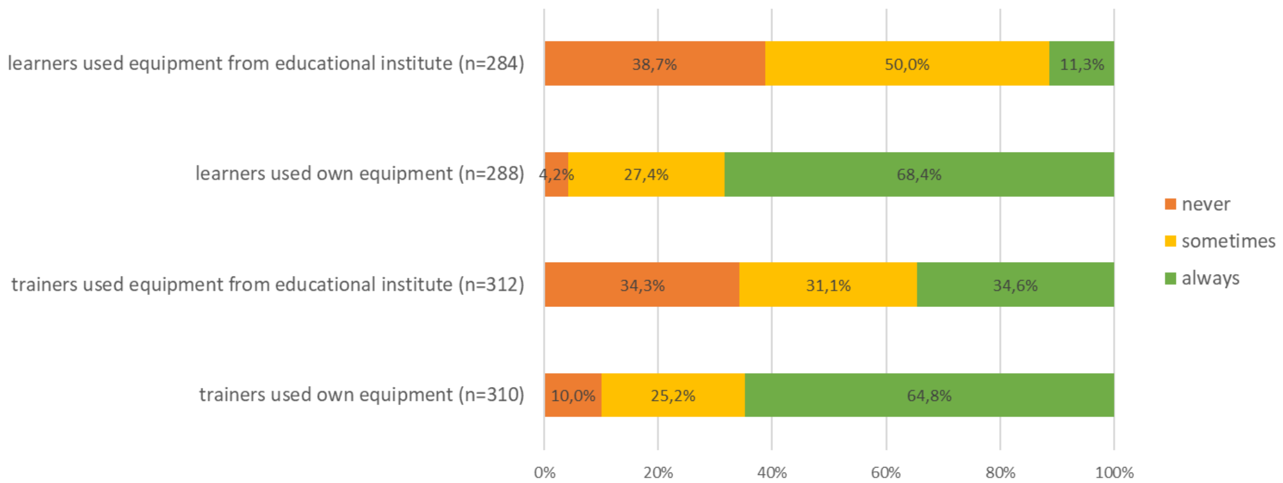



and tools per se bring added value to the classroom. With regard to our project topic, it is somewhat alarming that VR/AR/MR have the second lowest level of awareness or use among educators. Under these conditions, we have set the focus of XRforPED correctly - and still have a lot of work ahead of us.

## 2.2 Owner of the IT equipment used during the C-19 lockdowns

As a further indicator of the extent to which the digitisation of teaching is actively planned and promoted by education authorities and institutions, we have taken a look at the equipment made available to learners such as trainers and teachers.

Fig. 2.2 Ownership of IT equipment used during the C-19 lockdowns (N=324)



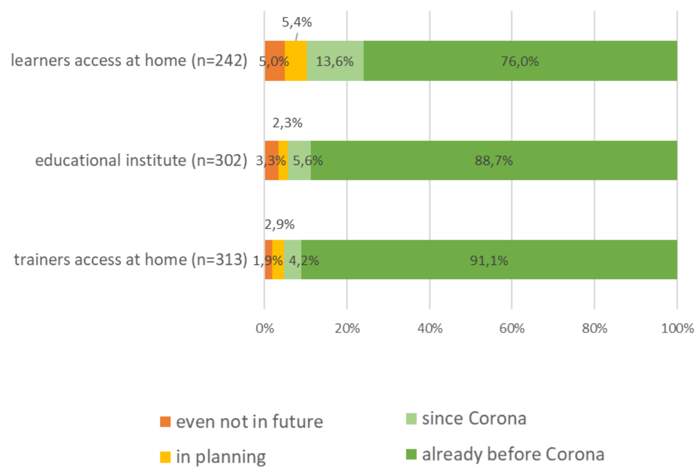
Things seem to have started to progress here, because trainers and teachers always confirm that 34.6% of them receive their digital equipment from the educational institution, and for a further 31.1% this is at least partly the case; 34.3% say that they are never provided with infrastructure and equipment in this respect. Amongst learners, 61.3% say that they always (11.3%) or occasionally (50.0%) receive IT equipment and access to the internet from their educational institution.

In both groups, however, the largest proportion is those who use their own IT equipment partly or at least occasionally (95.8% of learners and 90.0% of trainers and teachers); these high values are probably also related to the fact that computers, notebooks and mobile phones have become everyday objects for us through which we now also learn or participate in lessons.

### 2.3 Access to high-speed internet

A look at access to high-speed internet also shows that this factor is no longer a major obstacle. Only 1.9% of trainers and teachers, 3.3% of educational institutions and 5.0% of learners say they do not have a stable broadband internet connection at present and will not have one in the future. It is striking that most of them were already sufficiently supplied with it before Corona. This means that poor internet connections can hardly be used as an excuse for the lack of digitisation in education; it is more the case that the connections are strong enough for many users to learn digitally and consume large volumes of data at the same time.

Fig. 2.3 Access to high-speed internet (N=324)




Nevertheless, it must of course be remembered that our data is not representative and that people from urban areas with higher educational qualifications are over-represented in our sample. In terms of further digitisation of learning, intensive efforts should continue to be made to provide educational institutions, educators and learners with sufficient infrastructure, hardware and software free of charge! The costs for this must be borne by the public sector, especially to prevent people and institutions in disadvantaged regions or social classes from not being able to participate in the digital advancements in education, or only to a limited extent.

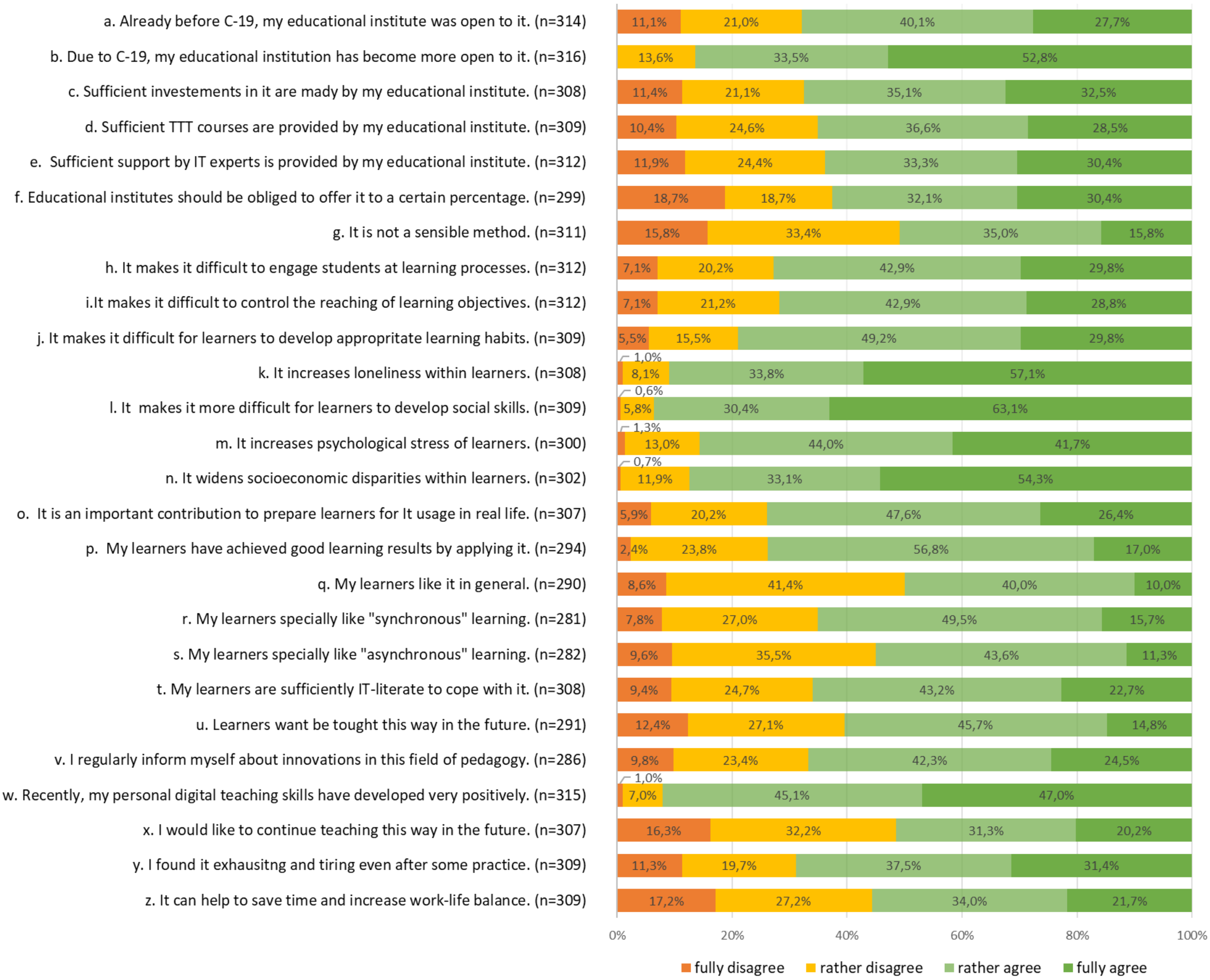
### 2.4 Trainers' experiences and opinions on remote and digital teaching and learning

This question is, of course, one of the most central to the entire study. Two or three years ago, this would have been a rather academic and hypothetical issue for many educators, because the majority of them would have had little or no practical experience of using remote and digital learning in their own teaching. Now, in 2022, this has changed completely. As we have learned from the previous sections of this questionnaire, all actors involved (educational institutes, learners, educators) have relatively good internet access, have the necessary equipment (at least privately) and, due to C-19, the use of digital methods and tools in the classroom has both spread and deepened enormously.

We would now like to hear how educators have fared with this, what their experiences have been and how these have affected their attitudes. Therefore, we asked them to agree or disagree with the following statements.

The evaluation of the answers leads to interesting findings. The statements a) to e) highlight largely positive feedback with regard to the fact that European educational institutions are slowly beginning to arrive at digitalisation, that there are corresponding investments, training of educators and the provision of IT experts; about two thirds of the educators see positive or very positive developments at their institutions, one third sees this rather negatively or very negatively. The vast majority (86.3%) agree that the impact of C-19 on educational institutions has had a great or very great influence on their openness to digital

Fig. 2.4 Trainers´ agreement/disagreement to statements with regards to remote and digital teaching and learning (N=324)




education. Since it is to be expected that after the C-19 pandemic is over and school lockdowns have ended, the digitisation of schools will also return, we have made the certainly controversial statement with f) that educational institutions should even be obliged to offer a certain percentage of their lessons digitally; educators are divided on this, but a majority of around 42% would be in favour of such an approach.

The feedback for statements g) to n), which focus on practical, methodological and psychosocial areas of digital learning, is much more critical. When assessing whether or not digital learning is a useful pedagogical method, two almost equally strong camps of supporters and sceptics are formed. However, over 70% of educators report that digital learning has made it difficult to engage learners in the learning process (h) and to monitor the achievement of learning goals (i); over 80% say that it has made it difficult for learners to develop study habits (j), that it has increased psychological pressure on learners (m) and that it has increased socio-economic differences between learners (n); over 90% of educators believe that it has increased loneliness among learners (k) and has prevented learners from developing social skills (l).

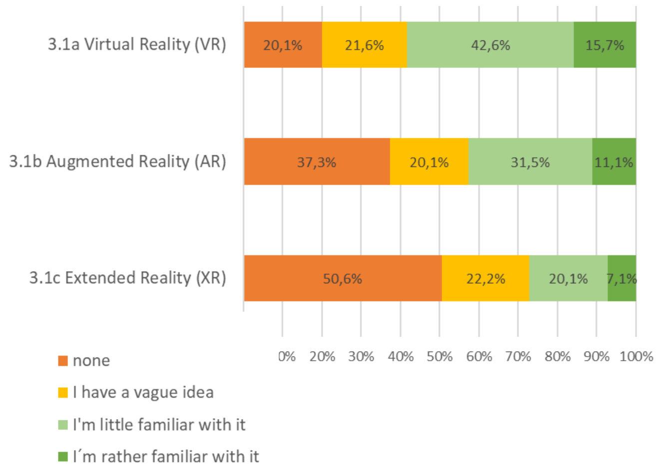
In this set of questions, we also see some of the weaknesses of our study: firstly, the questions targeted multi-layered and complex situations, which makes it difficult to separate cause and effect (were the lockdowns the cause of learners' loneliness and their psychological stress or was it the distance learning sessions conducted during lockdowns?); secondly, educators and their learners are also a very heterogeneous target group that we were not able to survey in a sufficiently differentiated way (the development of social skills and the importance of digital media for social contacts may have a different significance for primary school pupils than for students); thirdly, it is also possible that these effects are more likely to occur if the methods of digital and distance learning are not used correctly (the problem then lies more with the poorly trained educator busy simultaneously with many other issues and not with the method itself) and because data from the online survey cannot be backed up by further data (e.g. from intensive interviews or expert rounds with educators) due to a lack of time and money: fourthly, we only asked the educators. By asking the learners we would very likely have had quite a different perspective and set of results. There are certainly more shortcomings, but this cannot be done any other way for such a study in such a complex field using very little financial, time and human resources. Therefore, we view our data with due caution and know that bias is very likely. On the whole, however, we assume that the data tends to give us a correct picture and can be a very important basis for further decisions or research projects.

Coming back to our interpretation of the answers, it seems that neither the majority of educators nor trainers and teachers in their classes nor managers of educational institutions have (anymore) negative attitudes towards digital methods and remote learning, but that they are very critical of these methods in terms of social competence development, learning organisation and the mental health of the learners. These observations and reservations need to be taken seriously to increase confidence in digital learning; at the same time, comprehensive and profound measures need to be taken at several levels to eliminate or reduce negative impacts as much as possible (e.g., better orientation of methods and tools to the needs of people, better technical and didactical training of educators and a generally balanced use of digital technology).

### 3. Immersive teaching

We have seen that experiences and attitudes towards digital teaching in general have developed rather positively. In the last block of our questionnaire, we wanted to know how this relates to immersive technologies (VR, AR, XR). But here we had to take a step back and ask whether the trainers are even aware of these technologies and what they are about.

Fig. 3.1 Knowledge about VR/AR/XR technologies amongst trainers (N=324)



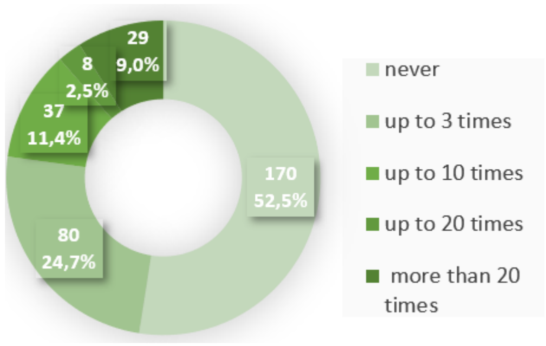

#### 3.1 Knowledge about VR/AR/XR technologies amongst trainers

In question 3.1 we asked the trainers to self-assess their knowledge about different forms of immersive technologies. From their answers we can see that it is not particularly pronounced. Thus, 57.4% of the trainers state that they have no (37.3%) or only a vague idea (20.1%) of what is meant by augmented reality; with regard to extended reality, the figure is even higher with 72.85% (50.6% and 22.2%); the situation is somewhat better for virtual reality, where only 41.5% (20.1% and 21.6%) of the trainers declare themselves to be largely ignorant concerning immersive technologies. This is understandable because VR is the oldest of these technologies and people who pick up VR glasses are quite common in the media and are also conspicuous. From our perspective, however, we do not view this result too negatively. We were rather surprised to find that between 27.2% (XR) and 58.3% (VR) of the trainers are somewhat to fairly well versed in immersive technologies.

#### 3.2 Number of experiences

With 52.5%, more than half of the respondents have never come into contact with immersive technologies, another 24.7% at most 3 times. Only 9% have used immersive technologies more than 20 times. Based on these figures, it can be assumed that - regardless of how trainers themselves assess this - knowledge and skills in dealing with immersive technologies are only developed to a very limited extent among the majority.

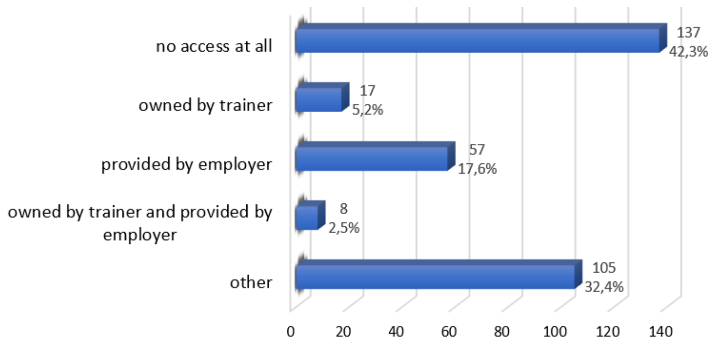
Fig. 3.2 How often have you tested/used VR/AR/XR technologies (N=324)




## 3.3 Trainers' access to VR/AR/XR equipment

You can only learn something or build skills in it if you have access to it! This is a very banal fact, but one that is nevertheless quite often disregarded, e.g., by asking trainers to familiarise themselves with digital methods and tools without providing them with the necessary infrastructure, equipment or training. This is also reflected in our survey; 42.3% of trainers say they have no access to immersive technologies at all, 5.2% have provided themselves with equipment, and another 32.4% use other options. Nevertheless, around 20.1% have access to immersive technologies through their employer, which is usually an educational institution. Whether this is very pronounced can be doubted, considering the low experience scores in Fig. 3.2 and the low usage in teaching in Fig. 3.5.

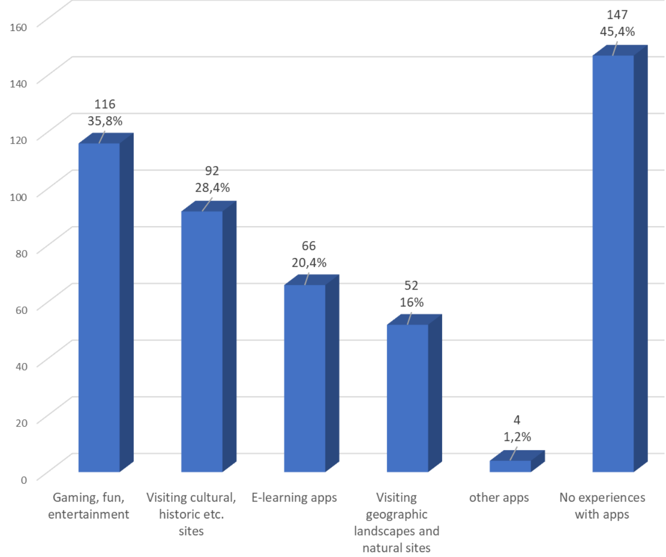
Fig. 3.3 Trainers´ access to VR/AR/XR equipment (N=324)




## 3.4 VR/AR/XR apps trainers have experienced

First and foremost, the trainers have experience with immersive apps in the fields of games and entertainment (35.8%), followed by apps to explore cultural or historical sites (28.4%), special learning apps (20.4%), and apps around geographical landscapes and nature sites (16%); only 1.4% of the apps related to other topics. Although games and entertainment come first, the other app areas show that learning, experience and knowledge transfer - albeit in a broader sense - do play a certain role.

Fig. 3.4 VR/AR/XR apps trainers have experienced (N= 324; multiple answers possible)




## 3.5 Experiences and interests in immersive learning in the classroom

One of the most interesting questions when it comes to immersive learning in the classroom is whether trainers are interested in it at all, or whether they might even have experience of it. 91% of the trainers said they have no experience at all in using it in the classroom, which clearly answers at least this question. A very different picture emerges when asking trainers about their interests and curiosity in immersive learning apps and methods. Only 12.7% say they are definitely not interested, but a large majority of 55.2% are clearly willing to learn more; while 32.1%, about a third of the respondents, are still undecided.

Fig. 3.5 Trainers with immersive teaching experience N=324)

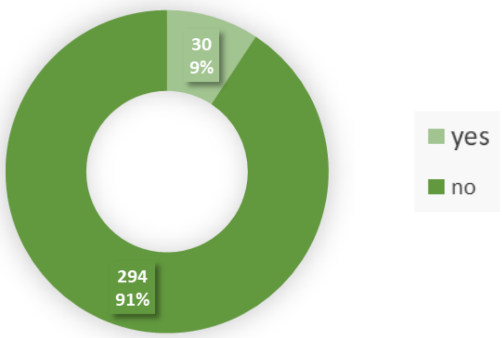
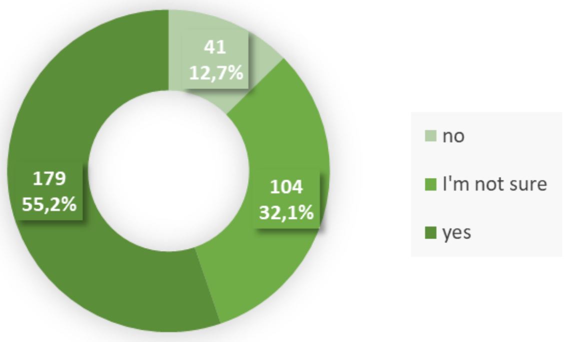


Fig. 3.6 Trainers interested in immersive teaching (N=324)



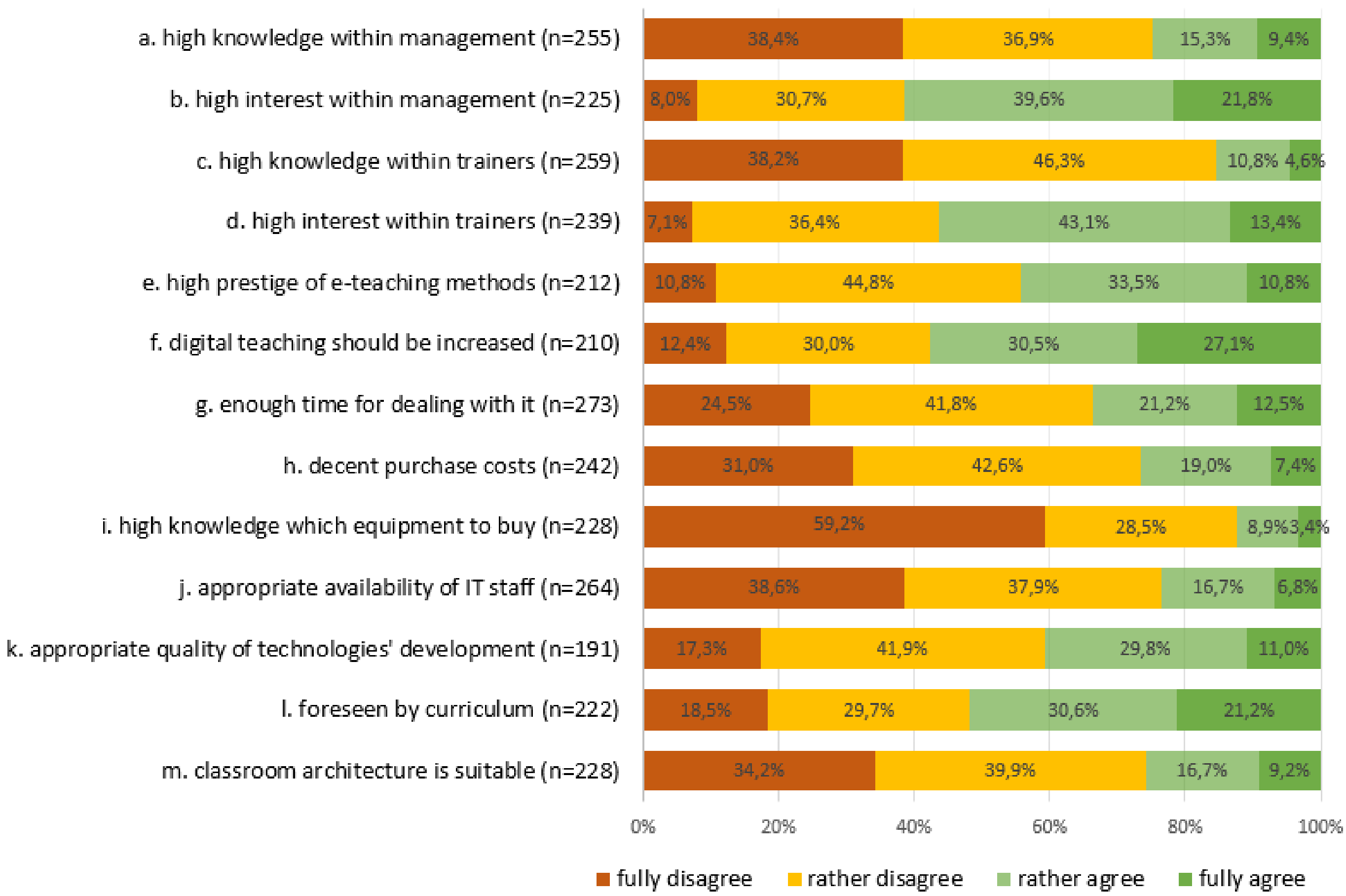

On the whole, the picture is similar to what we have said above about the attitude of trainers towards digitalisation of teaching in general: there are certainly sceptics and those who do not think much of it, but there is a great openness and willingness among teachers to use digital methods and tools in teaching and a great curiosity to learn about new ones.

## 3.6 Trainers´ agreement/disagreement with VR/AR/XR frameworks in educational institutions

Knowledge and experience of immersive learning is not particularly strong among educators, and few educational institutions offer it. Fig. 3.7 shows which reasons trainers and teachers see as being responsible for this.

Let us perhaps start with the positive results: There is broad consensus among respondents that there is great interest and motivation to engage with immersive learning technologies both among management (b), who set the strategic direction of educational organisations and often provide funding, and among teachers (d), who are responsible for classroom applications. The majority also postulates that there is a positive attitude towards digital learning in educational institutions, which means that it should be pushed even further. There is therefore a clear commitment to increased digital teaching in general and interest in immersive learning in particular.

Fig. 3.7 Trainers´ agreement/disagreement to statements with regards to remote and digital teaching and learning (N=324)



On the other hand, opinions are fairly balanced in the areas of whether e-teaching methods have a high prestige in general (e), whether immersive technologies are sufficiently developed for problem-free and meaningful use in the classroom (k) and whether curricula and training guidelines leave enough room for immersive learning experiments at all (l).

In the opinion of educators, the difficulties and problems that currently still predominate, mainly include that there is too little knowledge on the subject at both management and teaching levels (a, c), that they have too little time to deal with it, that the acquisition costs are too high (h) and - the biggest problem of all - they do not even know what equipment they need, that there is too little support from IT specialists (j) and that the design of classrooms makes it difficult to use immersive learning methods (m).

Although at first glance the feedback from educators seems to outweigh the disadvantages for experimentation or even the sustainable use of immersive technologies in the classroom, we do not believe that we face insurmountable obstacles. The most important thing of all is that both groups relevant to teaching - management and teachers - show great interest, are motivated and are eagerly in favour of further digitising teaching. Many of the obvious problems can be solved by something that should not be foreign to educational institutions: learning! Basic knowledge about immersive technologies, what forms they take, what devices are used for them and what apps are available, how to get equipment cheaply (it is much less expensive than most expect), can be taught relatively easily. There are extremely informative EU projects on this topic that give a good overview (many of them can be found on www.vam-realities.eu), also many companies now specialise in this, including sufficient offers for the comprehensive training of educators. The requirements for classrooms is minimal and can be achieved easily and quickly by rearranging tables and chairs. Somewhat more difficult is certainly the lack of time resources of teachers - here one can only be advised to carefully reconsider the existing curricula and to streamline them as much as possible so that much needed modern learning content and forms can be incorporated without overburdening teachers as well as learners. This will certainly require a lot of courage and some traditions will have to be broken, but it is better to take this step sooner than too late. The only problem that, in our opinion, cannot be solved so easily is that of support by IT experts. The shortage of these professionals is not an institutional or sectoral one, but a general one. Many factors come together here - such as demographic change with fewer employees in general or the big pull of well-paid jobs in industry - that cannot be solved in the short term. A far-sighted strategy would be for all types of educational institutions to make the teaching of digital knowledge and skills a core task, which would help to increase the digital literacy of the entire population and thus make them less dependent on support from IT experts in their everyday lives.

## Summary and derivations

#### 4. Methodological set-up, sample and reliability of data

In our online survey, it was possible to obtain responses from 324 educators from 24 European countries (including 20 EU member states).[2]

60.8% of the respondents were women, 36.1% men and 3.1% non-binary/genderqueer. The age distribution is evenly distributed and roughly corresponds to the real distribution across this professional field.

With regard to the educational levels at which the educators work, the proportion of university teachers predominates, because many of the project partners are higher education institutes, which is also the main target sector of the project; apart from this, the remaining educational levels (preschool, school, vocational training, general adult education, social education) are more or less equally represented. The distribution of professional experience is also evenly distributed, which made it possible to collect feedback and opinions from both those more experienced and those less experienced. With 84.6%, the majority of respondents are employed by educational institutions, the rest are freelancers, owners of educational institutions or not working at the time of the survey (e.g., due to parental leave, illness, unemployment, etc.). The respondents range from well to very well trained in their profession; 61.4% have undergone three or more years of professional vocational training, only 20.4% have no training or training of less than one year at the time of the survey. 86.1% of all respondents participate in regular further training measures in pedagogy, didactics and methodology, which are partly organised and financed by the employer, but also by the educators themselves.

We are aware that for our online survey, the sample is far too small to be considered representative according to scientific criteria, however, with the relatively limited time, staffing and financial resources available within the context of an Erasmus+ pilot project, the project group managed to draw at least a balanced sample with relevant and competent representatives of the target group.

The results of the study led to important insights for the further project work and - together with findings from the interviews with 21 project leaders of EU projects on immersive learning - have significantly influenced the didactic and methodological orientation of our products. In these interviews, we also asked the project leaders how they see the framework conditions of immersive learning in the classroom - and they largely came to the same conclusions as participants of the online survey.[3]

Furthermore, the results of this work are also highly relevant to other educators and educational policy makers. On the basis of these results, it is possible to derive measures that can improve the pedagogical training of educators at the national as well as at the European levels.

### 5. Derivations in a nutshell

In our postulates below, we do not give an exclusive summary of the statements made above - they are already very concise and concrete - but make bold statements that should lead to critical reflection, intensive discussions and - above all - to innovative changes and innovation in pedagogy.[4]

1. The C-19 pandemic has led to an **enormous boost in the diversity of digital learning and work in our education systems.** Contrary to many expectations, many digital methods and tools were used even before then. What is astonishing is that the **vast majority of educators have received little or no training in the use of digital methods and tools during their careers** - **and this does not seem to bother anyone very much.** What would be unthinkable in any other profession - e.g., a surgeon who operates without knowing how to handle scalpels, a pilot who confidently takes a jet plane with passengers up into the air without knowing how to land it, a dentist who says "please open your mouth" and at the same time looks in amazement at the completely unknown drill in his hand - seems to us to be completely normal when it comes to educating people. We should think very carefully about whether we want to continue to expose our learners to such risks.
2. Such ignorance not only casts doubt on whether homo sapiens even deserve its epithet, but is also - and this is quite serious - very dangerous. The next societies will be primarily (e-)knowledge-based and if Europe wants to be a world leader in this area, we have to prepare Europe's citizens, especially children and the youth, to face these challenges. Therefore, it is **imperative that rapid and intensive changes in educational standards are planned and implemented**. The **digitalisation** of society, economy and politics will be achieved most quickly and effectively if learners **not only learn about it as early as possible - but also through it!**
3. To ensure this, **educators in particular need to be trained quickly and comprehensively** in how to **prepare learners for an ever more rapidly digitising world, including using more digitised teaching methods and tools**! The good news – as our survey shows - is that educators themselves have grasped this necessity and want to further digitalise their teaching. It is extremely important to **build on this positive attitude and the existing interest** and to offer the educators **every support - quickly and sustainably, before frustration and demotivation spread due to a lack of support.**
4. One of the big problems in this context seems to be the **lack of time and a generally increasing shortage of skilled workers in pedagogy**, which leads to existing staff being even further stretched and not having the time and energy to deal with new methods and instruments. Several levels need to be applied here - one of them is certainly the **rigorous streamlining of training content and curricula**. We are currently teaching our children and learners largely outdated content, some of which is still based on a 19th Century bourgeois understanding of education and whose concepts and methods date entirely from pre-digital times. Much of the content today is no longer relevant, bears little rela-

tion to real life, or is now easily provided on a daily basis by modern technologies. **Very courageous decisions need to be taken** here, because **a system that only ever adds new content, but does not jettison any old content, is doomed to failure within a very short time**.

5. A very important result of our research is that educators - in management as well as in teaching - seem to be **rather open-minded with regard to digital media and are interested in continuing their education and improving their skills**. But they need support in the form of better **equipment, advice on strategic and operational decisions, intensive training** in the use of new media and additional support from IT experts.
6. **The vocational and continuous education and training of learning staff** needs to play a special role. The concept of lifelong learning is already anchored society and is propagated and demanded above all by the economy. It would be surprising if educators in particular were excluded from this. Especially for them, the **best available teachers must be engaged** to bring them up to speed immediately in all innovations of pedagogy. Since the rapid innovations in digitalisation will also lead to ever faster innovations in pedagogy, these **further training measures must also be carried out at short intervals – and participation should be obligatory**. Continuing education for educators should not be seen as a burdensome additional workload or, at best, as a nice-to-have, but as an integral part of a holistic educational philosophy of a knowledge-based society.
7. Comprehensive support for educational institutes is very likely not always to be covered internally, which is why **cooperation between education providers, research institutes and the private sector** is recommended. Educational institutes – no matter at which level and in which area - cannot have expertise in everything, they will have to look for support where it exists - on the open market! To be able to act in this way, **educational institutions need a certain amount of decision-making freedom and budgetary sovereignty**. This is especially true for public educational institutions (especially at school levels), which in many countries are still centrally controlled and administered and whose decision-making structures are characterised by low flexibility and rigid hierarchies. Here, it would be desirable to provide educational institutions with certain frameworks and budgets, but then - together with all stakeholders such as key authorities, teachers, learners, parents, external experts, etc. - let them make their own decisions. - to be able to make their own decisions. There is a reason why the Finnish school system - which is organised in exactly this way - is repeatedly voted the best in the world.
8. **All this** costs **money - a lot of money!** But there is no alternative but to admit that we are missing the connection to the digital age and leaving the field open to other nations and economies - and then it will be really expensive! The largest future economic sectors will be services - largely digital - and if Europeans are not prepared – meaning: trained! - for this at a significant level, then we will **lose the economic connection.** We can then only watch as other knowledge-based societies - such as the USA, China, Japan, South Korea, Australia, Canada, India and others - **continue to leave us behind**. It is a development that **starts with education and which then expands into other areas such as the economy, society and politics.** We have to take this step in any case - the longer we wait, the more we lose vital time and the more expensive it will be to catch up.
9. However, it should not be blamed solely on a lack of resources - especially money. All in all, the digital turn is above all a **psychological issue** in which older, analogue and newer, digital teaching paradigms seem to be at odds with each other, sometimes without understanding. But that would be the completely wrong approach and would not help us one step further in the matter itself. It is not a question of either/or and it is not about being right! It **is about the best possible combination of the best elements from both areas** in order to be able to prepare for the rapidly changing demands on knowledge, skills and competences. Here, educators and those responsible for education from both camps must approach each other **openly and cooperatively**, be prepared to critically and without prejudice question both the traditional and the new, and combine both into innovative methodological-didactic training concepts. First and foremost, educators must also learn and experience how learning should work best in the future. In addition to a high level of **methodological competence**, all experts involved need to be **very open**, have a **lot of understanding** for the other side, **consistently question meaningfulness** in all directions and have a lot of **courage** to change in different areas.

10. In all of this, it should not be forgotten that **digitalisation just offers methods and instruments that are only as good or as bad as the ways they are used**. And like every method and every instrument, the **digitised ones are not universally applicable** and can be used for everything. **Interdisciplinary groups of experts** made up of educationalists, psychologists, IT experts, sociologists, educational politicians, etc. are needed to define precisely in which areas the digitisation of teaching should be promoted first and foremost, and in which areas it makes only limited sense, and in which areas it does not make sense at all. Based on this, **training recommendations and guidelines** must be formulated - together with **revised curricula** - which **must be integrated as quickly and as much as possible into the pedagogical training of teachers and educators**.

Looking at your derivations, many things will sound familiar. Our study has certainly brought out one or two interesting new aspects, e.g., that the motivation and interest of teachers and trainers in further expanding their digital teaching areas is higher than assumed. But it is not surprising that, on the whole, we have come to the same conclusions as many experts who have been calling for similar improvements for a long time. What is surprising, however, is that so little has been done in this area by educational policy makers. As said above, we consider this to be extremely dangerous, because we see education as the basis for all other areas of society, economy and politics. Completely unexpected impulses for the digitisation of education, however, have come from the lockdowns caused by the C-19 pandemic, which have brought many methods and tools from the IT sector into the classroom for the first and for a long time. Now it is important to train and further educate teachers as quickly as possible on how these and other methods and instruments can be incorporated into modern European teaching concepts in a pedagogically meaningful and long-term way. Under no circumstances should we fall back into old digitisation doubts and negligence. Rather, the highest means and resources should be used to examine all digital innovations to see if and how they can be used for teaching, and then to train educators in their application. This should not be done to the detriment of traditional teaching and learning methods, but to enrich them. In essence, the question is not which methods one personally likes or dislikes, but which methods best prepare learners for the challenges of the present and future world.

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[1] *Response of an educator in the course of the European study to the question of what influence C-19 has had on her personal attitude towards digitalised teaching.*

[2] *The key criterion for answering the questionnaire was that respondents must have worked professionally as a teacher or trainer for at least one full year in one of the EU Member States.*

[3] *See Never Leave a Learner Alone, XRforPED (2022), www.xr4ped.eu*

[4] *The order of issues does not necessarily represent a ranking of urgency or importance.*

# Higher education needs to lead on immersive learning

VIRTUAL REALITY FINLAND RY

We need immersive technologies now more than ever, but we must work together to create a thriving, leading immersive learning ecosystem in Europe. Technology is ready to be implemented but now HEIs should be the driving force for change that pushed forward and accelerates the immersive learning revolution.

During the last couple of years, the Covid-19 virus has shown us how much we actually need technologies that enable learning and doing in a remote fashion. Schools in Finland have adapted extremely quickly to this new situation and most of the teaching is already done using virtual technologies. However, the big shift is still to come. Our learning methods and technology are still founded on listening and writing, instead of true experiencing and experimenting.

Even if we are going to have major short to medium term economic impacts due to the virus, we will need to look forward. Digitalisation is only going to accelerate. We need better technology to enable better productivity. Continuous learning and the technologies to make this possible are going to be deciding factors in the future competitiveness of our region.

Finland has the best education system in the world. This is a fact that has been demonstrated numerous times in worldwide studies. From the frontline we see that the age of immersive digital education is coming but it should also be accelerated, similar to what Tesla is doing for the electric car ecosystem.

The best way to learn is by doing. Virtual reality enables doing things in ways that would otherwise be impossible, expensive or dangerous. We can actually experience history. We can actually visit a high security nuclear powerplant and learn to maintain it without any danger. We can create, test and modify machines before they ever become physical. It is clear why virtual reality offers superior possibilities in comparison to other learning technologies.

So why is it not ubiquitous already? It comes down to usability, content and price. I must admit that on more than one occasion I have struggled technically with a PC VR setup. Wires have been inconvenient, content stores have been empty and finally, it has been quite expensive to purchase a powerful PC plus a VR headset.

Luckily, the situation has changed quite dramatically through Oculus launching its Quest headset.

Standalone VR headsets with 6DOF have qualities that make them the perfect entry-level devices for the education sector. Reasonable prices, greatly improved usability, no wires and improving channels to consume content give us the first platform that can really move immersive education forward.

Even though language, writing, books and the printing press have been tremendous inventions, immersive learning will be about experiences and 3D content. It is true that major investments will be required to develop technology and capabilities at many levels. It is still day one for the content creators and we are only seeing glimpses of what is actually possible when we start to create truly immersive learning experiences. However, now is the time to leap forward and start to build the required capabilities and ecosystems at the European level.

HEIs should lead from the front. They should be driven to find the best ways of utilising and exploring this potential so that the whole of society can benefit. They should not wait for some private sector company to create immersive teaching material but rather start to experiment and create it and the required capabilities themselves. Integrating the technology into teaching should be done in an iterative fashion, listening, learning and improving. It is now time.

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# EU PROJECTS


AR Anatomy
Right lung
Fraunhofer
Terrasse
Zimmer 2
Zimmer 3
Bad

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**FUNDING PROGRAMME**
H2020-ICT-2018-20

**DURATION**
01/11/2019-30/04/2023

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**SOCIAL MEDIA**
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# ARETE: Augmented reality interactive educational system

- Objective 1: To develop and evaluate the effectiveness of an interactive AR content toolkit;
- Objective 2: To apply human-centred interaction design for ARETE ecosystem
- Objective 3: To pilot and evaluate the effectiveness of AR interactive technologies
- Objective 4: To communicate, disseminate and exploit the project results

The ARETE project aims to support the pan-European interactive technologies effort both in industry and in academia, through multi-user interactions within AR technologies being evaluated in education in both professional and private contexts.

**Objective 1: To develop and evaluate the effectiveness of an interactive AR content toolkit**
ARETE will ensure that an interactive AR content toolkit will be developed for the creation of 3D objects based on AR standards. ARETE will create standards-compliant AR/3D data infrastructures for educational purposes to ensure applicability, reproducibility, interoperability, accessibility and sustainability.

**Objective 2: To apply human-centred interaction design for ARETE ecosystem**
ARETE will identify, update and integrate, on an ongoing basis, user-based insights into designing and developing AR content for the pilot studies.

**Objective 3: To pilot and evaluate the effectiveness of AR interactive technologies**
The ARETE ecosystem, which comprises of AR emerging technologies, a main platform, a training platform, a mobile app and a multi-lingual interface will be piloted. Students and EU citizens (i.e. 3000+ in EU member states) will participate in three different pilot studies.

**Objective 4: To communicate, disseminate and exploit the project results**
ARETE promotes project awareness and progress details to the targeted and to wider markets. Thus, a scientific, societal and economic focused dissemination and market outreach campaign will be well-formulated. In this context, we adapt a three-phase dissemination and market outreach approach to achieve this objective for take up beyond the life of the project.

**Work package 1: Ethics Requirements**
Objectives: To ensure compliance with the 'ethics requirements' set out in this work package

**Work package 2: Project Management**
Objectives: Management aims to ensure that the planned project activities are effectively performed, pursuing the project objectives in line with time schedule, budget, the establishment of standards for quality, risk mitigation, innovation management, conflict resolution, ethical and data protection.

**Work package 3: Interactive Augmented Reality Toolkit**
Objectives: Interactive AR Content toolkit ensures that 3D objects will be developed based on AR standards, global curriculum guidelines with a focus on English language literacy and STEM subjects, which are an important aspect for the development of 21st Century skills alongside digital literacy skills, including the important IEEE ARLEM 2.0 and IEEE VR/AR Augmented Reality.

**Work package 4: User-centred Interactive Design**
Objectives: The underlying objective of WP4 is to identify, update and integrate, on an ongoing basis, user-based insights into designing and developing the ARETE project, rendering it to be highly useful, usable, desirable and pleasurable.

**Work package 5: Interactive AR for PBIS**
Objectives: WP5 aims to develop and evaluate the multi-user interaction through augmenting the human interaction with different groups.

**Work package 6: Pilots' Implementation, Deployment and Evaluation**
Objectives: WP6 aims to execute pilot studies across Europe (Pilot 1, 2, 3). The implementation of interactive AR technologies within ARETE, which will primarily focus on the examination and implementation of both CLB and WWL platforms, will be conducted in this WP.

**Work package7: Dissemination, Exploitation & Communication**
Objectives of this work package are to efficiently disseminate and communicate details of the project activities, prepare communication channels and exploit the intellectual property developed within the project.

# Mixed Technologies for SMEs

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**FUNDING PROGRAMME**
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**DURATION**
01/04/2021 – 31/03/2023

**WEBSITE**
https://agile-learning.eu/en/projekte/mix-tec

**SOCIAL MEDIA**
https://sites.google.com/site/conferenceonprojectdevelopment

## Objectives of the Project

- An exchange beween practitioners on how XR can be usefully applied in continuing education and training (CVET)
- A concept of how XR technologies and didactic elements can best be combined
- A guideline for the cost-efficient and effective use of XR in CVET

## Difficulties with XR

Extended Reality (Virtual and Augmented Reality) has become increasingly important in the training of professionals. It allows the intensive visual impression of artefacts and processes that are too complex, costly or risky via direct interaction in a learning context.

Still, there are considerable problems with the implementation and use of XR - content-related and didactic difficulties as well as a complex technical implementation process and high costs. The technology is perceived as interesting, but does not necessarily lead to deep learning.

## Task of the project

The task of the project was to clarify which technologies should be preferred in which use case: where and when which hardware (tablet vs. headset vs. laptop, etc.) and which media presentation type (VR vs. AR vs. computer-mediated vs. physical) could be most useful and cost-effective. Furthermore, it sought to clarify how these technologies and didactic elements could best be combined into learning units.

## Lessons learned: A usage strategy

### Benefits of XR in VET

1. Within the context of education, XR technologies can be **powerful tools for enhancing visualization and understanding complex concepts**.
2. XR technologies can **bring the real world into the classroom**, allowing students to experience places and events that they might not be able to access in person.
3. XR technologies can be used to **combine different types of content**, such as text, images, videos, and 3D models.

Mix-Tec

Overall, with XR technologies educators can create engaging and immersive learning experiences that support learners in achieving their goals.

## Challenges

1. **Web-based Augmented Reality is not yet ready for production use.**
2. **Developing XR content requires expertise and specialized knowledge**, which usually requires trainers to work with (costly) external developers.
3. Follow-up costs can be difficult to predict.
4. **Tools and platforms supporting XR often limit the use of certain file types**, which can restrict the types of content that can be used.
5. **3D models, often used in XR experiences, need to be downloaded all at once**, which can be challenging for users with limited data volume.

## An option to overcome the challenges

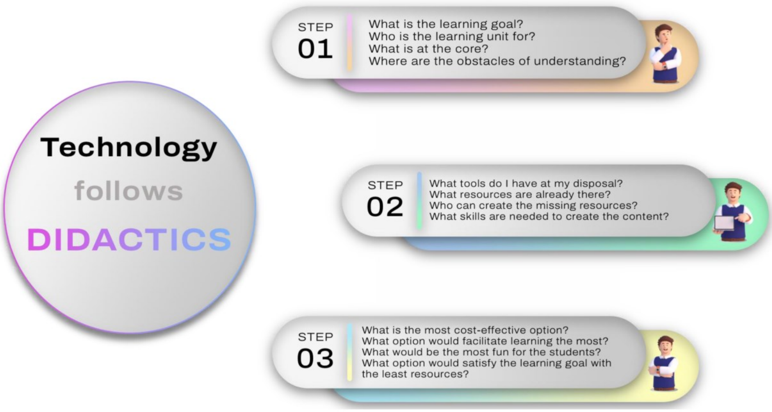
In Mix-Tec, an approach was developed to deal with the above challenges. The free and open source software H5P (https://h5p.org/) was used to create interactive learning content for the web. It is aimed at "laypersons", i.e. teachers in schools, universities and further education institutions and already has hundreds of thousands of users.

H5P relies on a modular approach that allows teachers and trainers to easily combine different content types themselves. So far, XR applications are not directly provided in H5P. In Mix-Tec, however, case studies have been developed on the basis of H5P, which give an idea of the potential (soon on the project website). Work on this will be continued.

## Best practices for using XR in education

1. **Start with identifying the learning objectives and target audience**, i.e. the requirements for the specific learning unit.
2. **Develop a plan for the XR elements.**
3. **Adopt an iterative development process**, that allows for regular feedback and iterations.
4. **Provide clear instructions and guidance**, e.g. written instructions, demonstration videos, or in-person training sessions.
5. **Conduct regular assessments**: evaluate the effectiveness of the XR elements regularly and ensure that they are aligned with the learning objectives.
6. **Update and maintain the XR content** to reflect changes or add new content to keep the learning unit fresh.

Overall, this will help to ensure that XR technologies are used effectively to support learners in achieving their learning objectives and developing their knowledge and skills. See also the image: Technology Follows Didactics.




Co-funded by the Erasmus+ Programme of the European Union

# VirSTEM

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FUNDING PROGRAMME
Erasmus+

DURATION
01/11/2020-30/04/2023

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## Virtual technology for use in STEM (Science, Technology, Engineering, Mathematics)

The goal of the project VirSTEM - Virtual technology for use in STEM (Science, Technology, Engineering, Mathematics) is to create an international open educational resource – the online course "Fundamentals of Modelling and Engineering Graphics" (3 ECTS) which innovatively integrates BIM (Building Information Modelling). The course will be designed for Bachelor level Engineering students of construction specialities, both in-person and distance learners, and distance service training for specialists.

The goal of the VirSTEM - Virtual Technology for Use in STEM (Science, Technology, Engineering, Mathematics) project - is to create an international Open Educational Resource – the online course "Fundamentals of Modelling and Engineering Graphics" (3 ECTS), which innovatively integrates BIM (Building Information Modelling). The e-course is designed for undergraduate students of construction specialities, for both full-time and part-time studies, and for the advanced training of specialists.

Modern new technologies in the construction industry are primarily based on BIM and require significant changes for the training of engineers. Monitoring training courses has revealed the need for more advanced training materials that integrate BIM objects and interactive training materials with 3D object simulators. Moreover, a new approach to training specialists is needed, given the global physical distancing situation. The leading role is played by distance and independent learning using high-quality interactive materials.

The "Fundamentals of Modelling and Engineering Graphics" course comprises of eight thematic modules, including 3D simulations, short video guides, interactive exercises for students to study and practice, tests and an innovative, intelligent rating system with feedback and certification.

VIRSTEM

Learning material from an e-learning course on various STEM subjects allows students to associate parametric information and the studied objects, thus providing a solid foundation for engineering education. The e-learning approach is practical due to its simplicity, cost-effectiveness and playful form.

The innovation of the VirSTEM project is to introduce BIM technology into the subjects during the first year of undergraduate engineering programmes. This provides interdisciplinary connections and a better understanding of the educational material. Engineering thinking skills are acquired in an interactive, playful way, providing a fundamental basis for target groups to use BIM technologies in the future to support creative thinking in their daily work and to develop innovative potential.

An online course is a prototype of a new concept of modern intellectual education. In this approach to learning, this will help:

- reduce the need for human and material resources for the acquisition of fundamental knowledge in basic technical subjects and the initial use of BIM,
- help enterprises speed up the training / advanced training of workers in production,
- provide high-quality and innovative educational material for beginners in the construction professions and interested users of BIM, regardless of their level of education and financial or physical capabilities.

The work in the VirSTEM project was done by educators, IT specialists, and designers in a group of five well-known higher education institutions that teach engineering in the Baltic Sea countries - TTK UAS Estonia, Vilnius Tech Lithuania, RTU Latvia, TAMK UAS and Metropolia UAS Finland. These universities have many successful partnerships and the project teams consist of experienced faculty and highly qualified BIM modelling professionals with valuable hands-on experience.

The F course was used in the BIP project on mobility and co-education of students from Lithuania, Latvia, Estonia and Ukraine. For the online training of an international group of students from 23.01 to 18.04.2023, the interactive content of the e-course created by the project was used. The students were in Tallinn from April 19 to 21, 2023, for a joint training and modelling practice in the Revit, AutoCAD, SketchUp, FormIt, and Archicad programs. The winners of the modelling competition received valuable prizes and the feedback from the project participants - teachers and students - demonstrated the high efficiency and promise of the educational material.

# VAM*Realities


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**DURATION**
01/01/2020-31/12/2022

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## Plug & play with virtual reality

In the VAM Realities project, higher education institutions, companies, and business representatives from all over Europe join forces to provide VR/AR/MR. It is Europe’s largest network of experts and a comprehensive showcase of related EU projects.

Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR), commonly referred to as Extended Realities (XR), will have a medium to large impact upon our learning and working worlds. The educational sector, schools and universities, must also be aware of these technologies, where and how they can be used and which factors can promote added value in the transfer processes or special unique selling points.

Due to the speed of technical developments and the mass of available information, products and services, it is difficult to keep track. How, what, with what, how much time, what costs - all common questions.

The VAMRS project has developed an XR coaching program to integrate XR technology into manufacturing SMEs, regardless of how familiar the employees and/or management are with VR/AR technology. The coaching program has been structured into different learning levels to cater to all participants and interests, to achieve tangible results for all participants and the integration of VR/AR technology.

The XR coaching model has been tried and tested, evaluated several times and can be freely used and adapted by anyone. A few points have proven to be conducive to successful implementation:

- Selection of 3 partners per partner country to participate in in-depth training/education;
- Signing of an official learning agreement between SMEs and partner organizations for participation in the training activity;

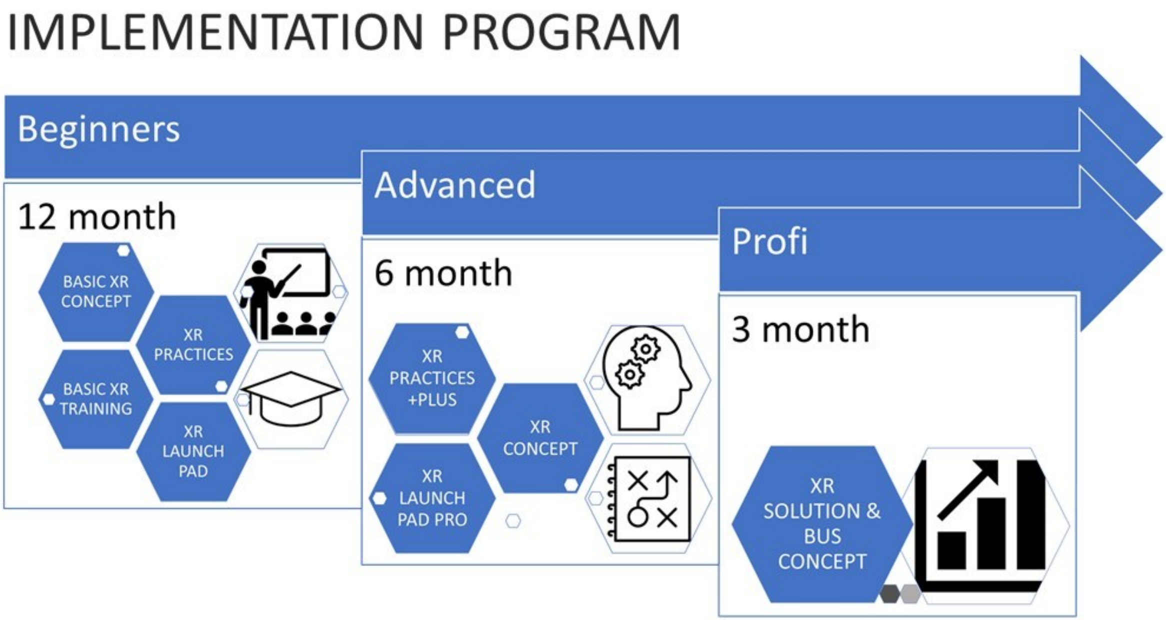
- Testing and learning about hardware, software, methods, materials, products, etc. selected by the project provider;
- The duration of the pilot project varies from participant to participant between 1 and 9 months.

It is recommended that each participating organization completes the coaching program with 40 hours of learning material. Relevant learning material must be selected by the learning content provider, taking needs and interests into account. The time, frequency and intensity of the coaching sessions can be adjusted flexibly and are based upon the needs of the participants.

The beginners level can be done individually, but is better in groups of 4-8 people. The dynamics of the situation must be assessed by the trainers and experts in order to create the best possible environment for getting to know, understanding and accepting the content. It is important to let everyone have their say so that perceptions, ideas, wishes and also reservations are revealed and discussed seriously. The next level follows almost seamlessly: technology you can touch and try out. In the third stage, practical experiences are shared with third parties during site visits. The "look behind the scenes" opens up new, highly individual starting points for personal, very effective learning and teaching. Here is a list of learning levels:

1. Introduction to the basic concepts of XR plus a step-by-step tutorial for VR/AR hardware.
2. Overview of XR technology and development background and overview of worldwide implementation;
3. Use cases for pedagogy and overview of current implementation.
4. Presentation of useful apps and software for getting to know VR/AR.
5. Introduction to the VAMRS State-of-the-Art report, which shows current hardware and software available on the market, suitable for everyone, and gives an overview of relevant use cases.
6. VAMRS Expert Panel: Connectivity and expert advice from the VAMRS Expert Panel and how the Expert Network can help SMEs in their country and region.
7. European VAMRS project showcase: Experiences for SMEs and connectivity and collaboration through the European VAMRS project showcase.
8. VAMRS SME Skills Gap Detector: How to interpret the self-assessment results and how this tool can support interested individuals on their XR journey.

Learning for teachers in schools and colleges has never been easier!



# Virtuaalimatkailu: Virtual Travel

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**COUNTRY**
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**FUNDING PROGRAMME**
European Regional Development Fund

**DURATION**
01/04/2021-31/08/2023

**WEBSITE**
https://projects.tuni.fi/virma/in-english

The project develops new service models utilising digitalisation for companies specifically operating in the traveling and experience economy. The project methods include immersive technologies to boost services and developing a new model of business.

The VIRMA project aims at revolutionizing the travel and experience economy through digitalization.

The COVID-19 pandemic has had a profound impact on numerous sectors, particularly the travel, event, service and experience sectors. The VIRMA project aims to address the challenges faced by these business sectors by fostering the development of innovative business models through the use of advanced digital and virtual technologies.

Focusing on companies operating in the travel and experience sectors, mass events, and related services, the VIRMA project is dedicated to creating new service models that leverage digitalization. The ongoing effects of the COVID-19 pandemic, lockdowns, and restrictions have necessitated the adoption of innovative digital strategies to revitalize these sectors and support their operations.

The primary objectives of the VIRMA project include supporting and assisting companies in the travel, event, service and experience sectors, helping target businesses create new and innovative business models, and utilizing the latest digital and virtual technology solutions. The project seeks to answer intriguing questions, such as the development of a virtual (travel) experience, the involvement of travel -related businesses in creating such experiences, and the path to continuous and profitable business operation.

The VIRMA project employs agile experiences, methods to integrate digitalization to boost services and the development of new business models. Pilots, workshops and genuine co-creation with SMEs in the Pirkanmaa region ensure effective dissemination and exploitation of the project results. The most important identified outcome will be a model of a digital service concept that can be generalized to benefit most stakeholder groups in the travel and experience sectors.

Throughout the pandemic, various personal experiences and lessons have been learned. Interest in virtual experiences has waned as individuals now prefer engaging in live experiences. Some companies believe that virtual tourism as a profitable business can only function if another event like COVID-19 occurs or device prices significantly decrease. However, XR solutions effectively support marketing efforts, which may involve incorporating 360-degree photographs or videos into commercial online services or social media platforms. Utilizing

360-degree, AR, and, to a lesser extent, VR technologies as marketing tools can be highly effective if the budget permits. In practice, almost anyone can create homemade 360-degree videos with an affordable camera. These videos, when featuring a compelling narrative and an authentic individual engaging in pleasant conversation, have been well-received.

Recommendations for political decision-makers include increasing funding and support for projects aimed at enhancing digital education and immersive teaching and learning experiences. Fostering collaboration between the private sector, educational institutions, and government bodies is crucial for developing and implementing innovative digital solutions in the travel and experience sectors. Furthermore, supporting the development of digital infrastructure is essential to ensure that all businesses have access to the necessary resources and tools required to participate in the digital economy.

The VIRMA project represents an important step towards a more resilient and adaptive travel and experience economic sectors, leveraging digital solutions to overcome the challenges posed by the COVID-19 pandemic. With a focus on innovation, collaboration, and effective implementation, the project has the potential to significantly benefit businesses and stakeholders in these industries, contributing to a more sustainable and prosperous future.

# The equitable, inclusive and human-centered XR project

**The main objective of XR4HUMAN is to co-create guidance on ethical, policy, regulatory, governance, and interoperability issues of eXtended Reality (XR) technologies with an emphasis on equity, inclusivity and human-centeredness.**

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**FUNDING PROGRAMME**
European Commission- EU/ Horizon Europe

**DURATION**
01/11/2022- 31/10/2025

**WEBSITE**
https://xr4human.eu

**SOCIAL MEDIA**
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XR or immersive technologies are characterized by "*immersive video content, enhanced media experiences, and interactive and multi-dimensional human experiences*" (XR Safety Initiative, 2021). XR technologies refer to virtual reality, augmented reality, and mixed reality. Beyond gaming and entertainment, XR is applied to diverse areas, such as surgical education (Sam Daley, 2022), armchair traveling (John Woods, 2020), simulation and specialized training in high-risk operations (William Cunneen, 2020), equipment and product development and maintenance (Jacob Dillon, 2018), planning, designing, and enhancing customer experience (Daan Terra, 2021). As a result, XR has the potential to revolutionize the way we approach immersive teaching and learning, since they bear the potential to provide students with engaging, interactive, and personalized learning experiences that are difficult or impossible to recreate in the real world.

However, to realize the educational potential of XR technologies, especially within the context of its use by minors, the new risks, ethical issues and challenges arising from their widespread use must be addressed. Despite the fact that there is a rich literature on these issues as well as on initiatives to regulate XR technologies, Europe and the rest of the World are still in the process of defining and establishing the ethics, regulatory, and governance structures for XR technologies.

Currently, some frameworks exists, such as The Privacy Framework of the XR Safety Initiative (Privacy and Safety framework, 2020), which addresses "abuse of power"; however, no framework to date is nationally or internationally enforceable. Also, frameworks such as The Privacy Framework are limited to issues relating to privacy and confidentiality. All the other initiatives are proposals in the literature that are yet to achieve regulatory and/or technical uptake (Michael Madary & Thomas Metzinger, 2016, Kent Bye, 2019) Relevant regulations, like the GDPR, naturally apply to XR environments; however, what this means for a technology with an unprecedented capacity for information gathering, remains to be clarified. It is characteristic that none of the above studies and initiatives address the issue of interoperabil-

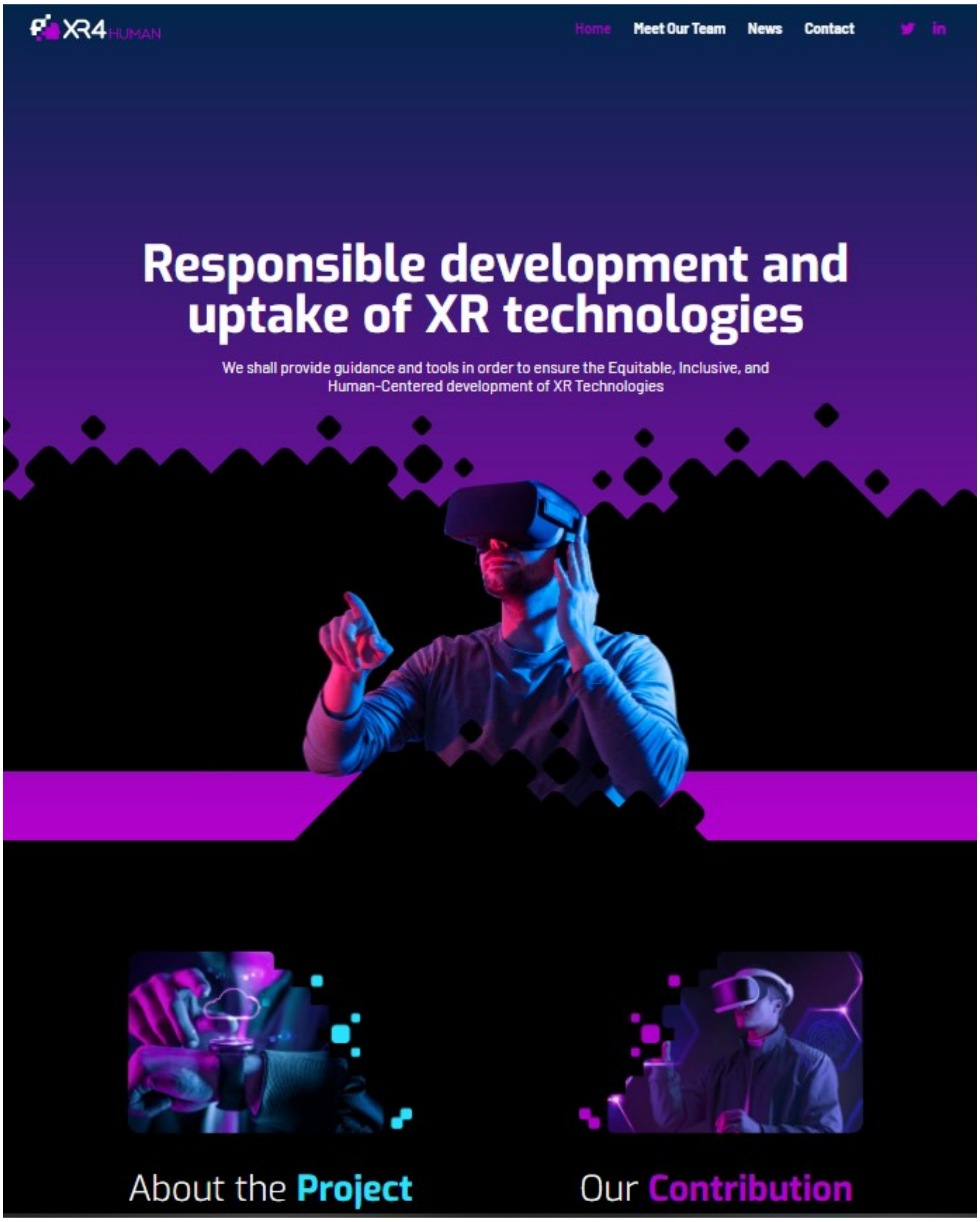
Funded by the European Union

ity, user empowerment, disinformation, and the possibility of mental, physical, and societal harm.

With these existing shortcomings in mind, XR4Human will use a human-centered approach as a framework from which gaps and challenges will be viewed, and it will formulate solutions.

To forge a competitive ecosystem, where the European XR Industry can play a leading role in the wider deployment, adoption and acceptance of ethical and human-centered XR technologies and, at the same time, empower citizens towards informed decisions when purchasing and using XR, XR4Human will develop measures as standardization and policy dialogues for developers, producers, and policymakers (ethical framework, regulatory guidance, guidance documents); demonstrations for developers, producers, and policymakers (practical application of the Code of Conduct); awareness-raising for users and citizens in general, implemented by developers, producers, and territorial institutions (rating system and educational materials for informed users).

These measures could affect the design of digital tools in general - and educational tools in particular - as these are used in immersive teaching and training. By applying ethical plan and human-centered design of immersive experiences, by addressing issues of diversity, inclusivity and accessibility, and cost, and by integrating XR technologies into existing teaching methods, educators will be able to ensure that all students benefit from these innovative approaches to learning.



# CORTEX²

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**FUNDING PROGRAMME**
Horizon Europe

**DURATION**
01/09/2023- 31/10/2025

**WEBSITE**
https://cortex2.eu

**SOCIAL MEDIA**
https://twitter.com/Cortex2EU
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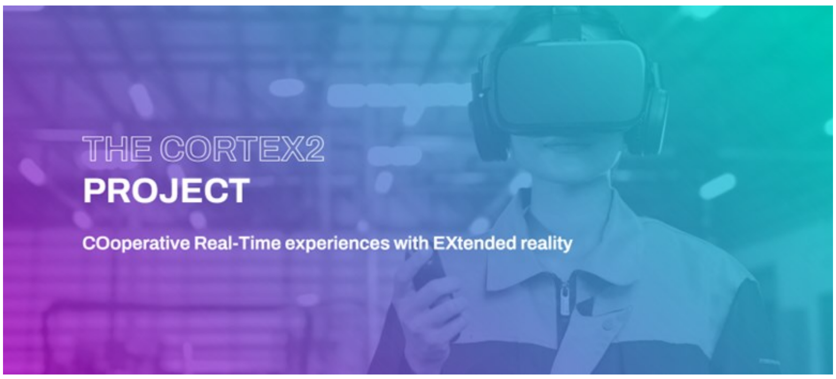
## COoperative Real-Time EXperiences with EXtended reality

The mission of CORTEX² is to bridge the divide between widespread video-conferencing tools and state-of-the art XR-based solutions, democratising the uptake of next-generation XR tele-cooperation among a large number of industrial segments and SMEs.

The COVID-19 pandemic pushed individuals and companies worldwide to work/study from home or change their working/teaching model, and disrupted education in over 150 countries, affecting 1.6 billion students. The share of employees who usually or sometimes work from home rose from 14.6% to 24.4% between 2019 and 2021 (*Employment - annual statistics', Eurostat, 2022*). In Europe, the proportion of people working remotely rose from 5% to 40% as a result of the pandemic. Today, all the signs indicate that remote working is here to stay, with 72% of employees stating that their organization is planning some sort of teleworking in the future *('2022 State of Remote Work', Buffer, 2022*). But not all organizations are ready to adapt to this new reality, where team collaboration is vital.

According to the World Bank (*Remote Learning During COVID-19: Lessons from Today, Principles for Tomorrow*), for remote learning to be successful it needs to allow for meaningful two-way interaction between students and their teachers; such interaction can be enabled by using the most appropriate technology for the local context.

The use of information and communication technologies (ICTs) for remote working and learning has gradually taken hold in different areas of our lives. This can bring multiple benefits, such as greater access to learning and training, increased motivation towards different learning content, and greater diversity for entertainment, socializing, or the enhancement of creativity.



**Different advances in technology are taking place and are being explored to improve immersive learning, including the topic of CORTEX$^2$, extended reality (XR) collaborative experiences**. CORTEX$^2$ aims to contribute to this goal with innovative tools (natural and flexible experience, semantic multi-channel fusion, integration of the Internet of things, IoT), with the **end** goal of **democratising the access to remote collaboration offered by next -generation XR experiences.**

In line with the above, **CORTEX$^2$ provides full support for augmented reality (AR) experiences as an extension of video conferencing systems when using heterogeneous service end devices,** through a novel Mediation Gateway platform:

- Resource-efficient teleconferencing tools through innovative transmission methods and the automatic summarization of shared long documents.
- Easy-to-use and powerful XR experiences with instant 3D reconstruction of environments and objects, and simplified use of natural gestures in collaborative meetings.
- Fusion of vision and audio for multichannel semantic interpretation and enhanced tools such as virtual conversational agents and automatic meeting summarization.
- Full integration of internet of things (IoT) devices into XR experiences to optimize interaction with running systems and processes.
- Optimal extension possibilities and broad adoption by delivering the core system with open APIs and open calls to enable further technical extensions.

**During its lifetime, CORTEX$^2$ will demonstrate the potential of fully interactive XR-based cooperation in several pilot areas,** such as industrial production, business meetings and **remote training.**

During the development and testing of the tools, and parallel to technical validation, **CORTEX$^2$ is taking into account important aspects like sustainability (reduced footprint) as well as the ethical, legal and social challenges of XR experiences**. In fact, **one basic pilar of CORTEX$^2$ is the analysis of the social impact associated with XR technology adoption,** exploring psychosocial and ethical factors influencing social presence (demographics like gender, culture, attitudes toward social experiences, agency etc.) and the possible negative effects involved in the use of XR, like technostress.

# A new trainer teaching framework in the post-Covid era

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**FUNDING PROGRAMME**
Erasmus+

**DURATION**
01/06/2021- 31/10/2023

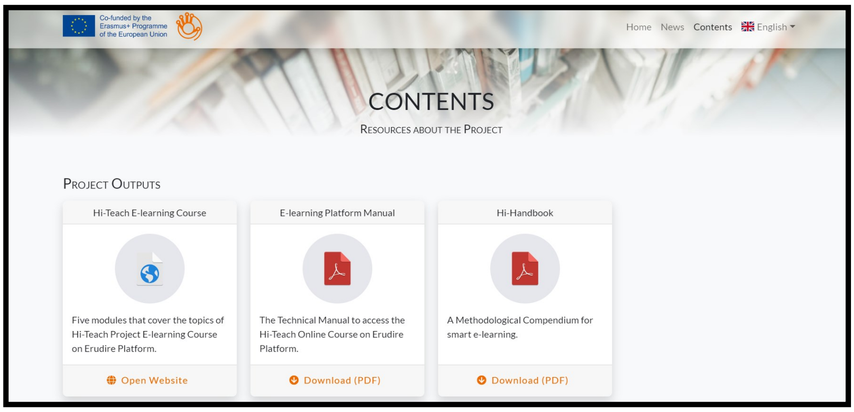
**WEBSITE**
https://hi-teach.unisa.it/#main

**SOCIAL MEDIA**
www.facebook.com/Hi-Teach-Project-112834074538609
www.linkedin.com/in/hi-teach-70b596225/

The HI-TEACH project proposes to strengthen university academic skills and knowledge by building on the experience gained from the Covid-19 pandemic period, during which many faculties and students found themselves adapting to the situation using digital and online tools and methods. This project proposes to seize the moment by turning this emergency period into a greater opportunity for the improved use of digital methods by both university faculties and students.

The Covid-19 emergency forced universities throughout the world to transfer their teaching activities online, giving rise to the largest digitization experiment in history. It was a challenge destined to profoundly influence the academic scenario of the future, making e-learning a permanent component of university teaching and placing individual teachers and the governance of different universities at a crossroads: whether simply to resort to the what is now outdated remote video lesson or to use turnkey training products, not conceived and created by placing the student at the centre of the teaching process, but packaged tout-court in an industrial approach. This condition is difficult to reconcile with the plurality and heterogeneity of learning needs that should not be demeaned, approved and compressed but rather valued, interpreted and satisfied to prevent the risk, due to Covid and other factors, of decreasing enrolment numbers and of financial resources (EUA, The impact of the Covid-19 crisis on university funding in EU, 2020).

In response to these critical issues, the project, through the creation of a strategic partnership between HEIs and methodological and technological innovation training centres, focuses on the development of digital and methodological skills for a pool of teachers from 10 HEIs



in 5 EU countries (IT, EL, ES, SI, PL) favouring the evolution towards the role of the Hi-Teacher, able to supervise hi-tech teaching equipment and to apply inclusive web-based teaching methods that look at the use of audio-visual and gaming as experimental grounds to introduce elements of flexibility, simplicity, accessibility, interactivity and personalization, which represent key quality indicators in open learning. This project design implies a transnational cooperation strategy for extended HE to generate relational, scientific and methodological capital of high added value that cannot be achieved alone by regional and/or national initiatives.

**The project's objectives were achieved by realizing the following activities:**

1) Develop for the benefit of EU teachers involved, technological skills and methodologies to manage learning processes through digital solutions and behavioural qualities of resilience, flexibility and adaptation to change to build permanent just-in-time, flexible, learner-centred digital teaching tools, that promote digital integration in learning with the adoption of smart e-learning solutions, to disseminate design and teaching skills.

2) Align 50 teachers from the partnership, involved in transnational mobility, to acquire and transfer methodologies, such as: game-based learning, movie editing and instructional design.

3) To nourish and keep alive over time a process of innovating a digital key models of university teaching with the development of a methodological manual that guides the integrated digital didactics of the Hi-Teacher.

4) Aliment and maintain over time, a process of innovating a digital key of university teaching models by creating a methodological manual that guides the integrated digital teaching of the Hi-Teacher.

**Expected results**

The project includes 3 main intellectual outputs:

**1. HI-TEACH LEARNING PROGRAMM: DOING DIGITAL EDUCATION 4.0,** includes the following integrated activities:
- Field Analysis
- Learning program
- Testing: by 50 teachers from Italy, Greece, Spain, Slovenia and Poland involved in the educational pathway articulated on the following three dimensions: Cognitive, Operational and Behavioural

**2. OER FOR THE HI TEACHER**, divided into two phases:
- Processing of learning content
- OER development

**3. HI-TEACH HANDBOOK:** The partners co-developed a methodological manual to evolve the teacher into the role of the Hi-TEACHER, also through learning about 'what are immersive technologies applied to education'; 'what is Virtual Reality (VR)'; 'what is Augmented Reality (AR)'; 'how to use VR, AR and digital learning material in new and innovative ways'.

# Transforming primary school students' English as a Foreign Language Learning (EFL) with Augmented Reality (AR)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**FUNDING PROGRAMME**
Erasmus+

**DURATION**
01/06/2021– 31/05/2023

**WEBSITE**
https://ar4efl.eu

**SOCIAL MEDIA**
https://web.facebook.com/AR4EFL


AR4EFL aims to equip primary school teachers with innovative tools and resources for teaching English as a foreign language to primary school students.

AR4EFL **aims** to equip primary school teachers with innovative tools and resources for teaching English as a foreign language to primary school students. To achieve this, the following objectives have been set:

- Motivating students to learn English as a second language by creating a realistic learning environment for them.
- Designing, testing, and disseminating an innovative educational package for primary school teachers based on Augmented Reality (AR) technology to guide and support the teaching of English (or any other) as a foreign language.
- To provide primary school teachers with quality training on how to use the innovative training package in order to encourage their pupils to improve their English language skills.

The project foresees the following **outcomes**:

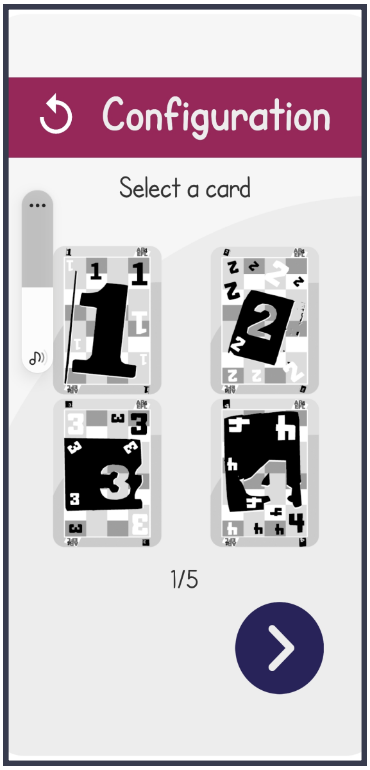
- The creation of the AR4EFL Handbook for teachers outlining the theoretical framework for using AR in teaching English as a foreign language.
- The development of an AR app for teaching English as a foreign language that encourages collaborative learning among students.
- The development of a set of seventeen well-organized lesson plans to guide teachers not only in the use of the AR4EFL app but also in the adaptation of these lesson plans so that they can adapt their

lessons to the needs of their students or even create new ones.

**As for my personal experience**, the opportunity to collaborate within a diverse team with various skills and expertise from various EU countries contributed to my personal growth and development by enhancing my understanding of the use of Augmented Reality technology in English language learning and in education in general.

In addition, it improved my cultural skills by enhancing my understanding and appreciation of cultural differences, which is an essential skill in our globalized society. As new partnerships emerged, AR4EFL provided me with opportunities for professional networking.

**For teachers to effectively use the AR4EFL app**, it needs to be integrated into the curriculum to ensure that it supports the learning experience. This will ensure that the AR4EFL app is used to facilitate learning and not as a stand-alone activity. However, this is assured as the AR4EFL app has been designed specifically for pupils in primary schools, with a focus on ensuring that it is not only simple to use but can also be integrated into the curriculum. This is also served by the created lesson plans, which teachers can adapt to the needs of their students or even create from scratch.




For teachers who are unfamiliar with AR technology, we recommend that they test the AR4EFL app beforehand and have a backup plan in case something goes wrong.

In addition, they can begin with a simple activity by providing pupils with explicit instructions on how to use it.

Finally, we believe it is essential to evaluate the learning outcomes when using the AR4EFL app to identify areas for improvement and ensure that it is utilized effectively in the classroom.

**The AR4EFL app cannot be used by students in Greek schools as the use of mobile phones is prohibited by law.** In 2018, the Greek government prohibited the use of mobile phones in schools, citing concerns about classroom distractions and cyberbullying.

Pupils and teachers alike are prohibited from using mobile devices during class time, as well as during breaks and extracurricular activities. The only exceptions to the prohibition are in cases of emergency, medical necessity, or when expressly authorized by a teacher for educational purposes.

However, that prohibition is controversial, with some, including the AR4EFL partners, arguing that it restricts students' access to technology and thus hinders their education, while others believe that it can reduce classroom distractions and improve student behaviour.

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**COUNTRY**
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**WEBSITE**
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# letzSCIENCE AR: Explore the stories behind research in Luxembourg

letzSCIENCE presents Luxembourg research topics in augmented reality. The aim of the project is to offer a low-threshold, immersive and entertaining entry into research and to inform the general audience on publicly-funded research topics and results.

## Exploring science in a whole new way: The letzSCIENCE AR app

*An immersive and interactive approach to communicating Luxembourg's research topics*

Science communication is an essential tool for promoting science and technology and plays a crucial role in encouraging fact-based discussions in society and promoting democratic debate. It involves disseminating scientific knowledge to the general public, policymakers and other stakeholders. The more effectively science can be communicated, the more likely people will be able to understand and appreciate the benefits that science brings. Today, science communication is moving beyond traditional methods and embracing new technologies, such as augmented reality (AR), to provide a more immersive experience for audiences.

The letzSCIENCE AR app is one example of such innovation in science communication. Developed by the Luxembourg National Research Fund (FNR), the app provides augmented reality experiences that showcase eight different research topics supported by FNR funding. Users can access these experiences using their smartphones or tablets and interact with 3D models of scientific phenomena, such as diatoms, plasma, cancer cells, solar energy, and more.


The app's primary objective is to raise awareness of research in Luxembourg in a creative and interactive way that will trigger viewers' curiosity for science. By presenting research topics using an augmented reality experience, letzSCIENCE AR aims to inspire users to learn more about scientific research and discoveries made in Luxembourg. Additionally, the app provides an overview of selected research projects and groups in Luxembourg, encouraging users to discover

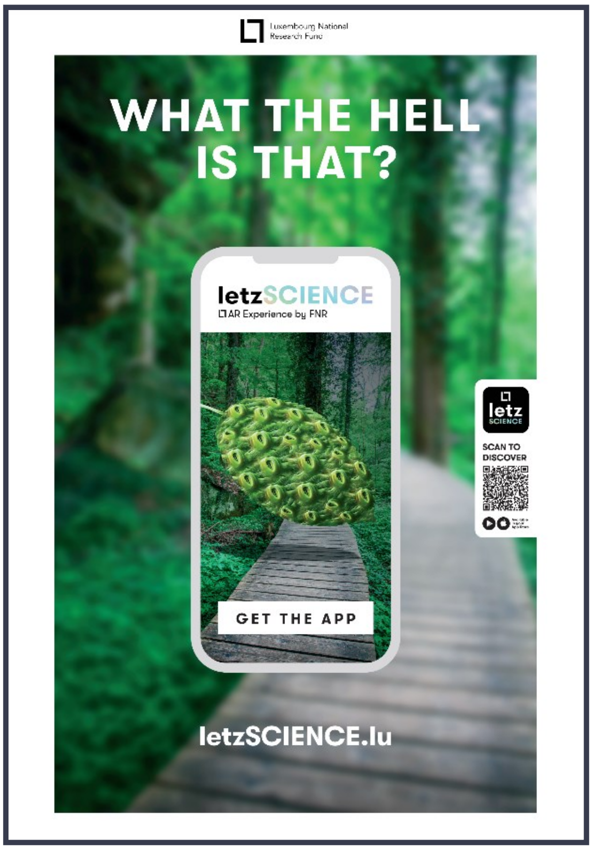
Luxembourg National Research Fund

their full stories on the dedicated website letzSCIENCE.lu.

The letzSCIENCE AR app offers a unique and captivating way for users to experience science that is more immersive and emotional than traditional methods such as reading or watching videos. Through the app, users enter a semi-virtual world that ignites curiosity and encourages further exploration. The emotions experienced by users whilst using the app are an essential aspect of science communication, as research has shown that emotionally engaged users are more likely to remember the information presented, leading to a deeper understanding of scientific concepts. Therefore, the letzSCIENCE AR app provides an emotional experience that creates an immersive and unforgettable entry into the discovery experience.

On the lessons learned side, there are multiple elements to consider. Firstly, content creation is crucial and takes time and resources, as you not only need to consider preparing discussions with the scientists but also the detailed briefing of the AR specialists who will design the experiences based on that briefing. Secondly, the real dissemination work only starts once the AR experiences and the related content are prepared, as at that point, you only have engaging and fascinating content at best, but no audience yet. Targeted digital marketing efforts are needed to be deployed in order to bring the content you have prepared to the audiences. This promotional step needs to be viewed through a customer-centric product sales lens, not as a scientific communication process. It is important to view this entirely as a sales exercise, even if the end goal is to communicate scientific content to a lay audience.

The pandemic has highlighted the importance of digital education, the need for innovative tools that support effective remote learning, and the added value that science brings to the democratic debate in society. By investing in digital education, policymakers can provide students, but more generally a broader audience, with high-quality learning experiences that provide them with evidence-based information that supports them in their opinion-forming process.




XR FOR PED

Mixed Realities for Pedagogues

# SHOULD VIRTUAL LEARNING BECOME A REALITY?

Policy issues and best practice for applying immersive technologies in European education

GREEN PAPER

www.xr4ped.eu

Co-funded by the Erasmus+ Programme of the European Union

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# XR FOR PED

# SHOULD VIRTUAL LEARNING BECOME A REALITY?

## Policy issues and best practice for applying immersive technologies in European education

www.xr4ped.eu

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Staatlich anerkannte, private Fachhochschule des Mittelstands (FHM)