Integrating VR/AR technologies in Higher Education

Report on best practices across Europe

VRinHE
VIRTUAL REALITY IN HIGHER EDUCATION

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1. Introduction

Over the last years, educational institutions have attempted to utilize digital tools to foster digital transformation. Digital transformation of Higher Education (HE) can be supported and promoted through digital initiatives like Virtual Reality (VR) and Augmented Reality (AR) integration. In this context, a few universities have been experimenting with adding VR/AR as a teaching tool or making VR lectures a part of the curriculum (Bezegová et al., 2017). However, VR/AR have not been established as teaching instruments. Their use and effective incorporation into HE courses, and curricula is sparse and limited to some sporadic actions of university departments and characterized by underinvestment. Similarly in partner countries, Austria, Bulgaria, Cyprus, Greece, and Latvia, VR/AR are not widely used in HE and there is no common strategy on how to integrate them in teaching and learning, despite their huge benefits to the education process. As stated in a Bologna Process Implementation Report, Higher Education institutions will themselves "*need support – including peer support – in making optimal use of digital technologies for learning and teaching and helping to develop digital skills more broadly in society*" through quality learning (European Commission/EACEA/Eurydice, 2020. p. 160). In terms of effective VR/AR integration into the HE curricula, instructors, academics, and learning designers, need in-depth education and training concerning what VR/AR is about, how it can be integrated into lectures, how students could benefit from utilising VR/AR, and how their own pedagogical approaches and classes can be boosted by using VR/AR applications.

As a response, the VRinHE project will focus on addressing the learning needs of universities and instructors, by building their competencies to develop learning-outcomes-oriented curricula that better meet the learning needs of students, in engaging and interactive ways. Faculty members across partner institutions will collaborate and implement trans-disciplinary approaches and innovative pedagogies such as VR supported student-centred learning, inverted learning and research-based learning which promote the acquisition of transferable skills. The target groups will be better prepared to implement VR and AR digital tools for creating engaging curricula, learning activities and assessment that advance learners' digital competences, in line with the European Commission's 2021-2027 Digital Education Action Plan that suggests digital transformation for education at all levels. Through a series of training opportunities and events, they will develop basic digital skills to be able to integrate VR and AR in their teaching practices. VR/AR integration could enhance the development of learners' soft skills such as critical thinking, problem solving, adaptability, creativity, self-motivation, leadership (Kallidus, 2017; Radianti et al. 2020). Therefore, their effective incorporation into HE curricula will result in learners' improvement of 21st century skills such as digital, problem-solving, and creative competences, put in the forefront by the labour market and the society.

The present report aims to present the data obtained through a systematic literature review (SLR) in the field of VR/AR applications in HE in partner countries and the European Union (EU). The review focused on several practical aspects in regards the implementation of these technologies such as methods, objectives, tools, and strategies used for implementing VR/AR teaching in the field of HE, that may prove helpful for HE leaders and faculty members interested in integrating them in their curricula.

The report is structured as follows. In Section 2, VR/AR/XR terms are defied and the current policy framework regarding VR/AR in EU as well as in partner countries is presented. In this Section we also present the finding from a VR/AR readiness survey to HE leaders, faculty, staff, and students from partner countries. This is important to understand the context in which higher education institutions experiment with VR/AR technologies. In Section 3, the methodology for conducting the SLR is briefly described. In Section 4, the results of the SLR are summarized and presented, in a way to answer the SLR research questions. Identified best practices in each partner country, but also in EU are described in detail in Section 5. This Section also includes selected best practices of VR/AR applications in HE from the rest of the world. Lastly, some conclusions are drawn in Section 6.

BACKGROUND

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2. Background

2.1. Defining AR/VR/XR

There is a fair amount of confusion about the differences between the terms Virtual Reality (VR), Augmented Reality (AR) and Extended Reality (XR). The purpose of what follows will be to clarify what is really behind each of these acronyms.

What is Augmented Reality (AR)?

Augmented Reality is an emergent technology that allows the superposition of digital elements into the real-world environment. In the AR experience, you can see a composite view of physical or real-world elements and digital elements. However, there is no interaction between the digital elements and the physical world elements. AR appears in direct view of an existing environment and adds sounds, videos, 3D graphics to it (Fig.1).

Figure 1. Augmented Reality example Retrieved from https://maker.pro/custom/tutorial/how-to-make-augmented-reality-apps-resources-for-beginners, July 2022

What is Virtual Reality (VR)?

Virtual Reality (VR) is an immersive experience also called a computer-simulated reality. It refers to computer technologies using reality headsets to generate the realistic sounds, images and other sensations that replicate a real environment or create an imaginary world (Fig.2). VR is a way to immerse users in an entirely virtual world. In VR experiences, the physical or real-world environment is entirely blocked out.

Figure 2. VR example. Retrieved from https://www.nbcnews.com/mach/science/what-vr-devices-apps-turn-real-world-virtual-ncna857001, July 2022

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What is Extended Reality (XR)?

Extended Reality (XR) is a newly added term to the dictionary of the technical words which refers to all real-and-virtual combined environments and human-machine interactions generated by computer technology and wearables. Extended Reality includes all its descriptive forms like the Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (MR). In other words, XR can be defined as an umbrella, which brings all three Reality (AR, VR, MR) together under one term, leading to less public confusion (Fig. 3).

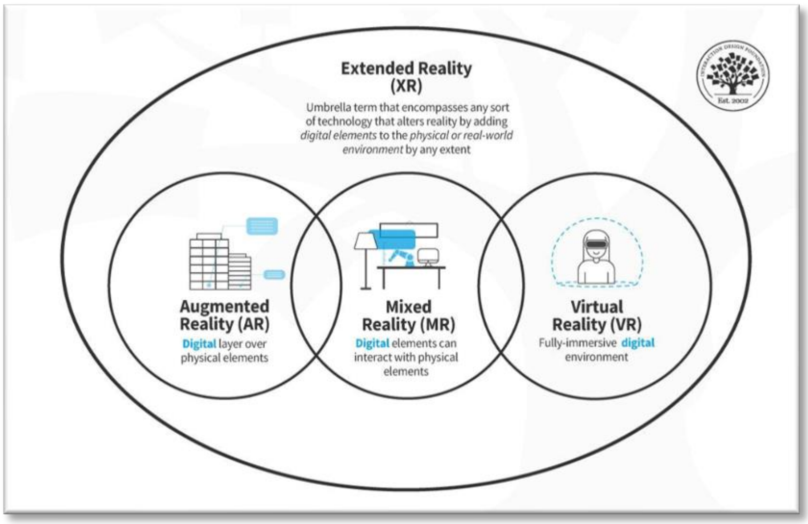


Figure 3. The term XR includes AR, MR, VR, and any technology that blends the physical and the digital world.. © Laia Tremosa and the Interaction Design Foundation, CC BY-NC-SA

2.2. European policy framework on VR/AR

Although European Commission, the executive of the EU, does not have a specific policy framework for VR/AR adoption in the field of HE, there are some of its decisions and recommendations that shape the context in which HE institutions can utilize these technologies. Below we briefly present them.

As stated in the work of Schwaiger (2021), in 2011 the Commission launched the Agenda for Modernisation of Europe's Higher Education Systems (EC 2011/567 final), which sought to improve "*the quality and relevance of higher education by exploiting the potential of ICTs*" (p. 7), aiming to make the "*knowledge triangle work by linking higher education, research and business for excellence and regional development*", by creating close and effective links between education, research and business. Lastly, it sought to "*build on the pilot project to strengthen the interaction between universities and business through knowledge alliances*" (p. 11).

The agenda was followed by the Digital Single Market Strategy, which underlined a new dynamic across the European economy as a whole, fostering jobs, growth, innovation and social progress, since all areas of the economy and society are becoming digital; consequently, it postulated that a "*change is needed in the way education and training systems adapt to the digital revolution*" and to the empirical findings that showed "*teachers' lack of digital competences, and their lack of confidence in using digital technologies meaningfully in teaching*. [...]. Additionally, a recent public consultation on the "Agenda for the Modernisation of Europe's HE Systems" showed that "*over two-thirds of students and recent graduates perceive a mismatch between the supply of graduates and the knowledge and skills that the economy needs.* [...] *Other important challenges identified by stakeholders include the impact of technology and globalisation on higher education* [...]" (EC 2015/196: final).

From this, initiatives were derived to increase the digital competences of educators as quickly as possible (EC 2017/29000, 41), and as a consequence, the European Framework for the Digital Competence of Educators endorsed initiatives that set up learning activities in digital environments for both teachers and learners; these allowed teachers to experiment with and develop new formats and pedagogical methods (EU:

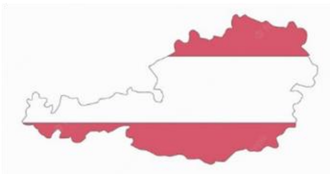
DigCompEdu, 2017, 52). This also included the continuous evaluation of information technology curricula at all training levels as well as the creation of applied blended learning environments in authentic settings, such as in workplace-based learning.

More recently, the European Commission proposed the first ever Digital Europe Programme, which will invest €8.2 billion to align the next long-term EU budget 2021-2027 with the increasing digital challenges. With this programme, European Digital Innovation Hubs (EDIHs) will function as one-stop shops to help companies respond dynamically to the challenges and become more competitive. EDIHs are expected to play a central role in stimulating the broad uptake of artificial intelligence, high performance computing (HPC) and cybersecurity, as well as other digital technologies like VR/AR by industry (in particular SMEs and midcaps) and public sector organisations across Europe.

Lastly, an important initiative is the recent creation of the VR/AR Industrial Coalition, which was first announced in 2020 in the Commission's Media and Audiovisual Action Plan. This initiative aims to inform policy making, encourage investment, facilitate dialogue with stakeholders and identify key challenges and opportunities for the European VR/AR sector. According to the rationale behind the formation of this coalition, Europe has a large potential industrial market which could benefit from these technologies. To remain relevant in this new context, Europe needs to build a digital skills pipeline, develop sustainable business models for VR/AR enterprises, support the digitization of European cultural heritage, foster the development of digital audience experiences, and ensure it does not fall behind in the business-to-business market.

2.3. Policy frameworks on VR/AR per partner country

2.3.1 Austria



Digitisation in teaching is seen as the complete penetration of traditional teaching processes by digital tools and applications, which in turn changes conventional forms of educational approaches. The available approaches and applications comprise tools such as online learning or blended learning formats, freely accessible online course (e.g., MOOCs), and virtual reality / augmented reality seminars making use of VR/AR soft- and hardware to completely immerse students. The main goal is to use these available technologies intelligently and sensibly to improve the quality of education offers. Universities play an essential role in this process and can actively shape digitisation efforts, as they are mediators and producers of knowledge and thus, contribute to – and even shape – the digital transformation. The co-called "University 4.0" approach has to be reflected in all areas of Higher Education institutions, not only limited to teaching, but also in research, publication and even administrative areas (e.g. the use of a digital identity with features such as digital certificates).

Higher Education governance is a key factor in this endeavour: It puts is focus on digitisation as reflected in the Austrian University Development Plan, which defines the process of digital transformation (including teaching important basic digital techniques such as computational thinking or digital skills) and its active shaping as a "key system goal". To achieve this goal and strive for the best possible options for students, performance agreements between the 22 Austrian public universities and the Federal Ministry of Education, Science and Research are elaborated every three years as a basis for their financing:

- In these agreements for the years 2019 to 2022, the main aim was to ensure an increased use and provision of open educational resources as sources and tools available in the public domain were seen as the essential foundation for providing digital teaching and studying.
- The agreements made for the years 2022 to 2024 focus on digitisation in learning and teaching, on so-called "new teaching and learning worlds", the continuous development of digital teaching and learning at universities and on open science in a more general way. As digital media is an essential part of daily life, higher education institutions have to reflect this trend and pick up on the latest developments. According to the official source of the Austrian government,

“This applies in particular to the use of innovative teaching and learning technologies, which has increased massively, especially due to the sudden switch to distance learning in March 202 as a result of the Corona pandemic. It has triggered a multi-layered process of innovation and reflection at universities and higher education institutions that can no longer be reversed.”

The Higher Education sector in Austria seems to be aware of the fact that the focus cannot only lie on students and the digital resources available to them, but also has to be put on teachers, as they all – tutors, lecturers, professors – need to be able to use the digital tools confidently and correctly. For this reason, service centres for digitally supported teaching have been established.

Following studies and working groups about distance learning in Austrian Higher Education institutions during the COVID pandemic, several practical recommendations for implementation were made for post-pandemic digital educational approaches. In order to adjust to the individual universities’ circumstances, however, the Austrian Minister of Education stressed that it is up to the universities themselves to consider to what extent and for which subjects they are able and willing to offer digital teaching. Additionally, they should also be able to decide individual whether digital courses from other (also foreign) universities can be included in their educational offers as a supplement and additional service. At the University of Graz, a study was conducted which focused on the use/application of VR and AR in Adult Education. This international systemic analysis found that research and concepts for the use of VR/AR in Adult Education is not widely prevalent; this is also very evident in the Austrian Adult Education sector, where there is hardly and research to be found on this topic.

2.3.2 Bulgaria

Bulgaria’s national policy framework for the overall development of the education in the country and in particular – the higher education, is contained in several documents. They represent long-term programs and strategies for the 2021–2030 period, which are officially adopted by the Bulgarian government. Their implementation has either already started or is expected to begin within a short timeframe.

There are plans for the development of the virtual and augmented reality technologies (VR and AR) in the higher education sector in those documents. Emphasis is also placed on the improvement of the overall digital skills and competences of both the students and teachers.

The first document is the Strategy for the Development of Higher Education in the Republic of Bulgaria for the 2021-2030 period, which was adopted on January 8th, 2021. The strategy presents the main principles and priorities in the development of the higher education for the period until 2030. The ten described goals are relevant to the current challenges, especially those related to the accelerated development of digital technologies and the need for increased digital competences.

One of the goals is for "development of a sustainable mechanism for updating the existing curricula and programs and creating new ones" and one of the activities for achieving that goal is "accelerating the teaching of modern digital technologies and strengthening of the interdisciplinary connections in the curricula". As described, this activity includes three measures, one of which is "the inclusion in all curricula of disciplines and practical trainings in new digital technologies, such as artificial intelligence (AI), augmented reality (AR) and virtual reality (VR)".

The strategy also acknowledges the need for the educational process to be focused on the students attaining, among other things, digital competences.

Another part of the national policy framework is the Strategic Framework for the Development of the Education, Training and Learning in the Republic of Bulgaria (2021-2030). It is not focused only on the higher education sector, but rather on the entire educational landscape of the country. The document emphasizes the need to invest time and resources in increasing the students' key competences, which are required in the modern world, including their digital skills. For that to happen, the pedagogical specialists' digital competences and abilities to work with new ICT technologies also need to be developed. That way, they can integrate those innovative skills in their teaching for all subjects and that is also something, which is planned for in the document.

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The strategic framework also stresses the importance of developing innovative teaching and learning methods, based on digital technologies and open education resources.

Programme Education is another strategic document, which lays out the financing plans for the Bulgarian education sector for the 2021-2027 programming period with the help of funds from the EU – mainly the European Regional Development Fund (ERDF), the European Social Fund Plus (ESF+) and a few others. It was approved by the European Commission on August 8th, 2022. Programme Education is one of the main instruments for the implementation of the strategic goals in the aforementioned Strategy for the Development of Higher Education and the Strategic Framework.

The document lists the main priorities, which have to be funded in the next years:

1. Inclusive education and educational integration.
2. Modernization and quality of the education.
3. Connection between the education and the labor market.

One of the activities within Priority 2 is the digital transformation of the education through support for the practical work of students in a laboratory environment, so they can gain knowledge and skills for working with virtual and augmented reality technologies. Another activity within this priority is the support for building the digital competencies of both students and pedagogical workers in the higher education.

Priority 3 supports the adaptation of the vocational education to the needs of the labor market through the development and implementation of educational materials with an innovative digital content, incl. the usage of virtual reality.

There is a connection between the introduction of VR/AR technologies and the development of STEM education enabling additional resources for STEM practices. The Bulgarian education system has been traditionally supportive of STEM, providing students with numerous opportunities to broaden their experience in different fields outside the curriculum. Currently several non-government and academic organisations are responsible for the bulk of the STE(A)M initiatives in Bulgaria and most of them work closely with policymakers, trying to ensure the sustainability of their initiatives, some of which have been standing for decades and have turned into an institution of their own. The longest standing form of extracurricular activities have been the various Olympiads – mathematics, informatics, information technologies, physics, chemistry, astronomy, mathematical linguistics etc. Bulgaria has been a founding member of most of the international Olympiads in these fields and last year founded EJOI (European Junior Olympiad in Informatics). Bulgaria is also one of the few countries, where students receive direct support and mentorship from active researchers.

High school research is another well-established traditional STEM activity, due to the tradition of research organizations in mentorship and access to resources to talented high school students. The High School Students Institute of Mathematics and Informatics has been functioning since 2000, initially modelling its structure and activities after the US Center for Excellence in Education and then – gradually expanding and diversifying its methods. Currently it organizes two annual high school conferences, an interview-based grant initiative supporting high achieving students to participate in international research programs, and an international summer school in the field of mathematics, computer science, ICT, or astronomy.

The Bulgarian Ministry of Education and Science's current priorities include:

- Involvement of the three interests' parties in STEM skills intensification – kids/students, parents, school/education authorities.
- Funding for STEM education innovations and interdisciplinary projects development aimed at foster collaborations for sharing and co-creation of new knowledge among High Schools or/and Education Institutions.
- Better STEM through better STEM teachers: fostering change management in education and development of education change management strategies for each High School/education institution.
- Improvement and digitalization of STEM infrastructure (STEM Labs), facilities, and libraries (digital STEM libraries at High Schools/education institutions).
- Overcoming the inequality and better integration through learning communities and development of STEM knowledge map and paths (STEM BUS Bulgaria)

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- Pragmatism, transparency, and visibility of STEM efforts: ideas and contributions of all interest parties can be achieved through the development and sustainability of Open Data STEM portal Bulgaria.
- Integration with the foreseen EIT community hub in Bulgaria

In October 2022 Dream Space opened in Bulgaria – a free STEAM learning hub available for all teachers and students. Microsoft Bulgaria, in collaboration with Telelink Business Services, launched Dream Space – a STEAM learning hub offering immersive, research-based experiences to all Bulgarian students and teachers for free. The plan for this first school season is to reach 10.000 students and 600 teachers. Microsoft additionally plans to invest 1 million BGN within the next five years to upgrade Dream Space's laboratories and material base to fulfil students' and teachers' needs for resources and good practices. The concept of the Dream Space learning journey is research based, combined with Microsoft's global experience in the tech area. Dream Space shows Microsoft's commitment to Bulgarian society, which we have been a part more than 20 years. This is one step further – a learning hub where every teacher and student can experience science and technology in a unique way. The essential part of this educational journey will be innovative, fascinating, and fun technologies such as virtual reality, Sphero Edu robots, Arduino, and Minecraft: Education Edition.

2.3.3 Cyprus

In recent years, many initiatives have been undertaken in Cyprus towards developing and implementing virtual and augmented reality technology applications. University research laboratories and university-linked Innovation Hubs are at the forefront of the research, development, implementation, and promotion of VR/AR solutions in education, marketing, art, cultural heritage, and other fields. Additionally, Cyprus HEIs have effectively used VR solutions and applications to teach science, foreign languages, and history.

Nevertheless, to date, no specific policy framework(s) relate specifically to integrating VR/AR technologies in HE on a national level. Despite this, the integration of virtual and augmented reality is highly encouraged within other official strategies, including the “National Artificial Intelligence (AI) Strategy” (2020) and the “Digital Strategy 2020-2025”.

The “National Artificial Intelligence (AI) Strategy: actions for the Exploitation and Development of AI in Cyprus”, compiled by the Department of Electronic Communications, Ministry of Transport, Communications and Works, encourages the development of Digital Innovation Hubs in Cyprus to foster the development of Artificial Intelligence applications. In the strategy, universities and research organisations are at the epicentre of this effort to support companies in different market sectors with various technologies, including virtual and augmented reality and their applications.

Digital Strategy 2020-2025 of the Republic of Cyprus, specifically the Digital Society Portfolio within it, directly refers to said technologies. As it states, the Digital Strategy of Cyprus for 2020-2025 encompasses initiatives aimed at “the utilisation of virtual experience technologies to deliver virtual/augmented/mixed reality educational and cultural experiences that promote our history and cultural heritage, but also enable the delivery of safer realistic, immersive training to public servants whose jobs may require that (e.g. policemen, firemen, search and rescue crews etc.).” The advent of 5G in Cyprus is also described as a factor that will facilitate the growth of VR and AR in various areas, with an added focus on training.

2.3.4 Greece

In Greece, there is no specific policy framework for VR/AR adoption in the field of HE. However, since Greece is an EU member country, there are legislations that are shaped by EU recommendations and therefore form the context in which national HE institutions utilize these technologies.

According to the most recent law 4957/2022, Greek Higher Education Institutions (HEI) are expected to plan and implement policies that:

a) Enhance the utilization of new digital technologies,
b) Contribute towards the digital transformation of their services,
c) Upgrade their digital infrastructures and

d) Promote the development of digital skills in teaching, administrative, and other personnel, as well as in their students.

Each HEI is allowed to develop its own digital transformation plan, based on its unique needs and stakeholders' characteristics.

Moreover, there are centralized policies that are driven by the national Digital Transformation Strategy 2020-2025, also called the 'Digital bible'. This is the main strategic document, which sets priorities for the digital transformation of the country, as well as goals to develop the digital skills of Greek society - at all levels and ages.

The Greek Bible outlines the guiding principles, strategic axes, and interventions on a horizontal and vertical level that aim to enhance and support the digital transformation of Greek society and economy. Regarding education, the Bible includes one priority action that is directly related with AR/VR and is called Augmented Reality Labs.

The action envisions the creation of 100 pilot labs across the country that will provide opportunities to experience Virtual and Augmented Reality technologies. The labs will be located in schools and educational institutions of all levels, so to support the teaching and learning process in the field of education and training. The action also aims to improve the educational experience both in general and in professional and continuing education, to develop teaching staff specialized in these emergent technologies, to link education with production and research and to promote the development and improvement of digital skills of all ages in a modern environment.

In each pilot lab, all the necessary AR/VR equipment will be provided for the needs of training/practice of students of different specialties. Furthermore, in each lab, AR content, pedagogical scenarios and real time evaluations of the systems will be available.

2.3.5 Latvia

The goal of "Digital transformation guidelines 2021-2027" is to develop unified digital solutions and introduce new, efficient, publicly accessible services and infrastructure that meet the development trends of the global information society and the EU's digital single market. When creating the guidelines and vision for the development of education in Latvia until 2027, NAP2027, as well as the trends of Latvian education development indicated in the reports of international organizations - OECD, UNESCO, the World Economic Forum, the EU and other organizations - were taken into account.

"Development of technology and digital skills" is also mentioned along with several others points. Digital skills are equated with literacy and numeracy in terms of their importance, emphasizing that at least at a basic level, they are and will be needed by everyone in any field of activity. Moreover, digital skills are important not only in the professional environment, but also in the performance of various daily, domestic activities, which is determined by the general rapid development of e-services and the digitization of the economy.

In addition to the benefits related to digitalization, it is equally important to ensure that the increase in the use of modern technologies in the education process and outside of it does not negatively affect the health of children and adults. The increasing frequency and duration of use of modern technology among children and young people has a negative impact on their health indicators - quality and duration of sleep, physical activity, health of the support (including back) and locomotor apparatus, eye health, psycho-emotional health, which in the long term can cause various health risks. The Covid 19 pandemic has accelerated the world, i.e., see digital reorganization of Latvia as well, both emphasizing current problems and pointing to future development opportunities.

In recent years, positive trends have been observed in the field of education of future pedagogues. Since 2020/2021 of the study year at the Faculty of Education, Psychology and Art of the University of Latvia, it is offered to study the academic master's study program "Technology Innovations and Design for Education". The goal of the new study program is also to promote the ability of its graduates to create new pedagogical and design solutions for a technology-enriched learning process, that is, to transform from users of new technologies into their developers.

The creation of the study program has also contributed to the fact that the equipment with various types of technologies to be used in the preparation of future pedagogues has significantly improved at the Faculty of Education, Psychology and Art of the University of Latvia. For example, students have access to a modern and flexible computer classroom, a virtual reality laboratory, a robotics laboratory, and 3D printing. The ActivInspire software developed by the educational technology manufacturer Promethean was also purchased, which is an internationally highly regarded tool for creating interactive lessons. Therefore, students are provided with the opportunity to learn the basic principles of programming, educational robotics, the possibilities offered by virtual reality, work with 3D printers, development of websites and learning platforms. Currently, one of the biggest challenges is the performance of teaching staff.

Sources:

https://www.izm.gov.lv/lv/media/13864/download

https://www.saeima.lv/petijumi/Digitalie_macibu_lidzekli_Latvija.pdf

2.4. VR/AR readiness assessment results from Higher Education Institutions in partner countries

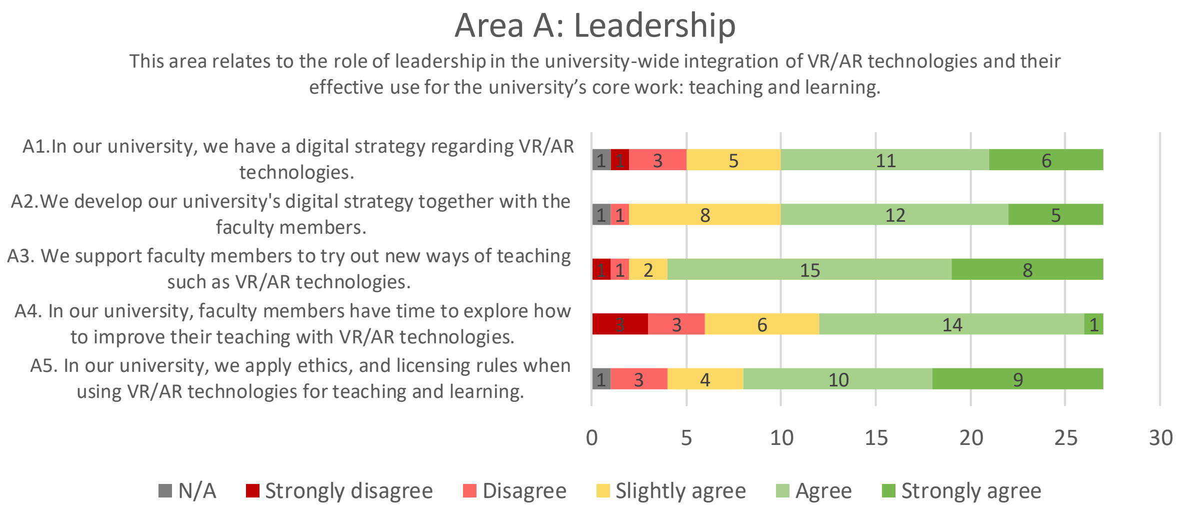
VR/AR readiness is considered a major factor influencing the technologies' acceptance in Higher Education. Through VRinHE project we developed a VR/AR readiness assessment tool for Higher Education members, that was distributed to over 150 Higher Education Leaders, faculty, students and learning technologists in total from partner countries (Austria, Bulgaria, Cyprus, Greece, Latvia).

The tool's questions (see Appendix) were derived and adjusted from SELFIE, a free questionnaire designed by European Commission to help schools embed digital technologies into teaching, learning and assessment. Sections that were covered were: -Leadership readiness: what is needed by university leadership teams and overall digitalization levels, -Infrastructure and equipment: what is available and what else is needed, -Continuous professional development for faculty, leaders, and support staff, -Teaching and learning, -Current teaching practices, -Assessment practices: how it is done and what role VR/AR can play, -Student profile – student competences, access to tools, etc.

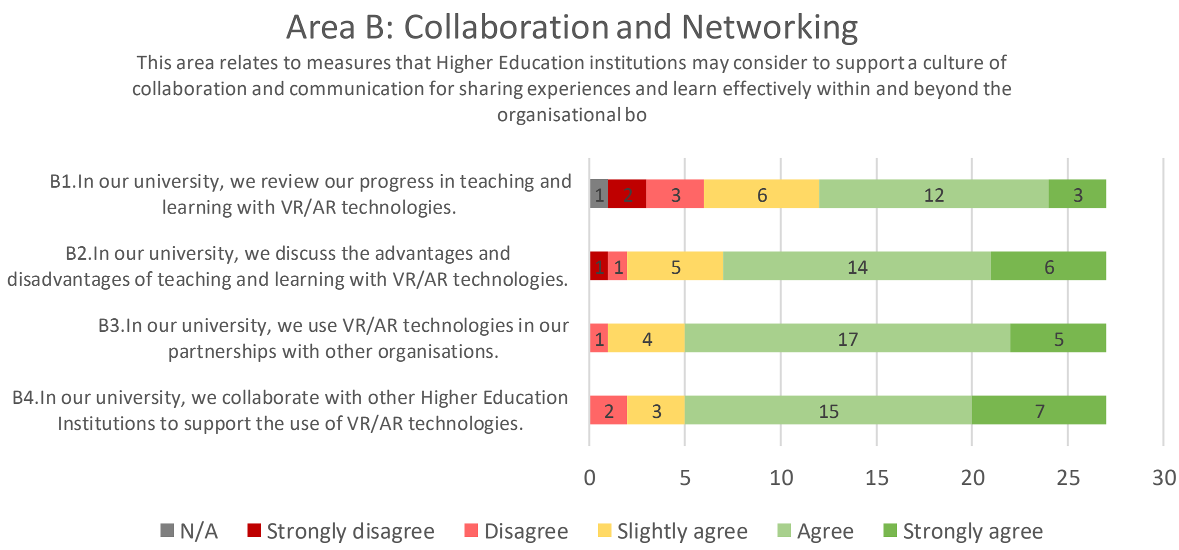
VR/AR readiness assessment of Higher Education Leaders.

We received 27 answers from HE Leaders (i.e., Deans, Vice-Deans, members of university's leadership structure) from the partner countries. Sixteen (~60%) were male, while almost half of the respondents had more 20 years of experience in education. Ten (37%) were aged between 40-49, 9 (33,3%) between 50-59, while 5 (18,5%) were older than 60 years old.

The results from each section are shown below:



Higher Education Leaders in partner countries consider their role quite supportive to integrating VR/AR in their institutions. More than half of them agree that there is a digital strategy regarding these technologies, which was developed in coordination with the faculty members. More than half of them also agree that they support faculty member try new ways of teaching as well as there are rules and ethics when using VR/AR in their institutions. They do however identify lack of time of faculty members to explore the affordances of VR/AR as a challenge.



Regarding collaboration and networking, the majority of Higher Education Leaders replied that they review their progress in teaching with VR/AR technologies and discuss their potentials for teaching and learning. Most of them use VR/AR in their partnerships with other organisations and collaborate with other HEI to support the use of these technologies.

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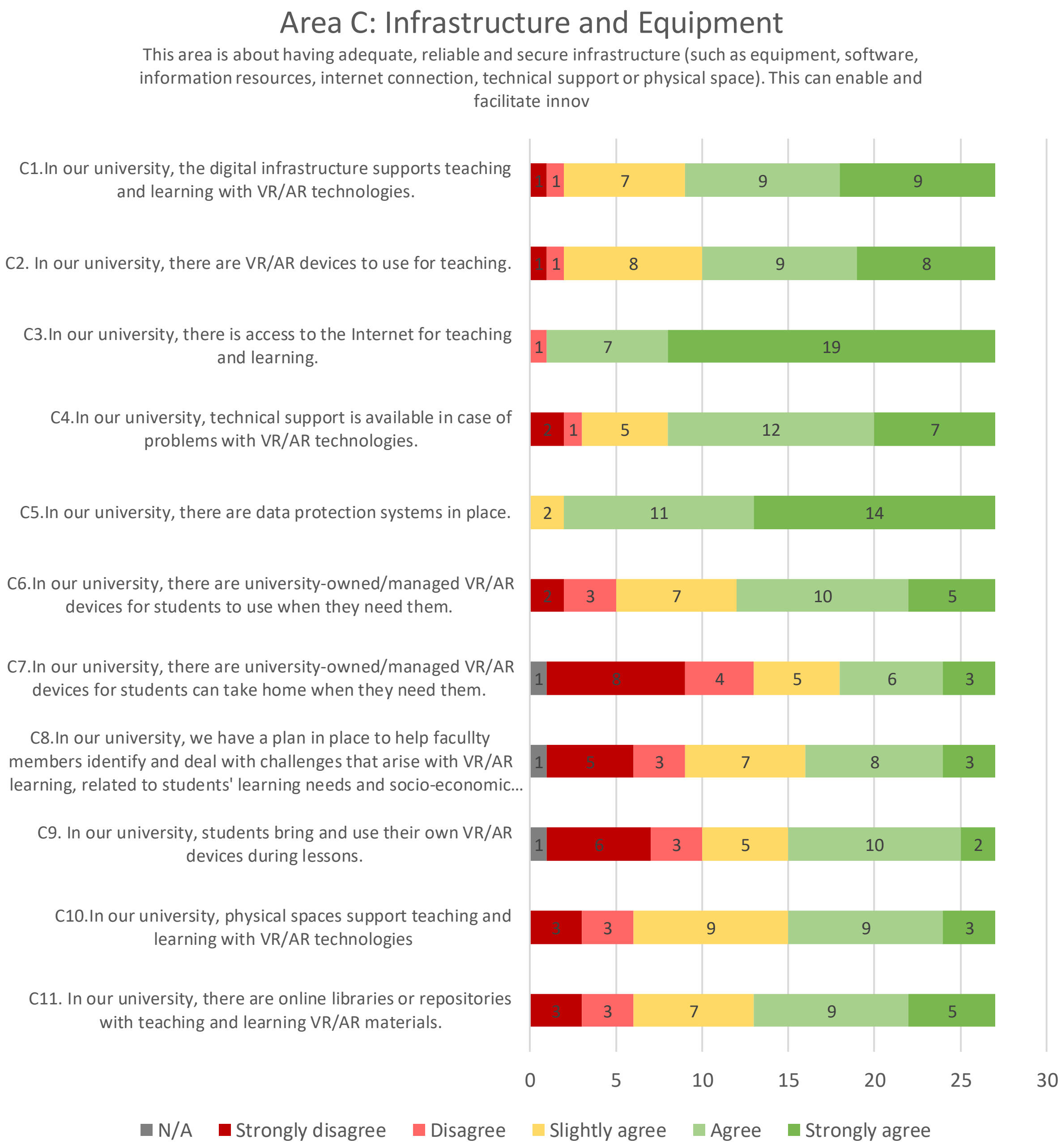
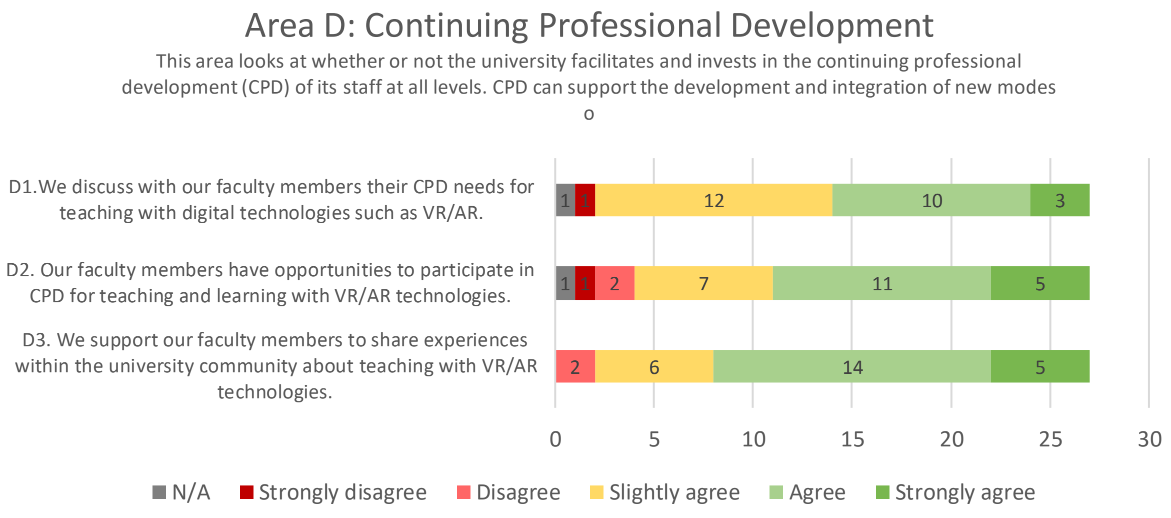
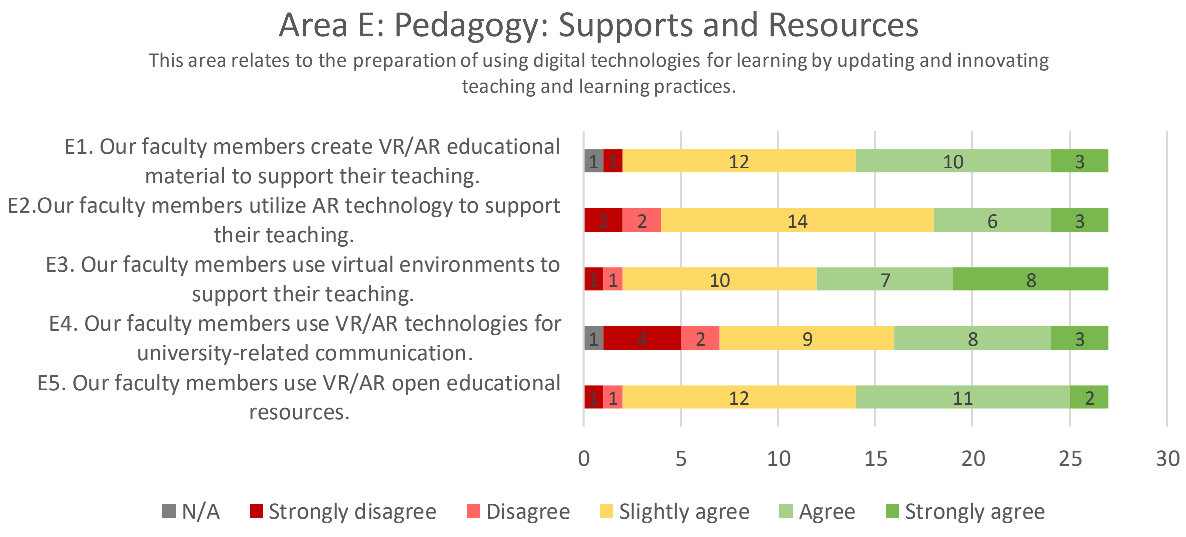


Despite the fact that the majority Higher Education Institutions have technical support available and are equipped with digital infrastructure, devices, and internet connection, they do not provide their students with the opportunity to borrow VR/AR devices when they need them, bring their own if they have one, neither have a plan to help faculty member identify and deal with challenges that arise with VR/AR learning, related to students' learning needs and socio-economic background.



Regarding facilitating and investing in the continuing professional development (CPD) of staff at all levels, half of Higher Education Leaders replied that discuss with our faculty members their CPD needs for teaching with digital technologies such as VR/AR, while the majority believe that faculty are supported to have and share experiences with VR/AR technologies within their institutions.



Regarding the preparation of using digital technologies for learning by updating and innovating teaching and learning practices, the majority of Higher Education Leaders slightly agree that VR/AR technologies are incorporated in the teaching and communication practices of their institutions' faculty members.

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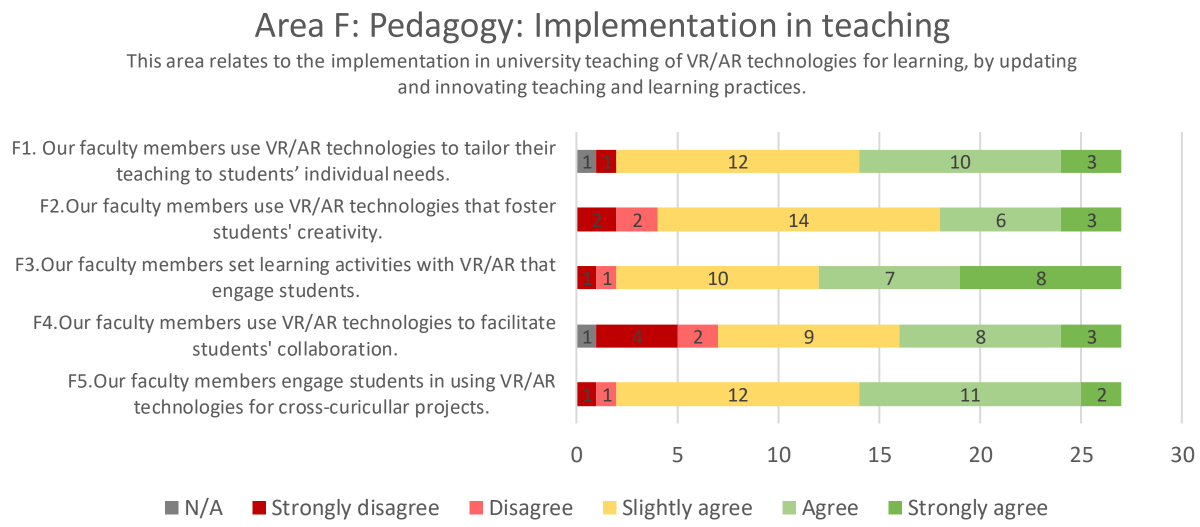
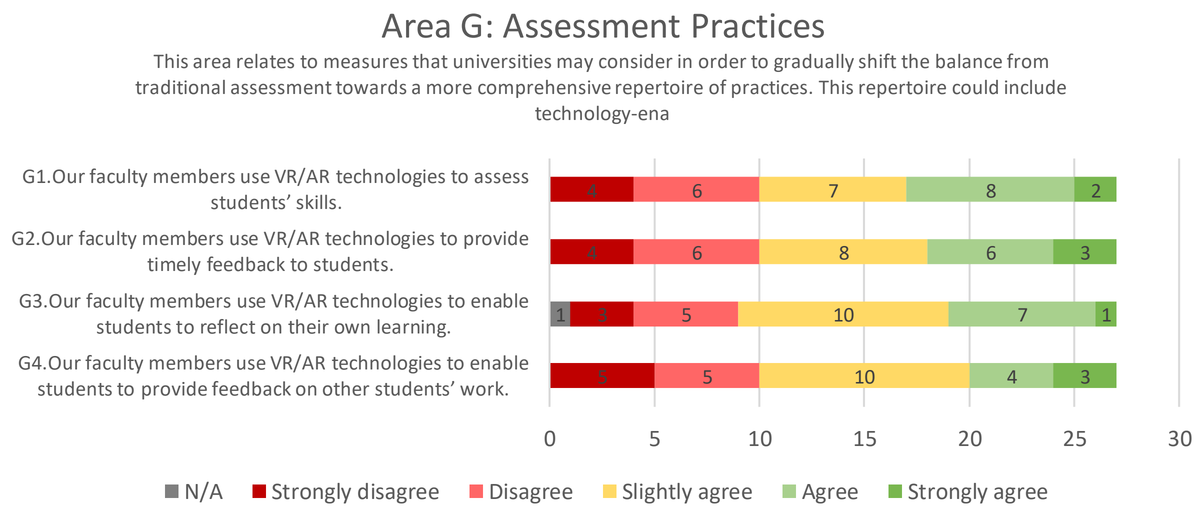
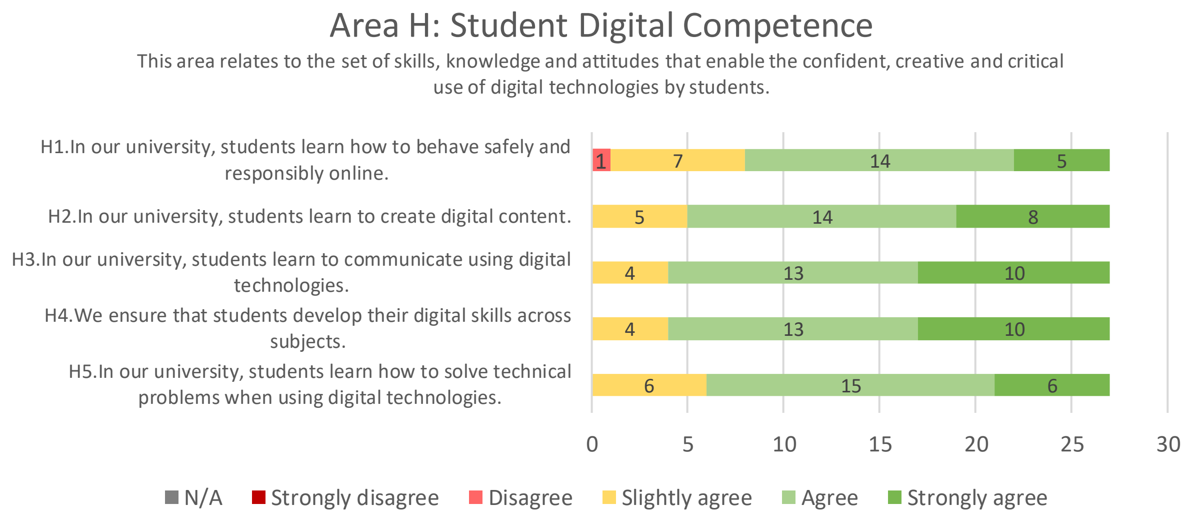


Regarding the implementation in university teaching of VR/AR technologies for learning, the majority of Higher Education Leaders slightly agree that VR/AR technologies are implemented in an engaging way, that is tailored to students' needs and fosters creativity. A significant percentage of HE Leaders believe that VR/AR is not used by faculty members so to facilitate students' collaboration.



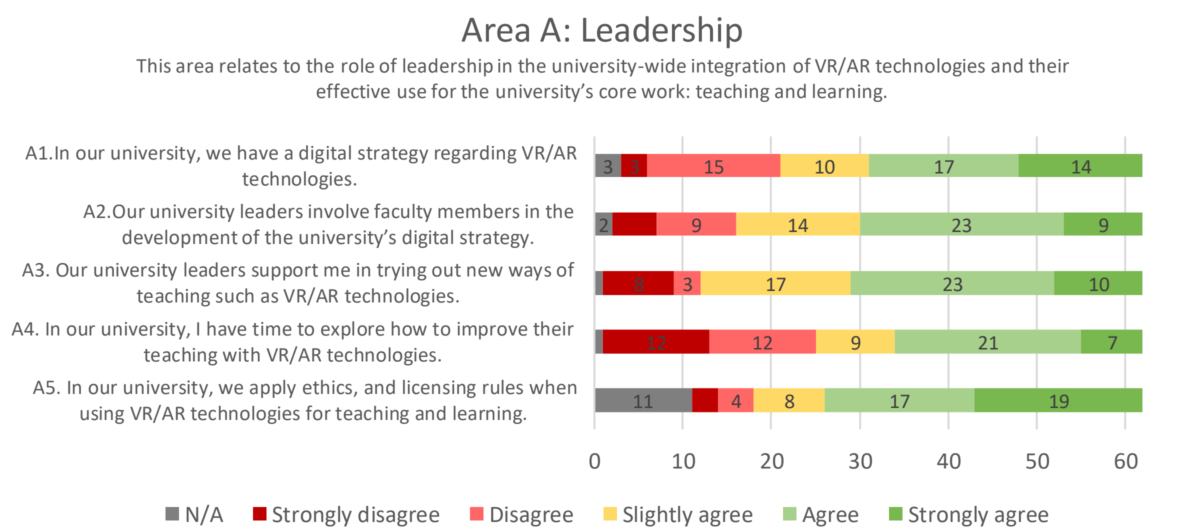
Regarding the use of VR/AR technologies as means to assess or provide timely feedback to students tools, almost half of the Higher Education Leaders replied that this is not the case in their institutions.



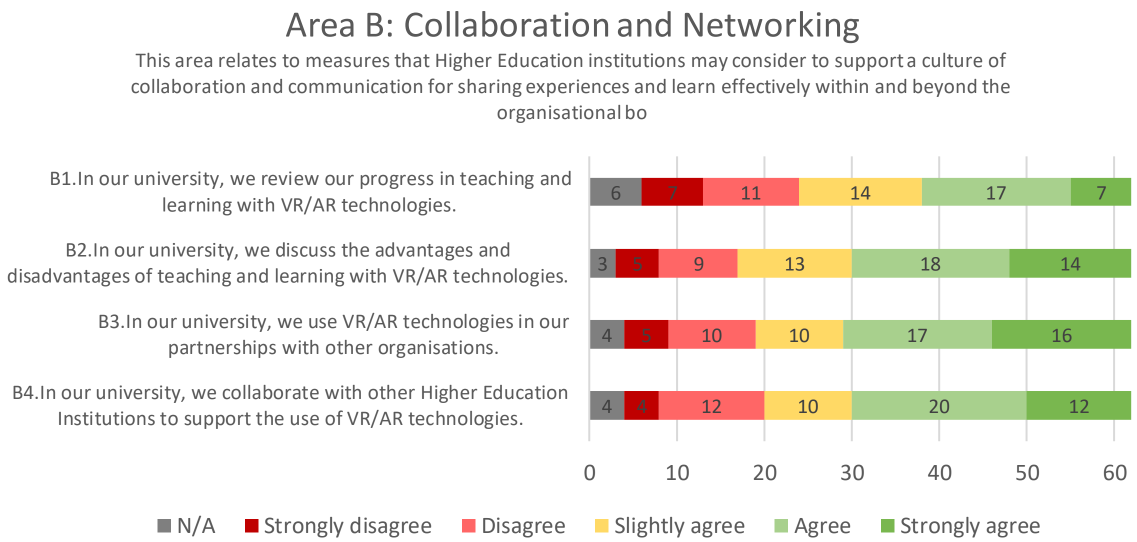
Lastly, all Higher Education Leaders agree that their institutions focus on developing their students' digital competences so to be able behave safely online, create digital content, and solve technical problem when using digital technologies.

***VR/AR readiness assessment of Higher Education Faculty members*.**

We received 62 answers from HE Faculty members (i.e., teaching assistants, instructors, lab assistants, research assistants, lecturers, assistant professors, associate professors, and full professors) from the partner countries. Thirty-two of them (~51%) were male. The results showed that their educational experience covered a wide spectrum as 16 (~26%) had 6-10, 16 (~26%) more than 20, 12 (~20%) 11-15, 8 (~13%) 3-5 and 7 (~11%) 16-20 years of experience in education. Almost 60% of them were between 30 - 50 years old.

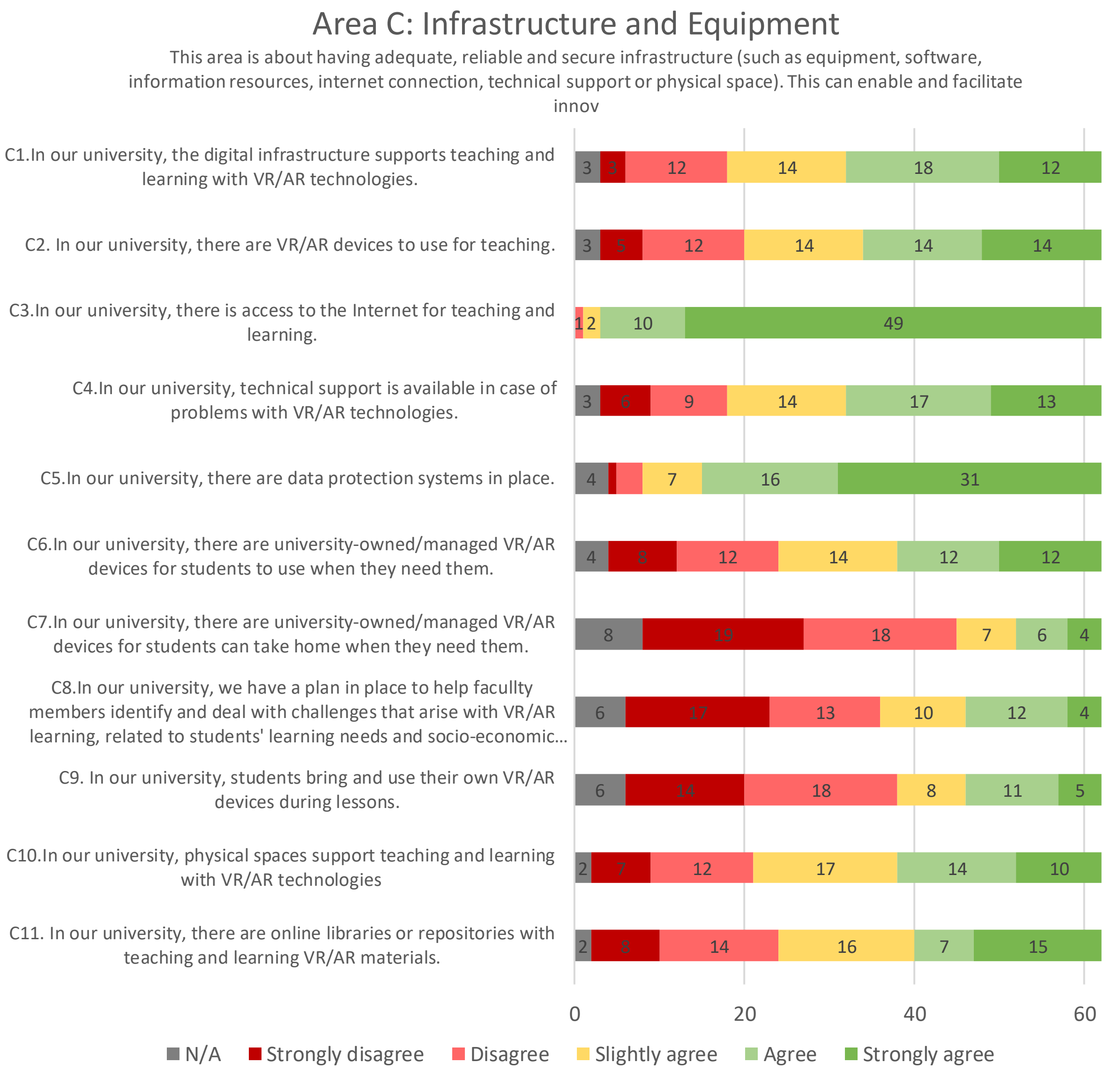


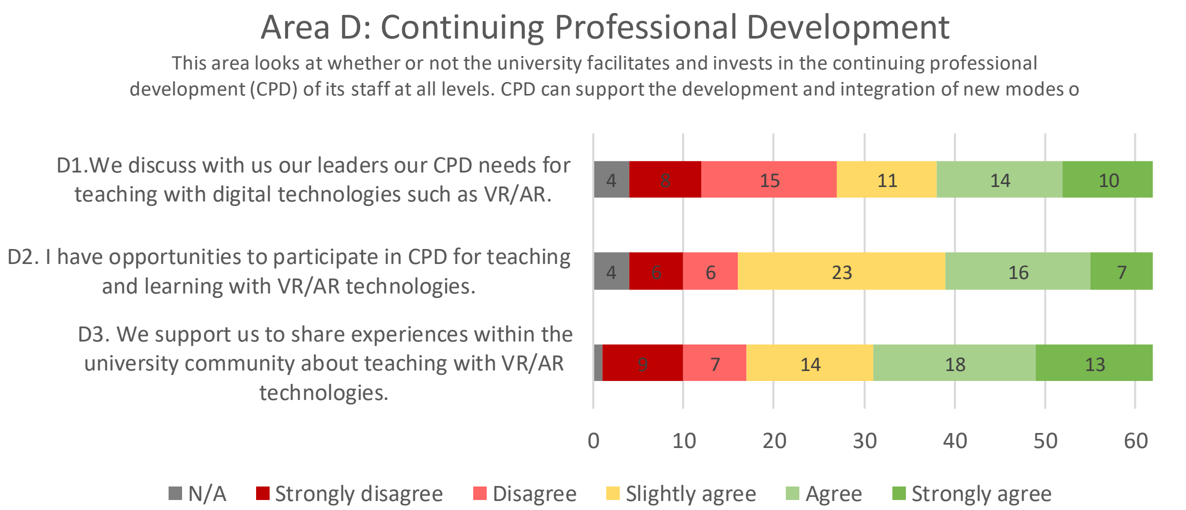
Higher Education faculty members in partner countries find the role of their HE leadership quite supportive to integrating VR/AR in their institutions. More than half of them agree that there is a digital strategy regarding these technologies, which was developed in coordination with them. More than half of them also agree that they are supported by their HE leaders to try new ways of teaching as well as there are rules and ethics when using VR/AR in their institutions. They do however identify the lack of time to explore the affordances of VR/AR as a challenge.



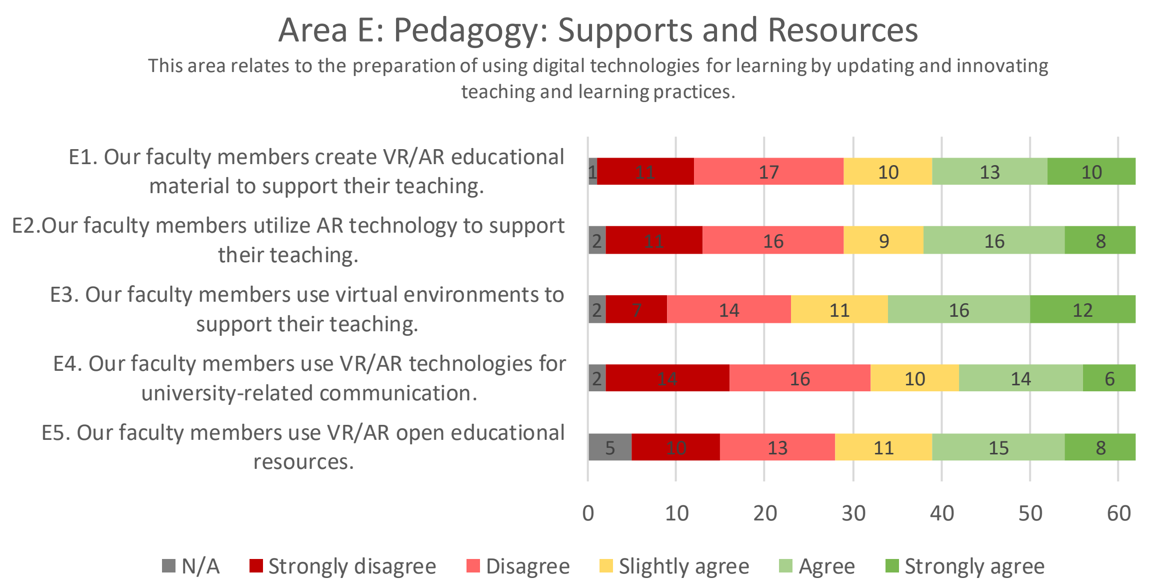
Regarding collaboration and networking, the majority of faculty members replied that they review their progress in teaching with VR/AR technologies and discuss their potentials for teaching and learning. More than the half of them use VR/AR in their partnerships with other organisations and collaborate with other HEI to support the use of these technologies.

Despite the fact that the majority Higher Education Institutions have technical support available and are equipped with digital infrastructure, devices, and internet connection, they do not provide their students with the opportunity to try, to borrow VR/AR devices when they need them, to bring their own if they have one, neither have a plan to help faculty member identify and deal with challenges that arise with VR/AR learning, related to students' learning needs and socio-economic background. One third of the respondents consider that their institutions lack physical spaces that may support VR/AR integration as well as online libraries/repositories with VR/AR learning or training material.

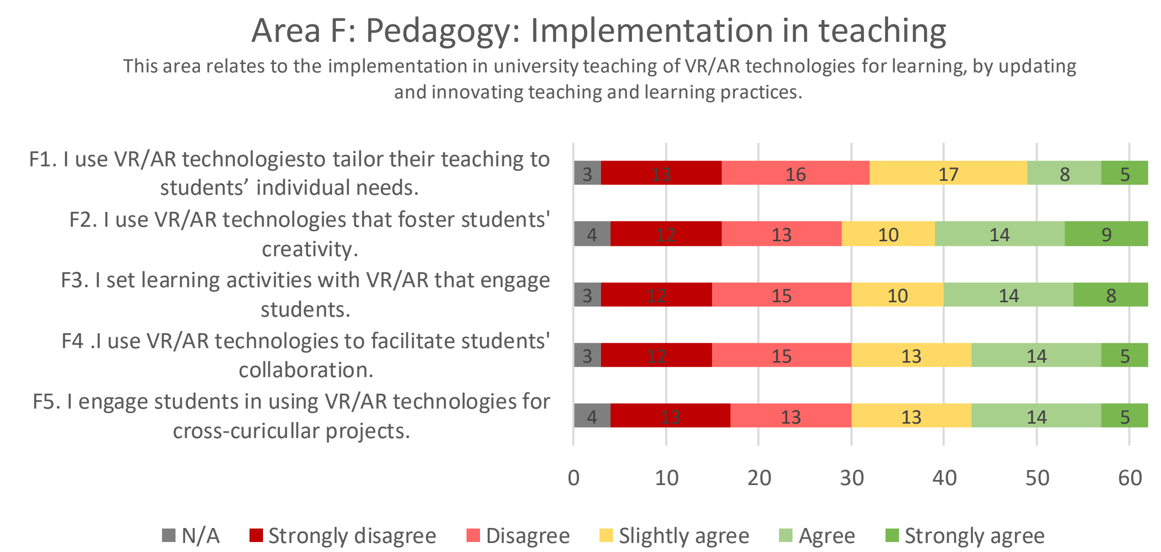

Area C: Infrastructure and Equipment
This area is about having adequate, reliable and secure infrastructure (such as equipment, software, information resources, internet connection, technical support or physical space). This can enable and facilitate innov
C1.In our university, the digital infrastructure supports teaching and learning with VR/AR technologies.
3 3 12 14 18 12
C2. In our university, there are VR/AR devices to use for teaching.
3 5 12 14 14 14
C3.In our university, there is access to the Internet for teaching and learning.
1 2 10 49
C4.In our university, technical support is available in case of problems with VR/AR technologies.
3 6 9 14 17 13
C5.In our university, there are data protection systems in place.
4 7 16 31
C6.In our university, there are university-owned/managed VR/AR devices for students to use when they need them.
4 8 12 14 12 12
C7.In our university, there are university-owned/managed VR/AR devices for students can take home when they need them.
8 19 18 7 6 4
C8.In our university, we have a plan in place to help facullty members identify and deal with challenges that arise with VR/AR learning, related to students' learning needs and socio-economic...
6 17 13 10 12 4
C9. In our university, students bring and use their own VR/AR devices during lessons.
6 14 18 8 11 5
C10.In our university, physical spaces support teaching and learning with VR/AR technologies
2 7 12 17 14 10
C11. In our university, there are online libraries or repositories with teaching and learning VR/AR materials.
2 8 14 16 7 15
0
20
40
60
N/A
Strongly disagree
Disagree
Slightly agree
Agree
Strongly agree


Area D: Continuing Professional Development
This area looks at whether or not the university facilitates and invests in the continuing professional development (CPD) of its staff at all levels. CPD can support the development and integration of new modes o
D1.We discuss with us our leaders our CPD needs for teaching with digital technologies such as VR/AR.
4 8 15 11 14 10
D2. I have opportunities to participate in CPD for teaching and learning with VR/AR technologies.
4 6 6 23 16 7
D3. We support us to share experiences within the university community about teaching with VR/AR technologies.
9 7 14 18 13
0
10
20
30
40
50
60
N/A
Strongly disagree
Disagree
Slightly agree
Agree
Strongly agree

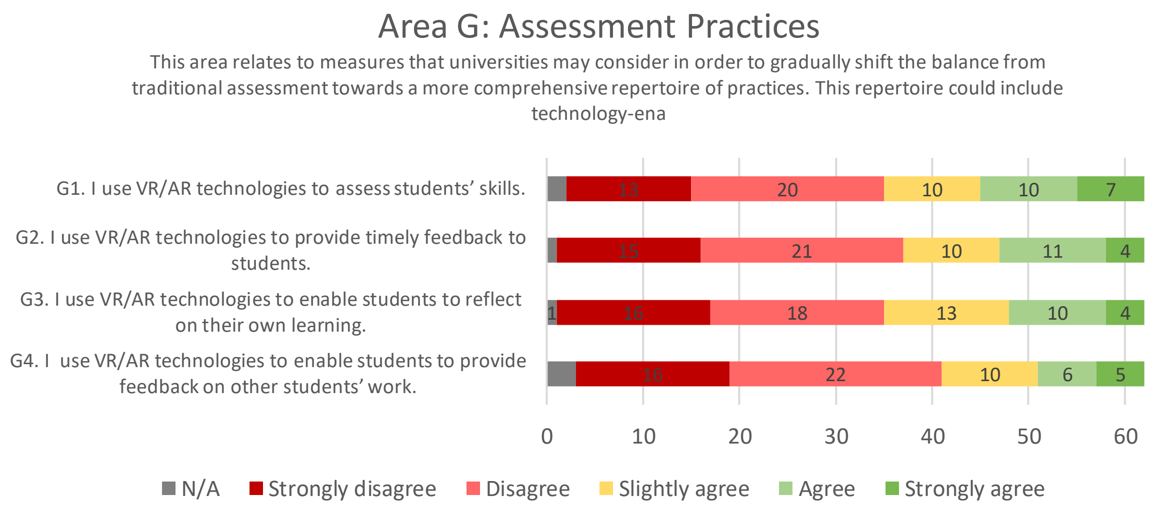
Regarding the opportunities for continuing professional development (CPD), half of the Higher Education faculty members replied that they do not discuss with HE leaders their CPD needs for teaching with digital technologies such as VR/AR, while almost half of them consider that they are supported to participate in CPD for teaching and learning with VR/AR technologies.



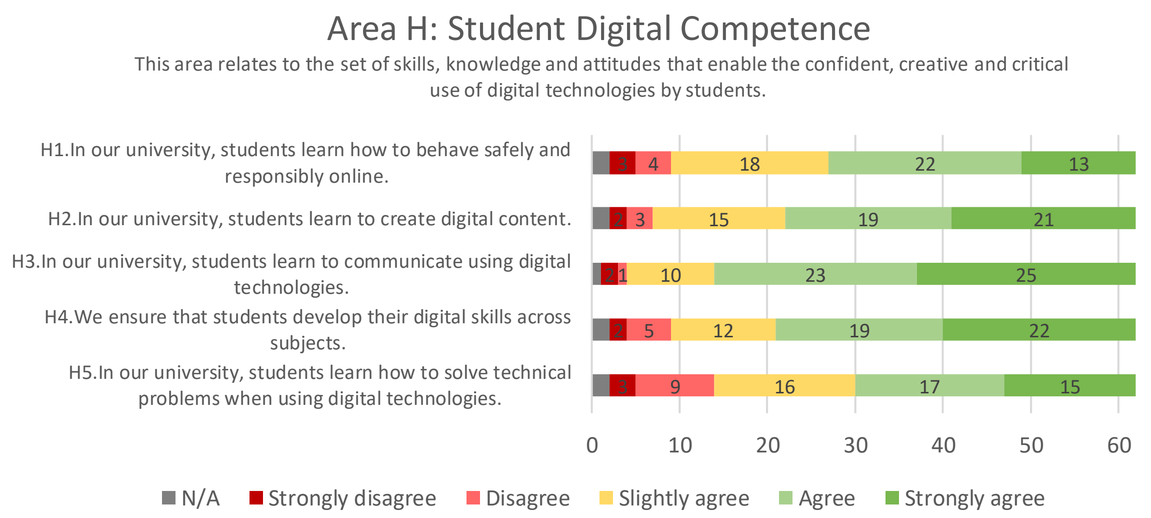
Regarding the preparation of using digital technologies for learning by updating and innovating teaching and learning practices, half of the Higher Education faculty members does not create VR/AR material to support their teaching, neither utilize these technologies to support their teaching and communication practices.



Regarding the implementation in university teaching of VR/AR technologies for learning, the majority of the Higher Education faculty members do not use VR/AR technologies in an engaging way, that is tailored to students' needs and fosters creativity and collaboration.



Regarding the use of VR/AR technologies as means to assess or provide timely feedback to students tools, the majority of the Higher Education Faculty members replied that this is not the case in their institutions.



Lastly, the majority Higher Education Faculty members agree that their institutions focus on developing their students' digital competences so to be able behave safely online, create digital content, and solve technical problem when using digital technologies. A small percentage however disagrees with the latter.

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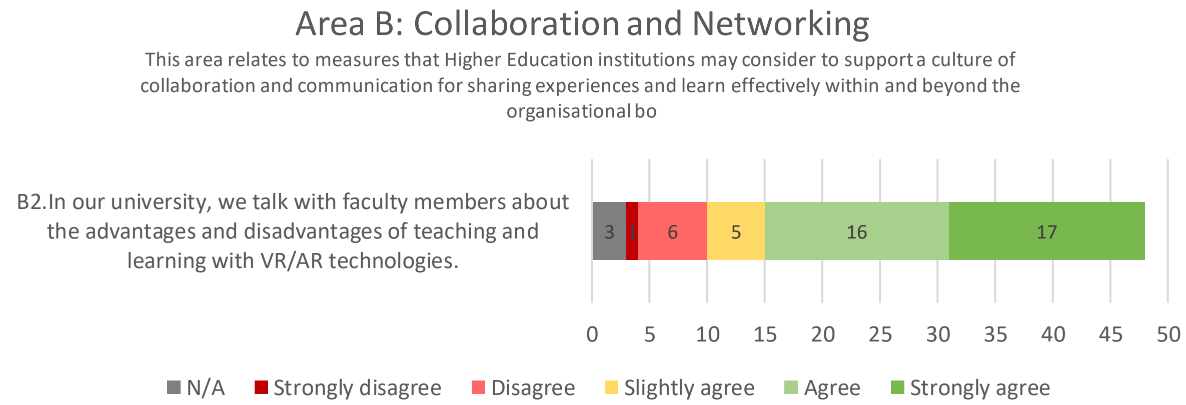
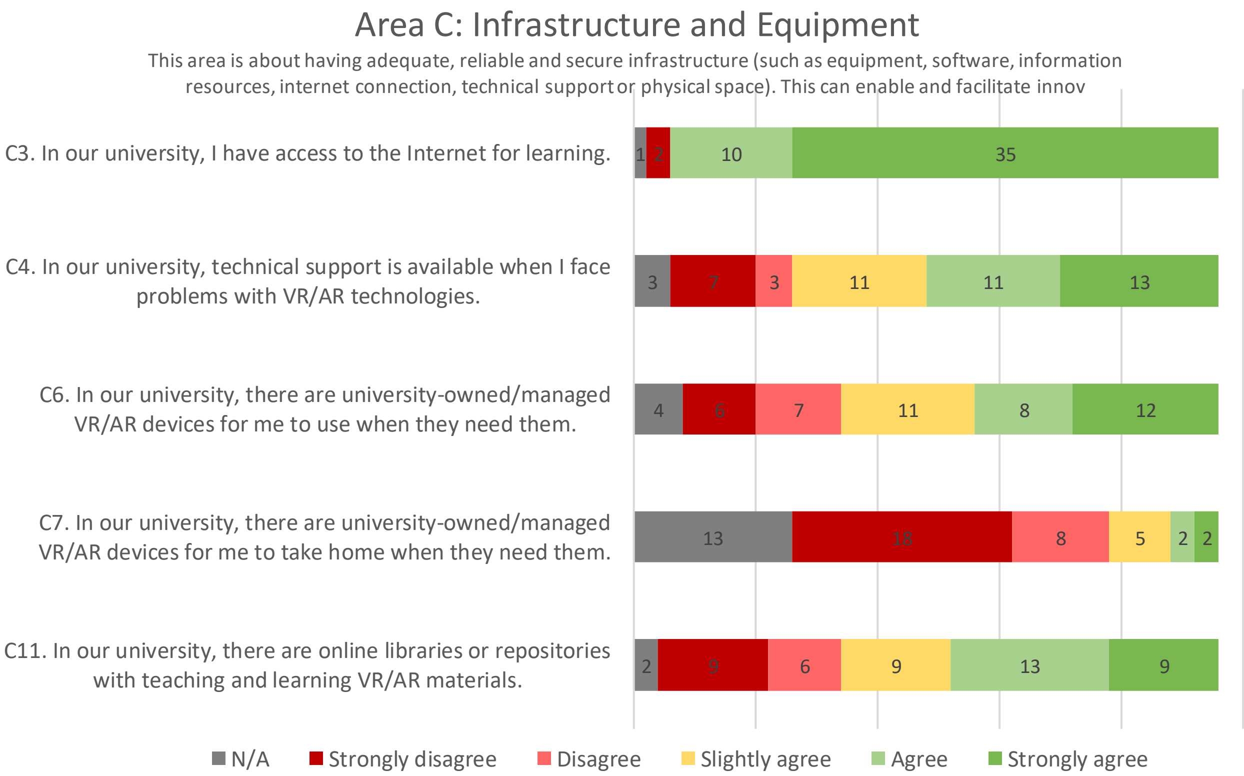
VR/AR readiness assessment of Higher Education students.

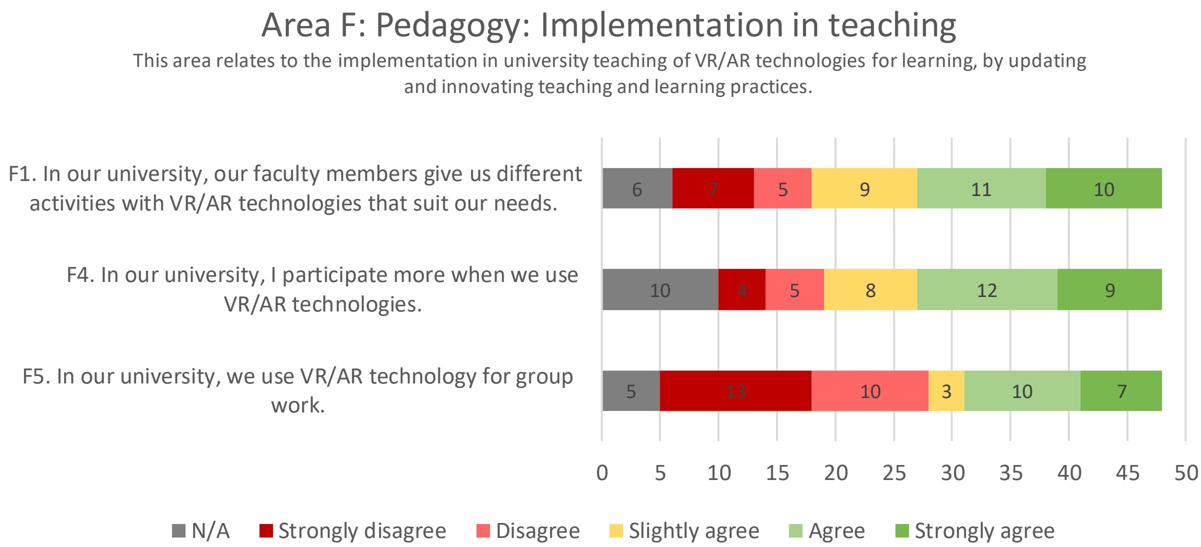
We received 48 answers from HE Faculty students (i.e., undergraduate, postgraduate, PhD) from the partner countries. Thirty-four of them (~70%) were female. Students were asked only specific sections and questions from the VR/AR assessment tool as presented below:



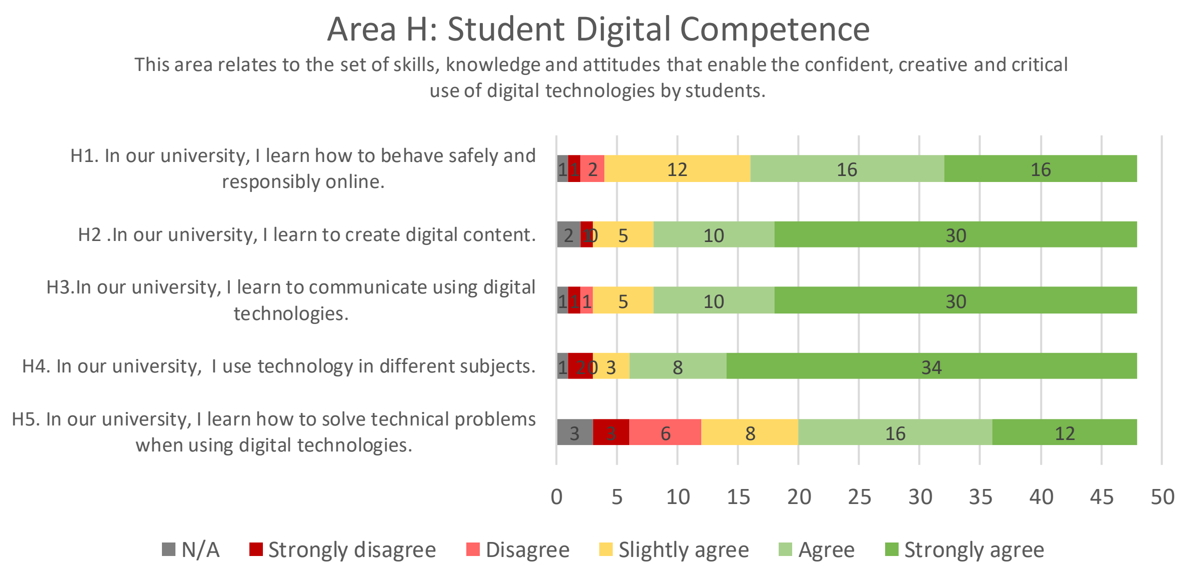
Regarding collaboration and networking, students' responses reveal that in universities in partner countries students and faculty members have the opportunity to discuss the affordances and limitations of teaching and learning with VR/AR technologies.



As for infrastructure and necessary equipment, almost all students have internet access for learning and the majority have technical support in case they face problems with VR/AR technologies. On the other hand, most students reply that there are not university-owned/managed VR/AR devices for them to take home when they need them.



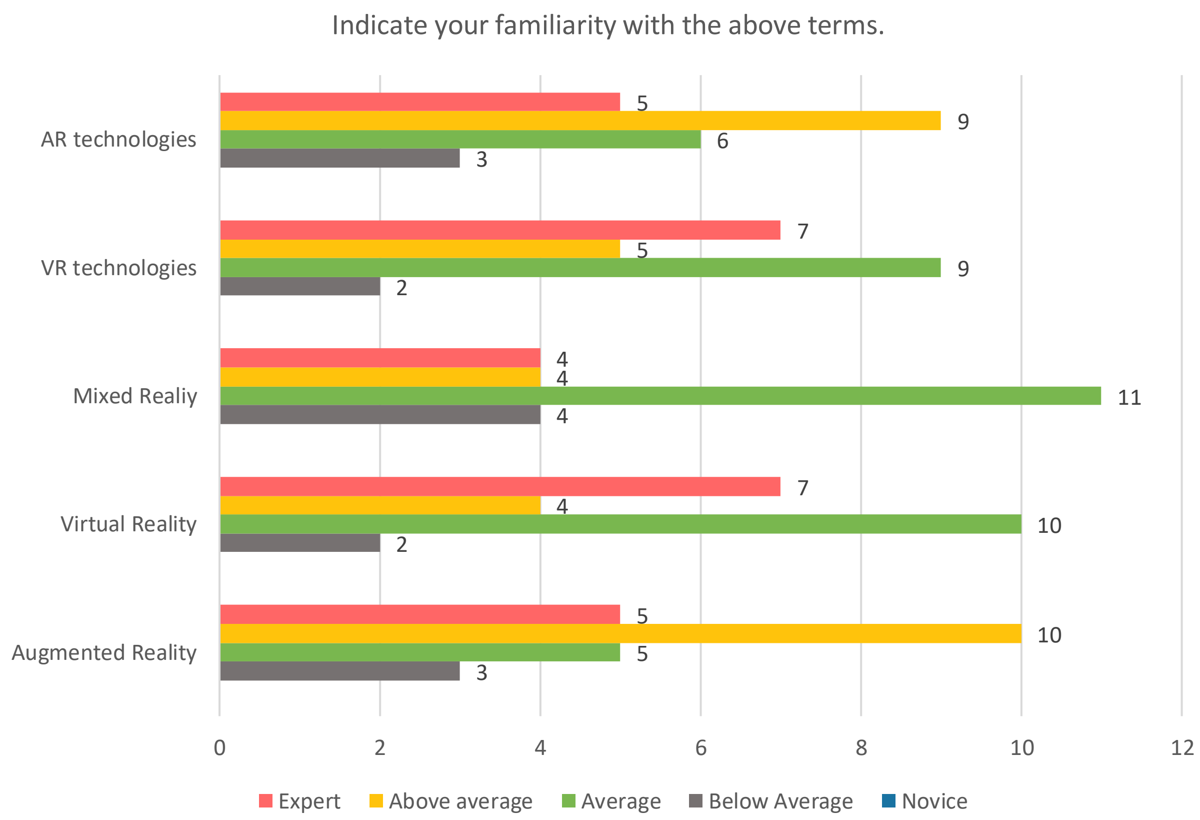
Half of the students have participated in learning activities with VR/AR content tailored to their needs. However, these technologies are rarely used for promoting collaborative work.

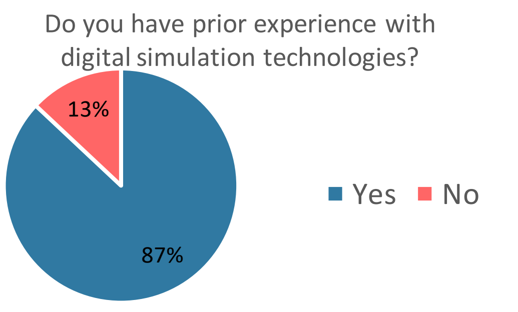


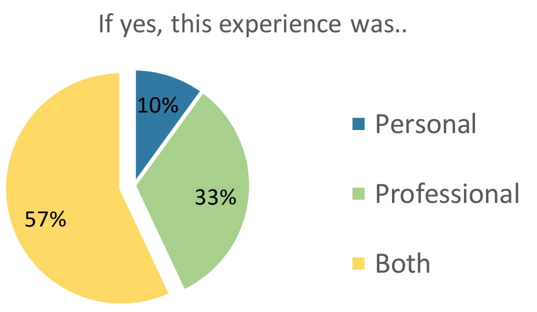
Lastly, the majority Higher Education students agree that their institutions help them develop their digital competences so to be able behave safely online, create digital content, and solve technical problem when using digital technologies. A small percentage however disagrees with the latter.

VR/AR readiness for Learning technologists & Instructional designers.

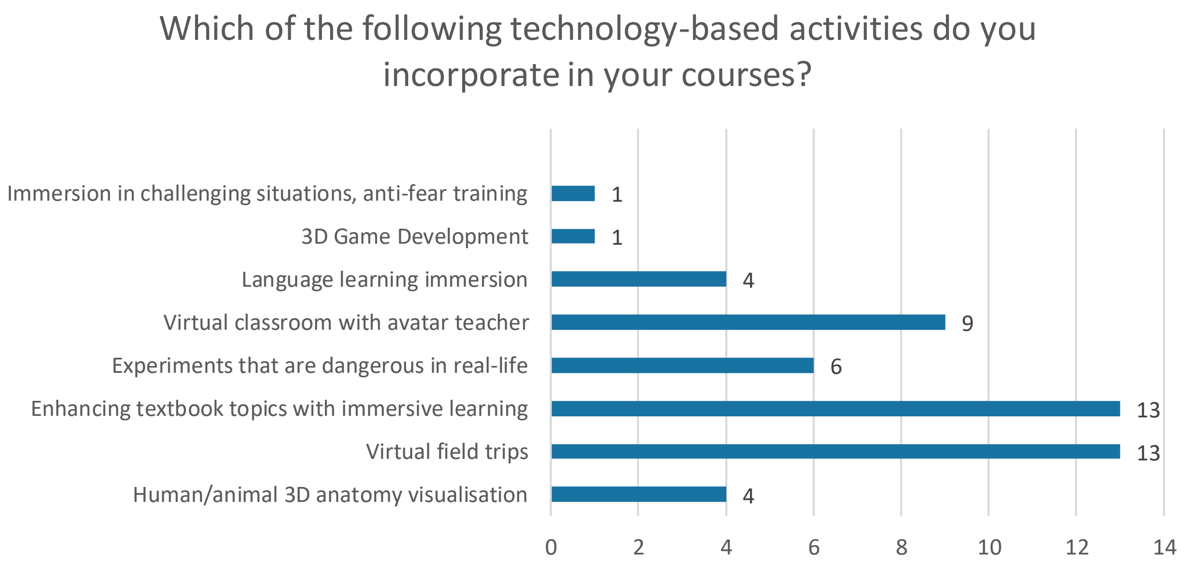
Twenty-three Learning technologists or Instructional designers that work in HEI in partner countries responded to the VR/AR readiness tool. 55 % of them are female, while 65% were between 30-50-years old. Regarding their familiarity with VR/AR technologies, we received the following replies.



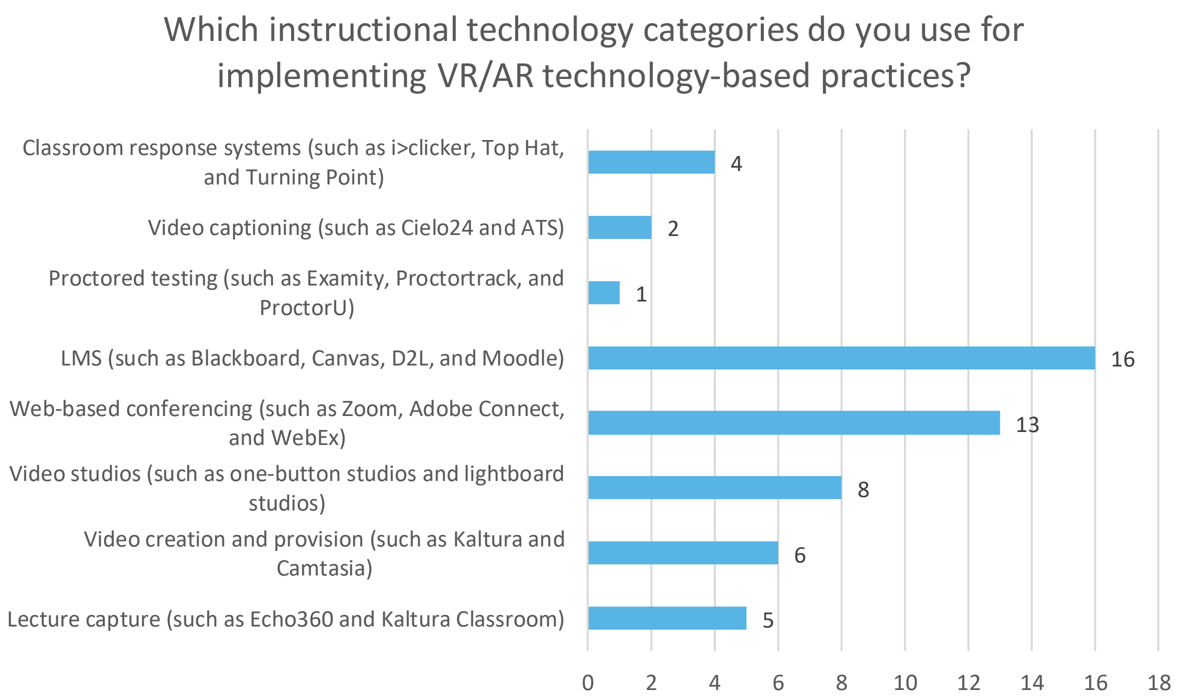




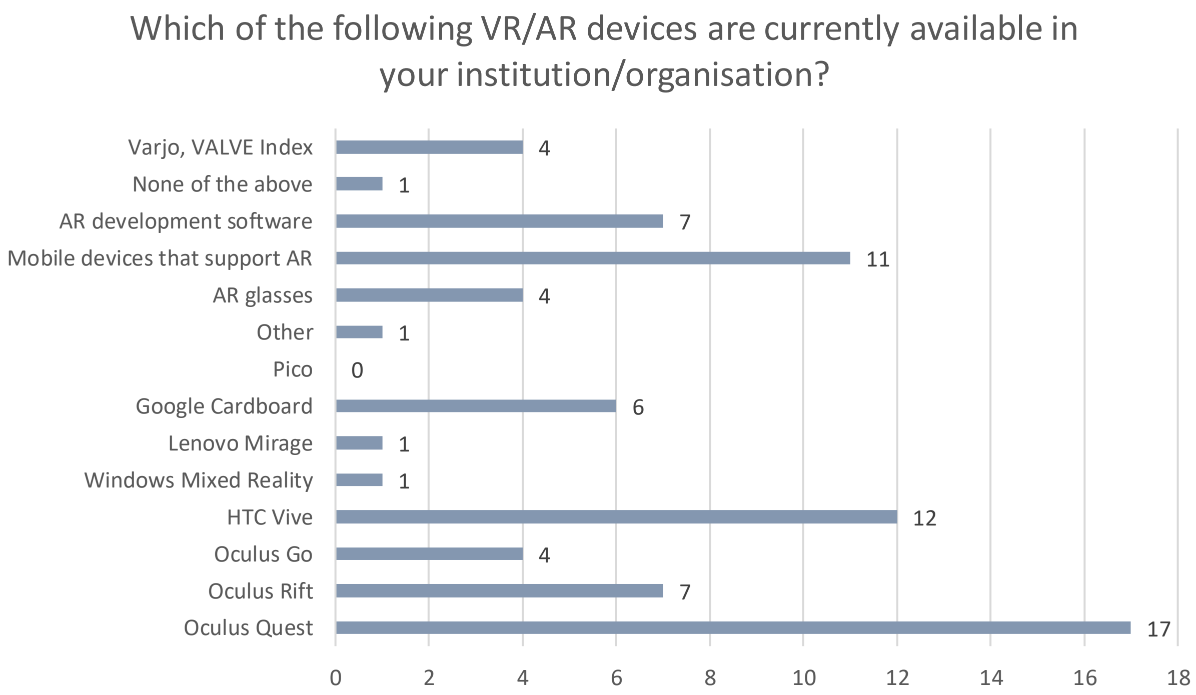
The most frequently used technology-based activities in regards with VR/AR were virtual field trips and AR textbooks, while one third of the respondents incorporated virtual classrooms with avatar teachers.



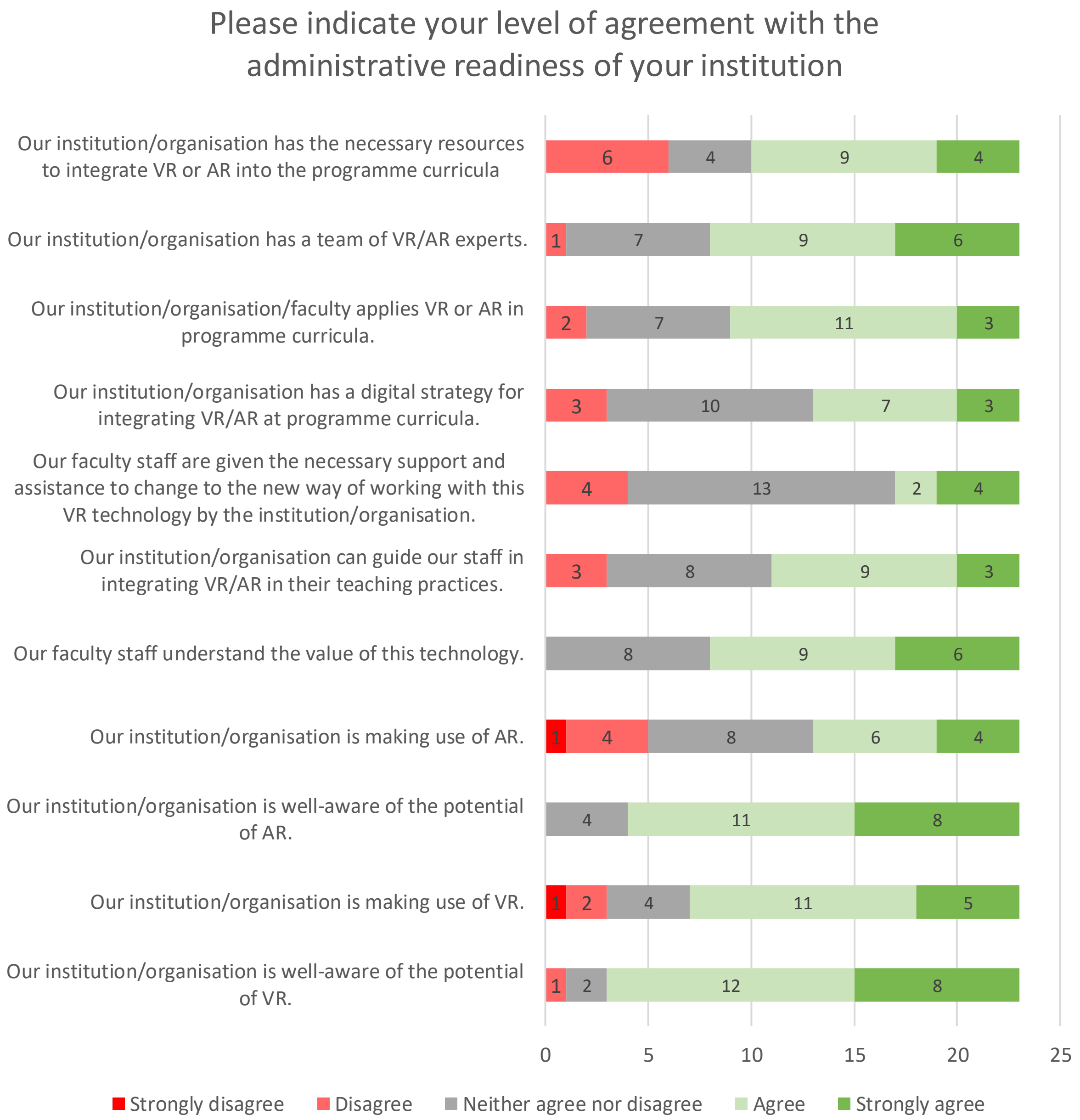
VR/AR technology-based practices were implemented mainly through instructional technology categories such as Learning Management Systems, Web-based conferencing and Video Studios.



Regarding the existence of VR/AR devices in respondents' organisations, VR Head Mounted Displays (HMD) such as Oculus and HTC are the most prominent ones. Regarding AR, mobile devices-compatible with the technology- are available in almost half of their institutions.



The respondents were also asked about the administrative readiness of their institutions. Despite the fact that the majority of their leaders are aware of the potential of VR/AR technologies, and some institutions are already using them (VR more than AR), the majority of the learning technologist/ instructional designers are not sure whether their organisations have a digital strategy for integrating VR/AR in programme curricula. Furthermore, most of the respondents identify that their faculty staff are not given the necessary support and guidance to change to the new way of working with VR/AR technologies by the institution/organisation. Lastly, one out of three respondents believe that faculty staff does not understand the value of these technologies.



They identify than faculty members do not have the necessary skills to support the integration of VR or AR in curricula, neither know when or how to use these technologies. The majority of the respondents however believe that their organisations could make that swift by providing training opportunities to their faculty members or external guidance in terms of selecting the most appropriate VR/AR software and hardware equipment.

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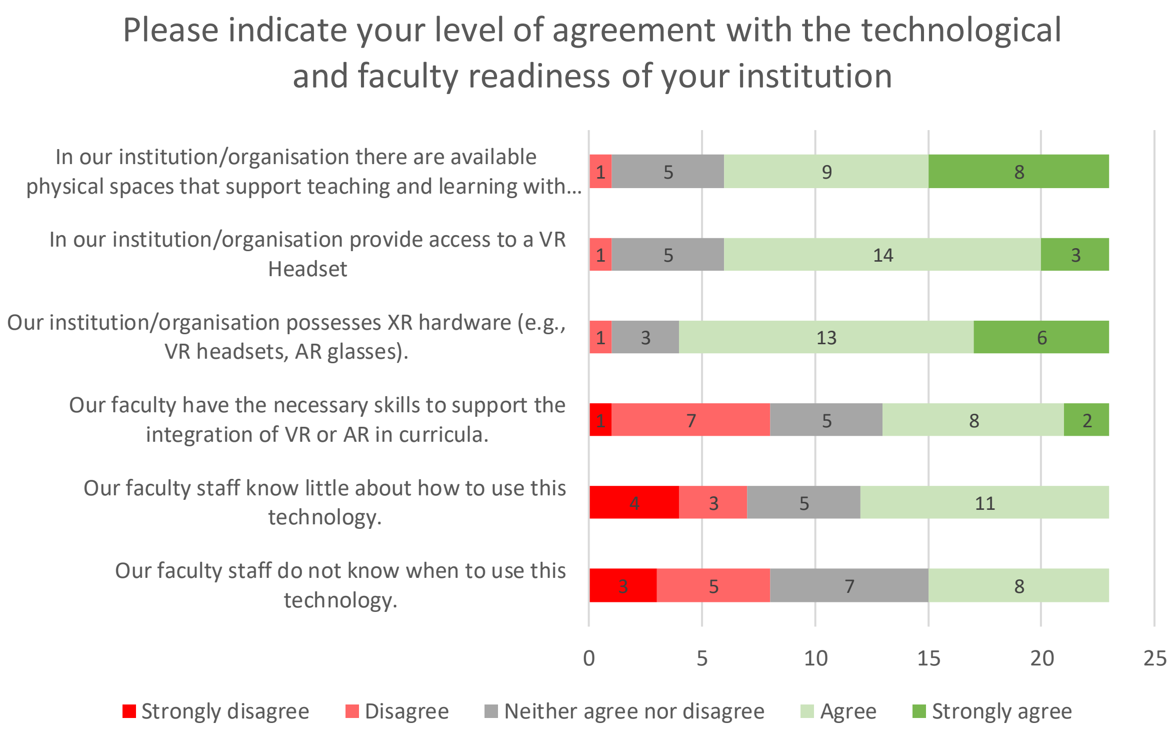

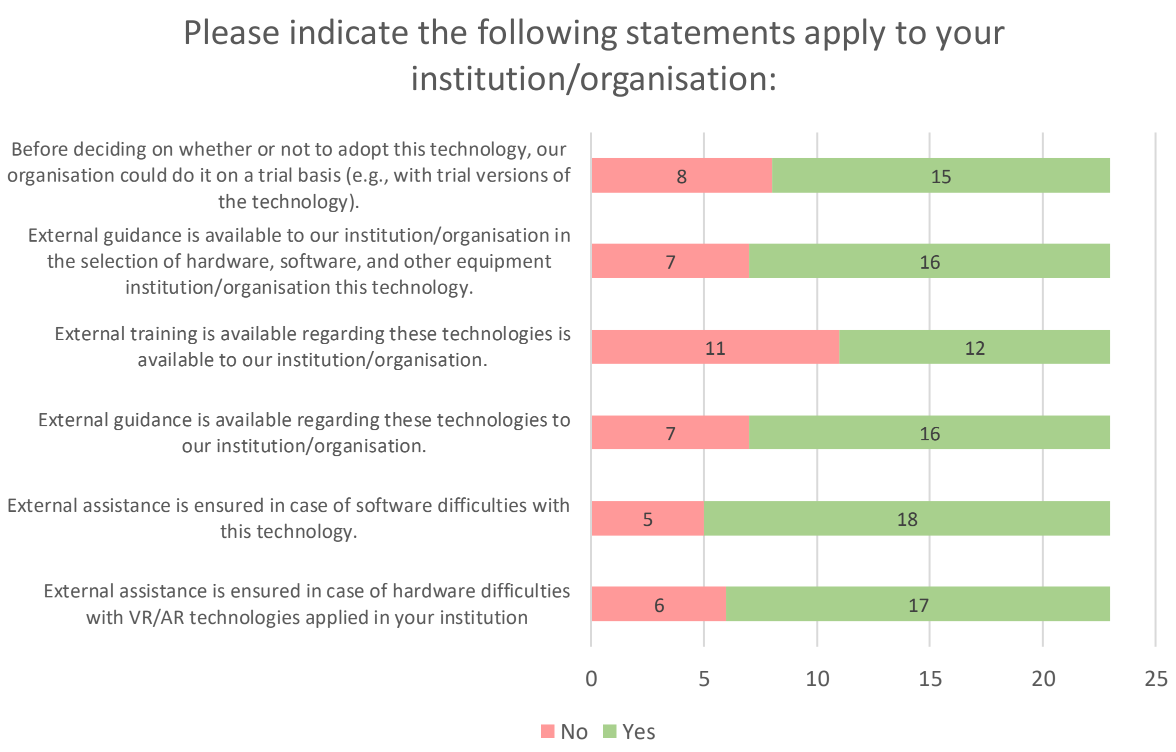

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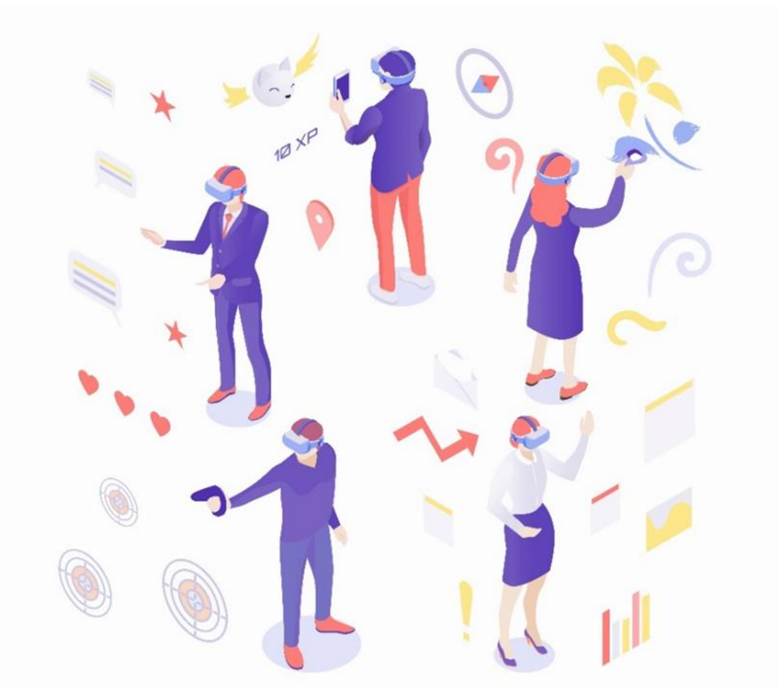
IMPLEMENTING VR/AR IN HIGHER EDUCATION
PEDAGOGICAL FRAMEWORK



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3. Methodology of the systematic literature review in European initiatives for VR/AR in Higher Education

The search for European initiatives regarding VR/AR applications in Higher Education was based on the methodology of a systematic literature review. Researchers from partner countries searched in national repositories of "grey literature" for relative Master or Ph.D. theses, in national conferences proceedings but also in established bibliographic databases like SCOPUS, Semantic Scholar, Google Scholar. Each partner was responsible for conducting the review in its national context, and in other three European countries.

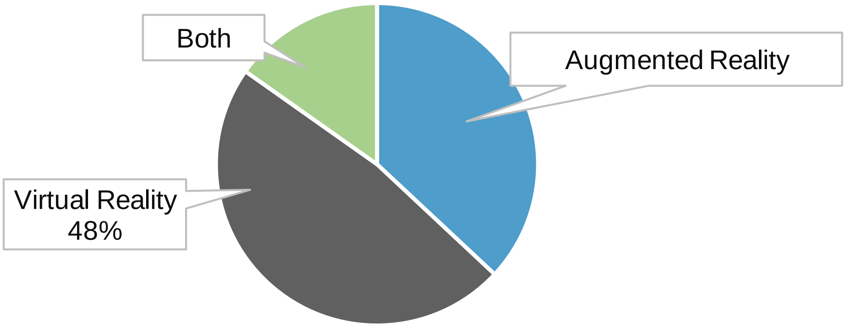
The studies that were selected for analysis met the following inclusion criteria:

- They were empirical.
- They were implemented in Higher Education context.
- They utilized either VR or AR technology.
- They provided sufficient information regarding the instructional settings and research method used.
- They targeted the development of soft skills (i.e., communication, problem solving, critical thinking)
- They were written in English or in any of the partners' language.
- Were published between the years 2018-2022

Data extraction was based on a scheme provided by University of the Aegean. Data obtained from the partners were recorded in a shared google-sheet file and were further analysed and summarized to provide answers to the research questions of the SLR.

4. Results

Forty-six (46) studies were selected for analysis based on the aforementioned methodology.



Graph 1. VR/AR ratio in selected studies

Almost half of them utilized **VR, which may indicate that this technology is more prevalent in higher education context than AR**, which was identified in 37% (N=17) of the selected studies. There were also seven studies (15%) that utilized both VR and AR at the same time (Graph.1).

VR and AR have been utilized in various domains and subjects. We identified six major higher education domains and several subjects in which VR/AR have been implemented.

STEM i.e., Engineering, Math, ICT, Biology, Chemistry are the most common ones, including almost 40% of the total SLR studies. **Humanities** i.e., Language, Pedagogy, Special Education is following with 18% of the studies, along with studies in **Healthcare and Medicine** i.e., Human anatomy and Nursing. Seven studies (15%) were in the field of Business administration and Industrial Design, while two studies (4%) in Geography and Geoinfographics respectively. We identified one study in Arts, which was in the Music domain, and two studies in the general field of skills development and knowledge acquisition.

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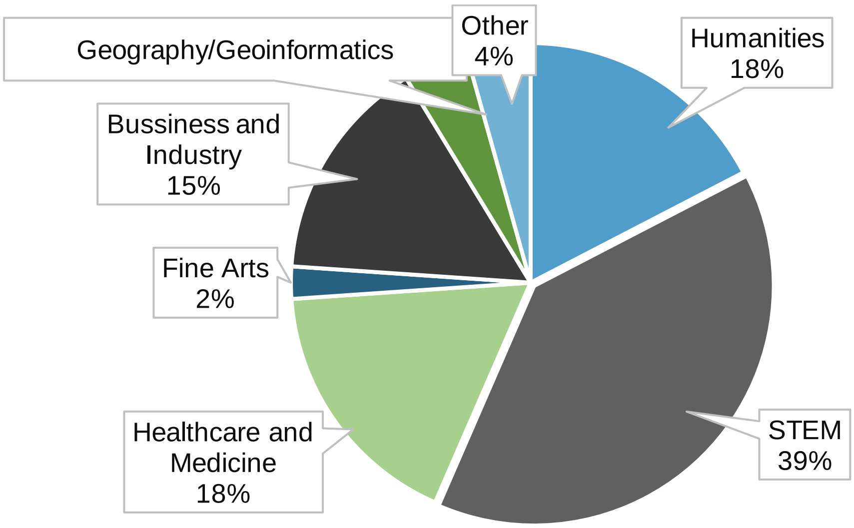


Graph 2. Higher education domains of VR/AR applications

4.1 What types of VR/AR are used in higher education?

We identified three types of VR technology that are being used in higher education context.

Non-immersive VR: in this type of VR users interact with a virtual environment usually through a computer where they can control some characters or activities within the experience, but the virtual environment is not directly interacting with them (Fig.4).

Figure 4. Example of non-immersive VR. Source: Virtual Medical Training: Don't Call It Virtual Reality

Semi-immersive VR: this type of VR provides users with a partially virtual environment to interact with. It is mainly used for educational and training purposes and the experience is made possible with graphical computing (Fig.5) and large projector systems.

Fully immersive VR: this type of VR gives users the most realistic simulation experience, complete with sight and sound. To experience and interact with fully immersive virtual reality, the user needs the proper VR glasses (Fig. 6) or a head mount display (HMD). VR headsets provide high-resolution content with a wide field of view. The display typically splits between the user's eyes, creating a stereoscopic 3D effect, and combines with input tracking to establish an immersive, believable experience. This type of VR has been commonly adapted for gaming and other entertainment purposes, but usage in other sectors, namely education, is increasing now as well.

Figure 5. Example of semi-immersive VR. Source: What is VR?

Figure 6. Example of fully immersive VR. Source: Virtual Reality (VR): What is it and how does it change our lives?

The results showed that **fully immersive experiences are the most frequent (~70%) type of VR used in higher education settings** (Graph.7) Semi-immersive and non-immersive VR types are also used but in such frequency.

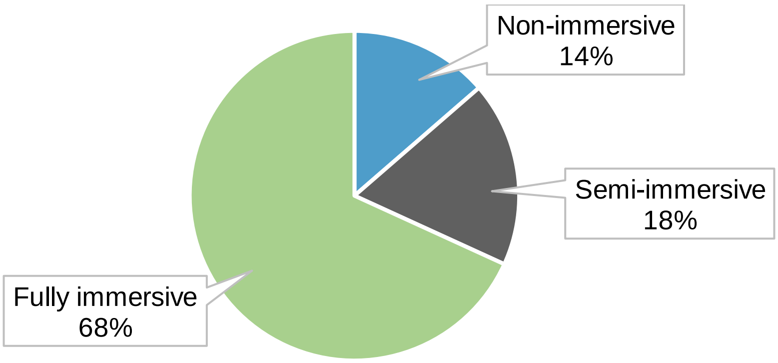


Figure 7. Types of VR used in higher education.

Regarding AR, we identified three types of the technology that are being used in higher education context.

Marker-based AR: these systems require specific labels to be scanned (i.e., QR codes, images) so that to register the 3D objects or digital content on the real world. **Marker-less AR**: these systems do not require any markers for image pattern recognition. These systems place virtual 3D objects in the real-life environment by examining the features present in the real-time data. They on the hardware of any smartphone including the camera (Fig.7).

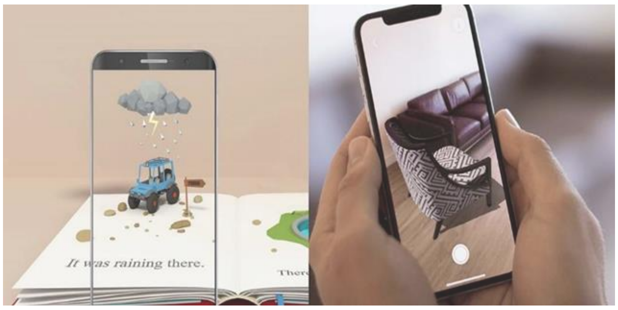
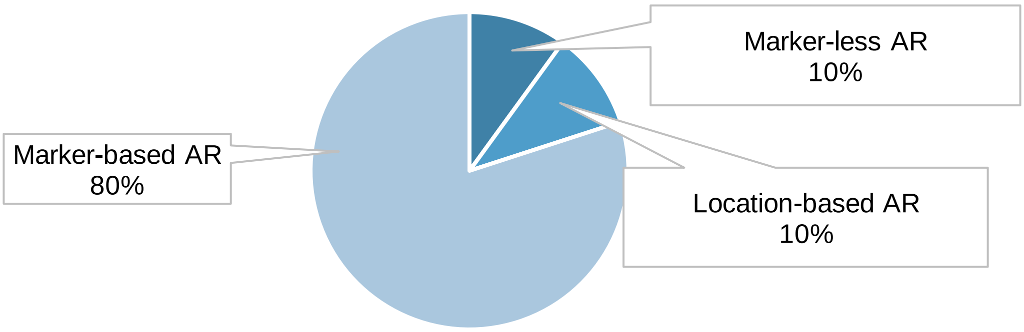


Figure 8. Examples of marker-based AR (left) and marker-less AR (right). Source: The difference between Marker based & Marker-less Augmented Reality

Location-based AR: these systems use position data (GPS or wireless network) from user's mobile device to identify a location and superimpose AR content (Fig.8).

Figure 9. Example of location-based AR. Source: Location Based Augmented Reality, Cachetown

The results showed that **the majority of the studies in higher education settings utilized marker-based AR** (~80%) (Graph.8) The rest of the AR types are equally represented in the rest of the studies.



Graph 8. AR types in selected studies.

4.2 Which technological means are used to implement VR/AR in higher education?

Inevitably, the type of VR/AR used in each case indicates the technological means that are going to be utilized. Given the aforementioned results, **the most frequently used devices for implementing VR in higher education are Head Mounted Displays (HMD)**. We identified a variety of brands and technical features which can be summarized in two main categories:

Desktop VR HMD: In desktop VR, the HMD is a peripheral to a more powerful computer that processes the heavy graphics. The computer may be a Windows PC, Mac, Linux, or a game console. Most likely, the headset is connected to the computer with wires. The game runs on the remote machine and the head-mounted display (HMD) is a peripheral display device with a motion sensing input. The most common devices identified in the SLR were the **Oculus Rift** and **HTC Vive.**

Figure 10. HTC Vive and Oculus Rift VR Headsets

Standalone VR HMD: In this category, the HMD has all the hardware components in a single device, which means that no connection to a computer is needed to experience VR. **Oculus Quest** was one the most common devices identified in the SLR that used this kind of hardware. Lastly, we also identified **desktops PC's** and **specially designed projectors** that were mainly utilized in non- or semi-immersive VR applications respectively. Regarding **AR applications**, **the vast majority of the studies utilized mobile devices such as tablets and smartphones** (Fig.11). These devices are equipped with a camera, GPS, accelerometer, gyroscope, and internet connection abilities, that enable access to AR content everywhere. **Only a few studies**

Figure 11. Google AR glasses

utilized AR glasses i.e., Google Glass, which resemble VR headsets, with the difference that user is able to view his/her surroundings and the AR content at the same time through them.

4.3 What are the objectives for integrating VR/AR in higher education?

Regarding the objectives of VR/AR integration in higher education curricula, research findings from the SLR could be summarized in four main categories as shown in Figure 12.

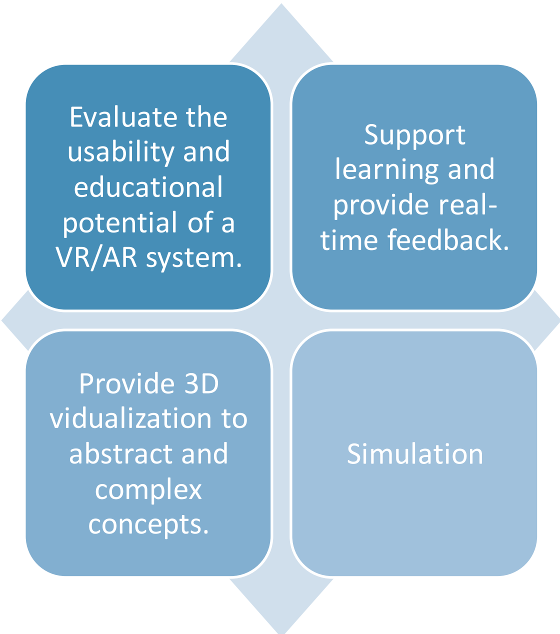


Figure 12. VR/AR integration objectives

The majority of the studies used a VR/AR system **with the aim to evaluate its usability and test its educational potentials for students**. A significant proportion of the studies implemented VR/AR **to support learning**, by either providing real-time feedback/guidance (in the cases of AR applications) or by giving students the ability to explore immersive learning environments. VR/AR were also **used to visualize 3D models of abstract concepts** such as a chemical bond or an anatomical structure.

Lastly, VR/AR applications were used **to simulate** real-time situations and provide students with a controlled transmission from theoretical to practical knowledge. Some indicative examples from the SLR studies include virtual laboratories and virtual workplaces (i.e., a hospital, a special education classroom).

4.4 What teaching models are applied for integrating VR/AR in higher education?

Half of the SLR studies, did not provide clear information about how teaching was structured with VR/AR technologies. From the analysis of the rest of the studies, we identified the following teaching models.

Hands-on practice: In this model, students performed hands-on activities with AR or in VR environments with or without the presence of their teacher, often after a theoretical session.

Virtual lectures: In this teaching model, teaching was structured in the form of a typical lecture where the teacher presented information and examples, sometimes along with a visual presentation. The classroom environment was completely virtual. Teacher and students were participating as avatars.

Asynchronous learning: In this model, a VR/AR environment was given to students as supportive material for practicing after classroom. In some cases, the VR/AR provided feedback and guidance to students, during the practice.

Visual aids during lecture: In this model, VR/AR were used as supplementary visual aids during a face-to-face lecture, so that to help students visualize abstract or complex concepts.

4.5 What learning theories serve as the basis for integrating VR/AR in higher education?

The majority of the SLR studies lacked reference to explicit learning theories. It should be noted that, during the coding, we avoided ‘‘reading between the lines’’ and only extracted the learning theories that were explicitly mentioned by study authors as their theoretical foundation.

Based on the results, VR applications are mostly based on Constructivist learning theory. Under this theory, we identified a number of different approaches that were used to help students construct knowledge in a virtual environment such as **active learning**, **experiential learning, exploratory learning**, **game-based learning**, **simulation learning**. According to Jonassen et al (2000) VR provides a controlled environment in which learners can navigate, and manipulate the virtual objects found within, and more important, the effects of such interaction can be observed in real time.

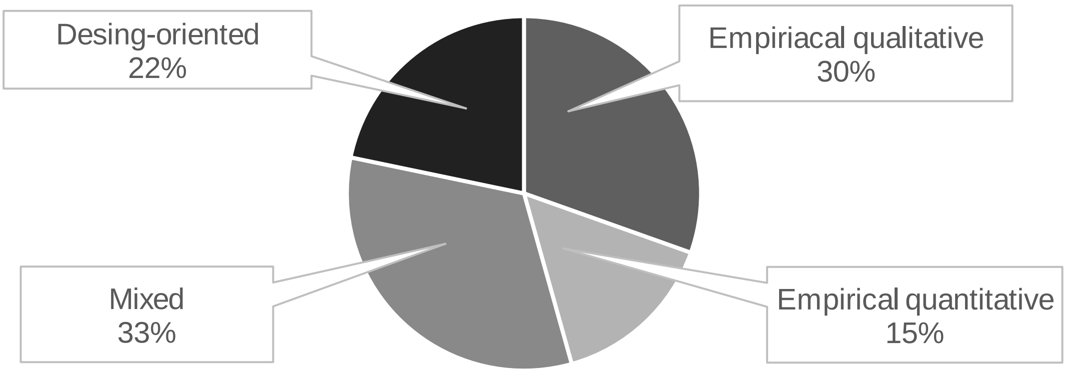
Furthermore, a virtual environment provides a problem manipulation space that allows the learner to freely explore and manipulate the virtual objects within the environment. Unlike many other educational tools, a virtual environment is designed without a specified sequence. Its focus shifts from the design of prescribed interactions with the learning environment to the design of environments that permit the student to experience any kind of interaction the system is capable of. This complies with the learner-centered approach where the learner can keep control over what he or she wants to explore or manipulate. In other words, the learner can choose to navigate through the simulated environment or interact with the objects of his or her interest for further observation. In doing so, the learner may make mistakes and wrong predictions and these experiences are the conditions for modifying existent knowledge and thus constructing new knowledge (Dijkstra, 1990).

The analysis also showed that AR applications were based mainly on Situated Learning Theory (SLT) and Constructivist Learning Theory, According to Dunleavy and Dede (2014), AR aligns well with situated and constructivist learning theories as it positions the learner within a real-world physical and social context while guiding, scaffolding and facilitating participatory and metacognitive learning processes such as

authentic inquiry, **active observation**, **peer coaching**, **reciprocal teaching and legitimate peripheral participation with multiple modes of representation.**

4.6 Which research designs and data collection methods are applied to examine the use of VR/AR in higher education?

Research studies in the field of VR/AR applications in higher education mostly utilize **design-oriented, empirical quantitative, and empirical qualitative research methods** (Fig.9). Questionnaires and pre/post tests were the most frequently used research instruments in the SLR studies. U**sability tests**, **interviews and focus group discussions were used by fewer SLR studies**.



Graph 9. Research designs in SLR studies

4.7 What are the results (advantages/challenges) associated with the use of VR/AR in higher education?

VR/AR were both associated with a number of advantages and challenges as reported in the SLR studies.

+ Advantages

- VR enables creating complex test scenarios and experiments difficult to implement in a real-world setting.
- It enables one to gain confidence in implementing technical procedures and activities.
- It allows for multiple repetitions of experiences, experiments, or situations.
- VR saves money and time associated with setting up actual test stations.
- Allows performing exercises at any place and at any time. Ensures scalability of educational activities.
- Reduces consumption of real resources.
- Ensures safety of operations.
- VR can adapt and apply to various fields and areas of education.
- VR increases the ability to communicate and collaborate with people in remote locations.

– Challenges

- High costs are often associated with creating an appropriate educational station using VR technology based on professional hardware and software.
- VR requires a lot of work to create a virtual environment with many test scenarios and details.
- VR often has a limited scope or lack of ready-made teaching scenarios.
- VR limits interpersonal contacts and experiences.
- It has a high probability of acquiring routine in the actions taken.
- There is a potential for health problems for users.
- The possibility of ignoring the basic laws of physics.

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AR has the potential to replace paper textbooks, physical models, posters, printed manuals, etc. It offers portable and less expensive learning materials. As a result, education becomes more accessible and mobile.

Unlike VR, AR doesn't require any expensive hardware. The majority of applications need just a mobile device.

Interactive, gamified AR learning can have a significant positive impact on students. It keeps them engaged throughout the lesson and makes learning fun and effortless.

Interactive lessons, where all students are involved in the learning process at the same time, help improve teamwork skills.

AR in education helps students achieve better results through visualization in the subject matter.

Professional training can also benefit greatly from the use of AR. For example, accurate reproduction of in-field conditions can help master the practical skills required for a certain job.

Safe and efficient workplace training.

Designing AR experiences requires training for higher education teachers.

Some students may find difficult to use AR applications.

Designing AR applications for a specific subject may be quite costly.

BEST PRACTICES ACROSS PARTNER COUNTRIES AND EUROPE

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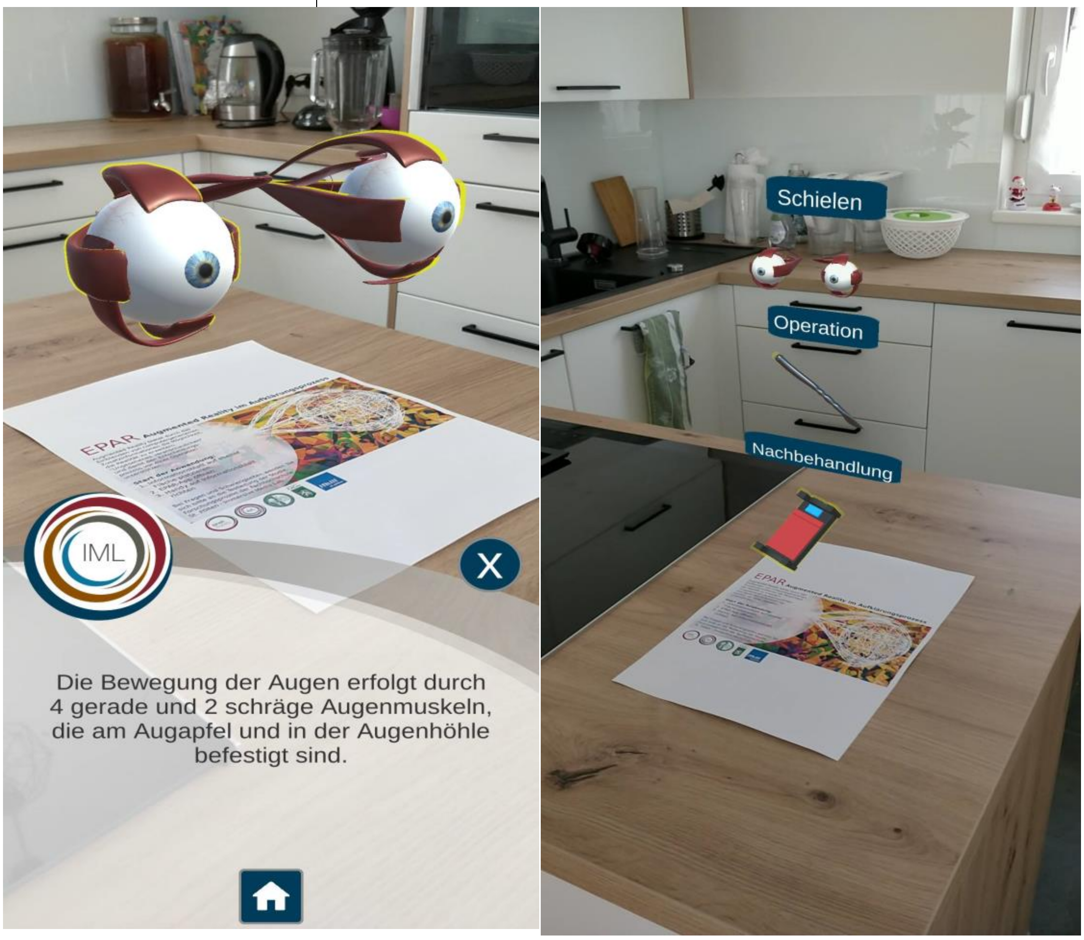
5. Best practices on VR/AR implementation in higher education

Both VR and AR have the potential to transform the way we learn and teach, from providing in-depth knowledge and helping us understand complex subjects to facilitating language immersion and virtual trips. The following tables illustrate two best practices on VR/AR implementation from VRinHE project's partner countries and EU.

5.1 Austria

Title of the initiative:	EPAR (Enlightening Patients with Augmented Reality)
Higher Education Institution:	Fachhochschule St. Pölten (University of Applied Sciences)
Domain of application:	Medicine
Technology:	Augmented Reality
Description of the initiative (describe the objectives, learning model, learning theory-if applicable-, how teachers and students worked, any challenges or advantages identified)	EPAR is concerned with expanding patient education about upcoming treatments and the optimisation and evaluation of information transfer using AR in the field of medicine based on digital storytelling. It is directed at adult persons with only a basic understanding of health-related concepts. It was positively evaluated with 22 radiology technologists and doctors. This initiative worked towards explaining complex medical procedures to patients in an accessible way using AR technology: the prototype displayed a radiation therapy holographically and acoustically, with a speaker explaining the medical procedure. The developed system was implemented with Microsoft HoloLens. Used methods: • Definition of patient education scenarios (e.g. orthoptics, radiotherapy, functional MRI). • Expert interviews with domain specialists to create content

	• Storyboards for immersive AR visualisation of the scenarios • 3D modelling and audio recordings for content generation • Technical implementation of the visualisation with a special focus on usability
Url:	https://research.fhstp.ac.at/projekte/immersive-media-lab
Photos:	



Photos are taken from https://research.fhstp.ac.at/projekte/immersive-media-lab

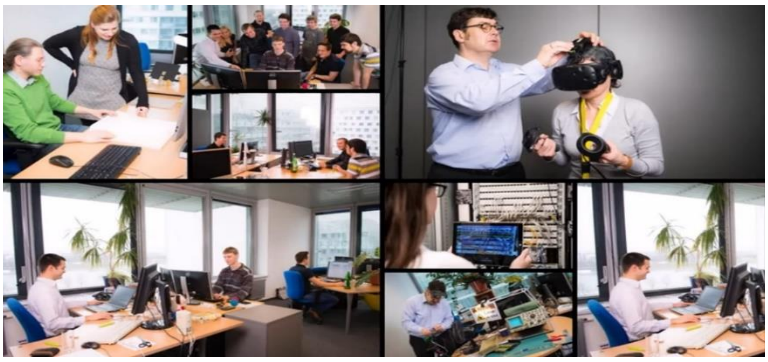
Title of the initiative:	VRVis – center for research in virtual reality and visualisation
Higher Education Institution:	University of Vienna, faculty of informatics
Domain of application:	Research
Technology:	Virtual Reality and other visualisation technologies and methods
Description of the initiative (describe the objectives, learning model, learning theory-if applicable-, how teachers and students worked, any challenges or advantages identified)	VRVis is a research institution in the field of visual computing, founded in the year 2000. It has more than 70 employees and conducts innovative research and development projects in cooperation with industrial companies and universities; in this function, it connects industry and research/education. VRVis presents present data, connections and questions in a visual and interactive form, transferring know-how from science to industry applications. It is engaged in application-oriented research in the field of visual computing and, in association with the Technical University of Vienna, the Technical University of Graz and the University of Vienna. As such, it is Austria's leading institution in the field and one of the largest research clusters in Europe.
Url:	www.vrvis.at/en
Photos:	

Photo taken from www.vrvis.at – screenshot from YouTube video (https://youtu.be/yJJ-Zl3WCNw)

5.2 Bulgaria

Title of the initiative:	Learning medicine *with VR*
Higher Education Institution:	Ruse University "Angel Kanchev", Medical University Varna (and its branches in the country), Medical Universities in the cities of Plovdiv, Sofia, Pleven, Stara Zagora, and Blagoevgrad.
Domain of application:	Medicine
Technology:	Virtual Reality
Description of the initiative (describe the objectives, learning model, learning theory-if applicable-, how teachers and students worked, any challenges or advantages identified)	Video methods, serious games, and virtual simulations are increasingly being introduced into the process of medical training in Bulgaria. The results obtained from the processing of the conducted survey among teachers and students in Bulgaria show that the use of virtual tools for enhancing students' educational qualifications is equally well received by both students and their teachers. However, both teachers and students recognize the importance of classical teaching strategies. In the medical education of the teacher, his knowledge, skills, experience, and manner of influence on students are of particular importance for the students. For this reason, virtual training and educational games can find their essential place in medical training as complementary and parallel methods that enhance their knowledge and skills. The acquisition of basic knowledge and skills in the field of medical training is important to be mastered in the presence and under the guidance of a teacher. The advanced training of graduates in their further education can already be done with the participation of a higher percentage of virtual methods, virtual simulations, and training games. The use of modern innovative methods must be carefully considered for education to fulfil its tasks in all stages of the training of future medical professionals. <u>Advantages:</u> ✓ Innovative education ✓ Applicable in distance learning ✓ Interest in VR – teachers and students <u>Challenges:</u>

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- Equipment
- Hard to implement
- Train the trainers

Url:

https://www.researchgate.net/publication/340122781_INVESTIGATION_OF_THE_IMPACT_OF_VIDEO_METHODS_AND_SERIOUS_GAMES_IN_THE_PROCESS_OF_MEDICAL_TRAINING_IN_BULGARIA/link/5f213163299bf1720d6dbf04/download

https://www.learntechlib.org/p/217921/

Photos:

Training components	*Percentages of positive answers given*
Video Materials	78.30
Web based resources, file libraries, databases and more	49.00
Communication channels – discussions, chats, forums, online groups, trends	35.70
Podcasts	5.60
Virtual environment, serious educational games and other innovations that put the student in a virtual situation	46.20
Mobile training applications on phones, tablets, and other electronic devices	42.70
Videoconferences	21.00
Presentations, surveys, online training	39.90

Title of the initiative: *Smart Classroom – a tool for developing learning materials with AR*

Higher Education Institution: Schools in Bulgaria – Varna, Ruse, Veliko Tarnovo, Shumen, Pazardjik

Domain of application: Education

Technology: Augmented Reality

Description of the initiative (describe the objectives, learning model, learning theory-if applicable-, how teachers and students worked, any challenges or advantages identified)

The Smart Classroom AR application was created in 2017 within the Smart Classroom project of Samsung Bulgaria, part of the company's corporate social responsibility policy. The aim of the platform is to provide an environment where teachers can create and share content. This content is executed in the mobile application Smart Classroom AR (android based).

The main components of the content are: scene, objects, markers, gallery and containers.

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<table>
<tr><td></td><td><u>Advantages:</u>
✓ The project can see the progress of students and communicate with them.
✓ The application is universal – content can be from different fields of science
<u>Challenges:</u>
• The developed content is for 10th grade students, the complicated curriculum for the last two years (11th and 12th grade) makes it difficult to identify the content for the subject of every profile</td></tr>
<tr><td>Url:</td><td>https://ar.smartclassroom.bg/#/#howItWorks
https://platform.solvefortomorrow.bg/auth/login</td></tr>
<tr><td>Photos:</td><td>

</td></tr>
<tr><td>Title of the initiative:</td><td>Virtual reality laboratory</td></tr>
<tr><td>Higher Education Institution:</td><td>Technical University of Sofia</td></tr>
</table>

Domain of application:	Education and research
Technology:	Virtual Reality
Description of the initiative (describe the objectives, learning model, learning theory-if applicable-, how teachers and students worked, any challenges or advantages identified)	Established in the year 2008 at the Technical University of Sofia, in virtue of the financing by the Ministry of Education and Science, with the joint efforts of the Faculty of German Engineering Education and Industrial Management (FDIBA), the German partners from the research centre LESC (Lifecycle Engineering Solutions Centre at KIT (Karlsruhe Institute of Technology) and the department for Automation of Discreet Production at the Faculty for Machine Engineering and with the support of the DAAD. It is practically a unit with the status of a faculty at the FDIBA (Figure 1.) and has already affirmed itself as an important structural unit part of established in the TU-Sofia Integrated University Centre for Virtual Engineering and Centre of Excellency. The Virtual Reality Laboratory is the only place in Bulgaria in which systematic research activities are conducted and which offers education in the area of virtual reality and its application for solving real life interdisciplinary engineering tasks. It has at its disposal developed human resource potential from young specialists with qualification from different fields (engineering science, information technologies, psychology) and unique for the country technical equipment and programming applications, according to the established technological and professional standard in the field. <u>Advantages:</u> ✓ Currently have been used during lectures and laboratory exercises in the Faculty of German Engineering Education and Industrial Management, Faculty of Computer Systems and Technologies and English Language Faculty of Engineering ✓ There have been adapted a few main projects in VR Lab as:

	○ Enhanced immersive representation of objects in virtual reality environment implementing implicit features ○ Large Scale Industrial Structural Optimisation for Advanced Applications ○ University Scientific Research Center ○ Virtual and Augmented Reality in Design for Manufacture ○ Cultural heritage, national memory and social development Challenges: ✓ There are only a few subjects in with the laboratory is used
Url:	http://vrlab.tu-sofia.bg/?hl=en_US
Photos:	

5.3 Cyprus

Title of the initiative:	VAM*Rs: University Business Cooperation for Promoting Virtual, Augmented and Mixed Reality Applications within Small and Medium-sized Manufacturing Companies
Higher Education Institution:	CARDET*, EU universities and SMEs

The domain of application:	Industry/Manufacturing
Technology:	Both
Description of the initiative	Virtual, Augmented, and Mixed Reality technologies play an increasingly significant role in many areas of life and the economy, especially in the manufacturing industry. With the speed of technological developments and the mass of information, products, and services available, small and medium enterprises often struggle to keep track of technology and grasp the opportunities they offer. Towards this direction, the VAM Realities project brings together higher education institutions and companies from all over Europe to join forces and provide answers to these questions. The project aims to provide higher education institutions with skills to guide SMEs into adopting VR and AR technologies and integrating these technologies into their business operations. In this direction, the project has developed a suite of resources for higher education institutions, which include: • The **VAM Realities State of the Art XR Technology Report**: State the Art Report provides an overview of the most essential and efficient VR/AR/MR technologies currently available to companies and what kind of hardware and software is successfully used in the various industries. • The **VAM Realities European Survey Report**: The report highlights the findings from a Pan-European Survey with 300 SMEs aiming to map the knowledge and needs of companies regarding XR technology and how they are already benefiting from these technologies. • The **VAM Realities platform**: an online platform offering unique networking opportunities within the field of XR technologies. The platform hosts the *VAM Realities Network*, an online repository of more than 350 registered XR experts and XR enthusiasts from Europe and the entire world. The platform also hosts the EU XR projects showcase, where you can access more than 40 EU-funded XR-related projects from all around Europe. • The **SME Online Skills Gap Detector**: an online self-assessment tool that allows companies/SMEs to find

	out how well prepared they are - or not - for the increasing importance of VR/AR/MR in their industries. ● The **VAM Realities University Business Cooperation Handbook**: a practical handbook which addresses how Higher Education Institutes can support manufacturing SMEs to adopt and integrate XR technologies successfully into their business operations. In addition to the above, the project is running an SME Coaching Programme in which higher education institutes and other educational institutions support SMEs in their countries to integrate XR technologies into their workings. As part of the coaching programme, two site visits have taken place in Bilbao, Spain and Milan, Italy.
Url:	https://vam-realities.eu/
Photos:	

Title of the initiative:	Boosting Virtual Reality Learning within Higher Business Management Education
Higher Education Institution:	University of Nicosia, EU universities and SMEs
The domain of application:	Digital Transformation
Technology:	Virtual Reality
Description of the initiative	VRinSight aimed to educate higher education teachers about Virtual Reality (VR) in multi-user, social VR. This project tells you everything you need to know about applying VR in education. The project set the following objectives: ● Identifying the challenges faced by the SMEs of Europe and the current deficiencies of Higher Education regarding VR technology

	• Spearheading a VR training programme for Educators and SMEs in the application of VR technology in Business Management • Increasing awareness of VR technology across Higher Education and Business in Europe and developing methods of integrating VR learning into Higher education Curriculum
Url:	https://www.vrinsight.org/
Photos:	

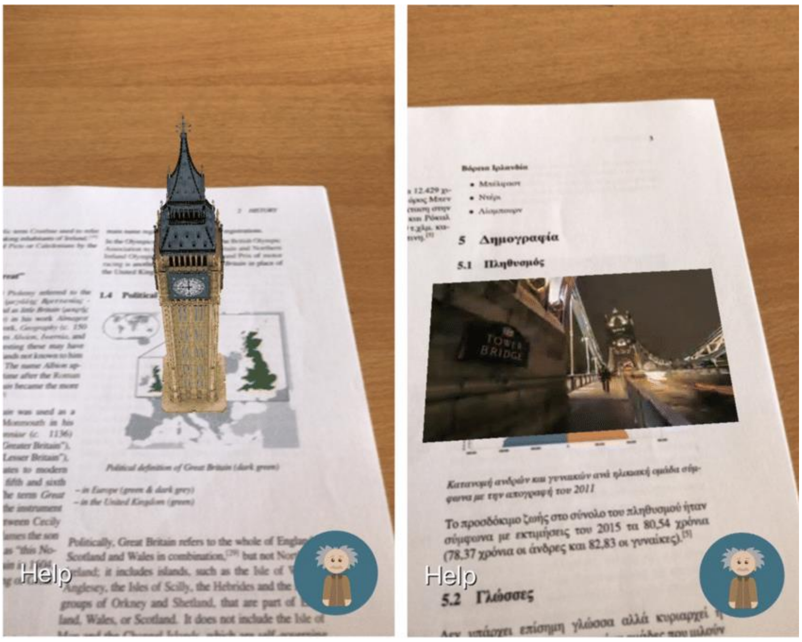
5.4 Greece

Title of the initiative:	*Achieving educational goals in microscopy education by adopting virtual reality labs*
Higher Education Institution:	National and Kapodistrian University of Athens, Department of Primary Education
Domain of application:	Science Education
Technology:	Virtual Reality
Description of the initiative (describe the objectives, learning model, learning theory-if applicable-, how teachers and students worked, any challenges or advantages identified)	An increasing number of educational institutions are incorporating virtual reality (VR) applications in the instruction methodology for their laboratory science courses. However, there is debate about the use of the physical vs. the virtual lab as according to research the former offers a positive research-training environment, whereas the latter offers safe and repeated practice in combination with an engaging experience. The purpose of this study was to explore whether virtualization applied to practically oriented education could: a) fulfill specific educational goals which correspond to the six levels of Bloom's Taxonomy, b) raise students' confidence about their knowledge and c) help students learn how to use an optical microscope in a physical biology lab.

	Fifteen graduates of the Athens University Department of Primary Education in Greece attending postgraduate studies in Science Education participated in the study. The sample was separated into two cognitively balanced groups to be educated on microscopy by two educational methods: a) the traditional tutorial and demonstration method, and b) our proposed tutorial and simulation method with a VR biology lab, Onlabs. Participants completed both a Pre- and a Post-test to assess the acquired knowledge, and a worksheet to assess their ability to operate a real optical microscope. The results showed that participants in the experimental group obtained higher Post-test scores and were better educated to correctly answer different types of questions corresponding to Bloom's Taxonomy than were members of the control group. Moreover, when working in the physical lab after having used Onlabs, the experimental group was more knowledgeable about the required experimentation skills compared to the control group.
Url:	Research paper: https://www.tandfonline.com/doi/full/10.1080/02635143.2020.1790513
Photos:	 A screenshot of the virtual reality biology lab, Onlabs.

Title of the initiative:	*Creating AR books in tertiary education*
Higher Education Institution:	International Hellenic University, Department of Computing and Informatics

Domain of application:	Learning and Teaching Theories
Technology:	Augmented Reality
Description of the initiative (describe the objectives, learning model, learning theory-if applicable-, how teachers and students worked, any challenges or advantages identified)	The objectives of this initiative was to evaluate an augmented reality platform named ARTutor, as a tool for converting existing textbooks to AR ones. Two-hundred students attending modules “Learning and Teaching Theories” and “Educational Technologies” were engaged. ARTutor was made part of the semester’s coursework. Students were divided in groups of five and each group was assigned a portion of one of 15 books taught in secondary Greek schools, in subjects such as information technology, history, mathematics and geography. The assignment given to the students was to study their allocated portion of the book, identify images that can be used as triggers, and find multimedia content (images, videos, audio clips and 3D models) that would serve as augmentations and enhance the book content. They were also required to subsequently use the mobile application to view and interact with their augmentations. In this way, the students were able to experience the platform both as teachers as well as students. All groups of students were then required to add their multimedia content to the books that were prepared in ARTutor beforehand. It should be noted that all students used the same ARTutor account, which means that groups assigned to different portions of the same book were working in parallel and essentially developing each augmented book collaboratively. The results from the evaluation study showed that ARTutor was easy to use, as it required no programming skills. Furthermore, the tool could be utilized to support understanding of abstract concepts by overlaying videos or 3D models as AR content. Lastly, most students agreed that there were no organizational issues that would prevent the choice of this educational technology, since it was designed for self-study and so no specialized equipment, or technical staff would be required at the institute adopting it. The teachers would only need a

	computer and an internet connection to develop and upload their educational material, and the students would only have to download the corresponding mobile application.
Url:	Research paper: https://slejournal.springeropen.com/articles/10.1186/s40561-018-0058-x#Sec7
Photos:	 *Examples of AR books created with ARTutor platform.*

5.5 Latvia

Title of the initiative:	Exonicus - VR Trauma Simulator
Higher Education Institution:	Riga Stradins University, American College of Surgeons Committee on Trauma, NATO medical training facilities

Domain of application:	Military medicine, trauma
Technology:	Virtual reality
Description of the initiative (describe the objectives, learning model, learning theory-if applicable-, how teachers and students worked, any challenges or advantages identified)	Exonicus work on Trauma Simulator in VR enhances military medical personnel training. Exonicus is a global medical training technologies company. Trauma Simulator is virtual reality software as a service of trauma management training and readiness for hospitals. Trauma Simulator is a free-play virtual reality training platform capable of training military medical personnel through dynamic physiologic responsive simulations that allow decision-training without an instructor. The primary focus was decision- training (i.e., cueing) when to initiate a blood transfusion, place a chest tube, or completing other life-saving procedures such as clearing a patient's airway.
Url:	https://www.exonicus.com/
Photos:	Insert 1-2 photos from the described best practice

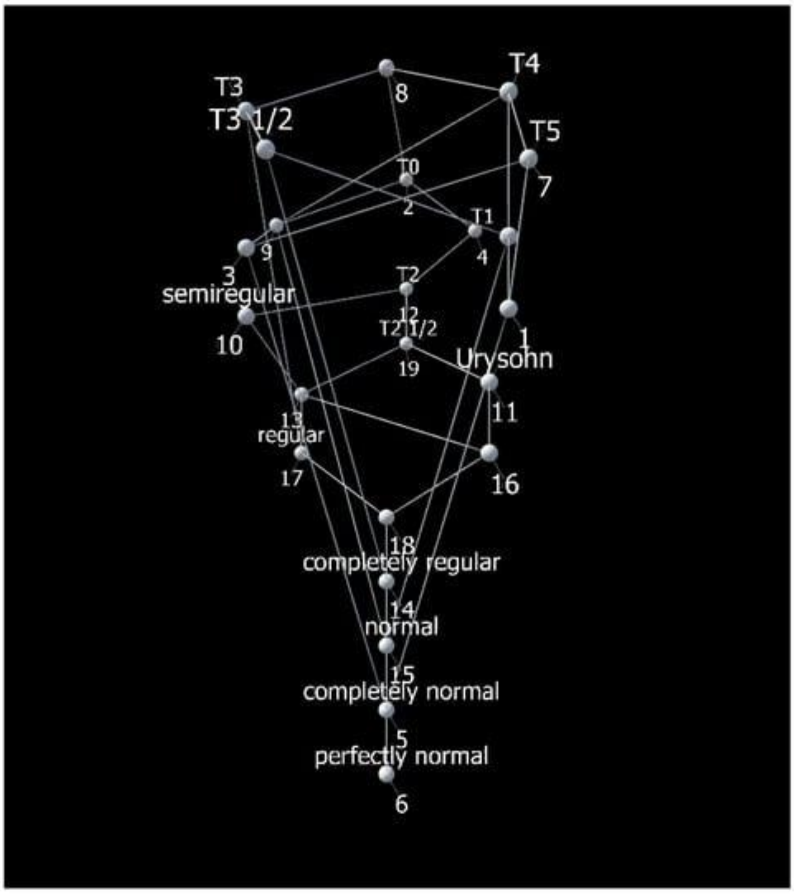

Title of the initiative:	Augmented reality art platform ART+
Higher Education Institution:	University of Liepaja
Domain of application:	Art
Technology:	Augmented reality

Description of the initiative (describe the objectives, learning model, learning theory-if applicable-, how teachers and students worked, any challenges or advantages identified)	Augmented reality platform ART+. Its users have access to more than 15 visual and sound works of art, which can be found in various places in Liepāja. The media and sound artworks included in the ART+ application can be seen, heard, viewed from a distance, and explored up close, walked around and even walked inside. For those who cannot go on an "art walk" in Liepāja, a special website has been created where all works can be viewed, as if in a simulated augmented reality experience. The application is available for both Android and iOS users.
Url:	https://artplus.app/
Photos: 	

5.6 Rest of Europe

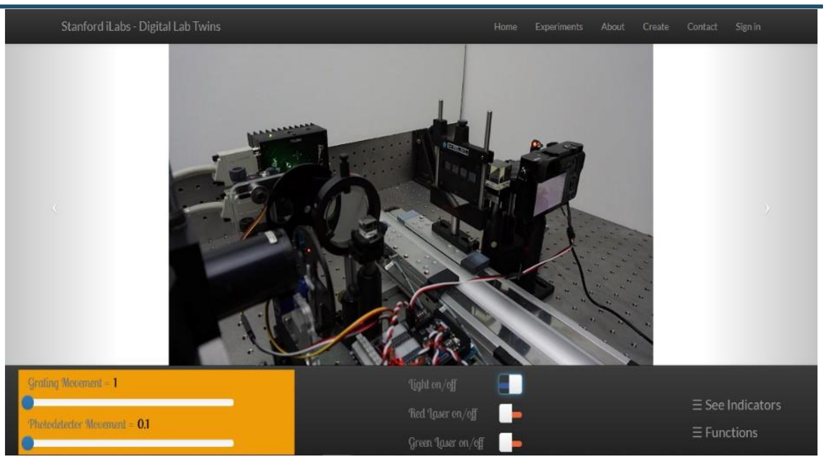
Title of the initiative:	ElectARmanual: AR training for installations and electrical machines practice
Higher Education Institution:	University of La Laguna, Spain
Domain of application:	Electrical engineering
Technology:	Augmented Reality
Description of the initiative (describe the objectives, learning model, learning theory-if applicable-, how teachers and students worked, any challenges or advantages identified)	The authors have developed an educational augmented reality application called ElectARmanual (which is supposed to support students in a practice laboratory and then in training for use of electrical machines). The application is an assistant, which guides the student step by step through the tasks that he may perform in order to understand instructions and explanations of the practice's manual provided by the teacher in the laboratory. An animation of 3D models is superimposed over the main panels at the workplace indicating how to connect the wires, and place several components (coils, magnets, rotor, wide pole pieces, etc.) for creating installations of several sorts, creating configurations of electrical machines with different purposes. For visualizing each sequence, the user will press a key from the laptop or press the "next" button on tablet or smartphone's screen.
Url:	https://www.sciencedirect.com/science/article/pii/S0747563214007110

Photos:	
Title of the initiative:	VR FCA project
Higher Education Institution:	Babeş-Bolyai University, Romania
Domain of application:	Mathematics
Technology:	Virtual Reality
Description of the initiative (describe the objectives, learning model, learning theory-if applicable-, how teachers and students worked, any challenges or advantages identified)	The VR FCA project is an attempt to include modern graphic capabilities, new technologies and game engines in Formal Concept Analysis (FCA) software tools. The aim is gamifying the FCA experience in order to activate the Conceptual Knowledge Processing features necessary for a good learning experience. This research is proposing a particular approach to the exploration of knowledge structures by moving the entire experience into a 3D VR environment and gamifying this experience by using the capabilities of state-of-the-art VR technologies. Once you enter a VR room, a 3D concept lattice unfolds in front of you, allowing you to interact with it, to fly around, to rotate, to teleport or to narrow the perspective to a certain group of nodes. The multiuser experience allows users to simultaneously enter the same VR room and to discuss and interact all together.

Url:	https://www.mdpi.com/2227-7390/10/5/709
Photos:	

5.7 Rest of the world

Title of the initiative:	iLabs
Higher Education Institution:	Stanford University, USA
Domain of application:	Science
Technology:	Virtual reality- Non immersive

Description of the initiative (describe the objectives, learning model, learning theory-if applicable-, how teachers and students worked, any challenges or advantages identified)	The iLabs platform is a low cost, highly scalable way to provide online learning for remote and virtual laboratory experiments into a classroom. As the COVID-19 pandemic has disrupted conventional laboratory experiment-based teaching, the iLabs platform can be a potential solution to include remote and virtual experiments in the curricula. The described process includes converting a physical experiment into an iLabs experiment and using it as a teaching tool in one course at Stanford University. Feedback collected from the students is discussed. Although performed on a small scale, the case study suggests that the platform has the potential to be a helpful teaching tool for science and technology classes. In addition to being a substitute for a physical laboratory during the pandemic, the platform can be included as a supplementary teaching tool complementing physical laboratory experiments after the pandemic as well and will aid remote education.
Url:	https://ieeexplore.ieee.org/document/9454028 http://ilabs.education/
Photos:	

Title of the initiative:	LADUVR: Learning Architectural Details Using Virtual Reality Technology
Higher Education Institution:	Shahid Beheshti University, Iran

Domain of application:	Architecture
Technology:	Virtual Reality
Description of the initiative (describe the objectives, learning model, learning theory-if applicable-, how teachers and students worked, any challenges or advantages identified)	LADUVR has been designed by the authors to show how VR would address the current shortcomings of architecture learning systems. The study discusses the benefits and challenges of developing these kinds of applications and shows how by using LADUVR users can experience being on a construction site, investigate the architectural details closely, and test what they have learned in an interactive and immersive environment. To continue, the study examines the feedback from the implementation of LADUVR; with the results indicating that LADUVR would indeed enhance the learning of architectural detailing in most aspects.
Url:	https://www.archnet.org/publications/13134
Photos:	

6. Conclusion

In conclusion, the use of VR and AR in higher education has the potential to revolutionize the way students learn and interact with information. AR enhances the learning experience by overlaying digital information on the physical world, while VR creates completely immersive and interactive simulations. Both technologies have been shown to increase engagement, motivation, and retention of information, as well as provide a more interactive and hands-on approach to learning. However, it is important to note that the implementation of these technologies in education is still in its early stages, and there is a need for more research to fully understand their impact and how they can be effectively integrated into the classroom. Additionally, there are concerns about the cost and accessibility of these technologies, as well as the lack of standardized training for educators to effectively utilize them in their teaching.

Despite these challenges, the use of AR and VR in Higher Education is rapidly growing and has the potential to greatly benefit students and educators alike. It is important for educators, institutions, and technology companies to continue exploring and investing in this field to further its development and potential for widespread adoption in Higher Education. Providing proper training to faculty members, so understand the affordances of the technologies as well as guidance in terms of selecting and using the right VR/AR software and hardware is essential to a successful integration in HE curricula.

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APPENDIX

The following VR/AR readiness questions were based and adapted to the project needs from SELFIE: https://education.ec.europa.eu/selfie

LEADERSHIP			
	LEADERS	**FACULTY**	**STUDENTS**
A1.	A1.In our university, we have a digital strategy regarding VR/AR technologies.	In our university, we have a digital strategy regarding VR/AR technologies.	
A2.	We develop our university's digital strategy together with the faculty members.	Our university leaders involve us faculty members in the development of the school's digital strategy.	
A3.	We support faculty members to try out new ways of teaching such as VR/AR technologies.	Our university leaders support me in trying out new ways of teaching such as VR/AR technologies.	
A4.	In our university, faculty members have time to explore how to improve their teaching with VR/AR technologies.	In our university, I have time to explore how to improve their teaching with VR/AR technologies.	
A5.	In our university, we apply ethics, and licensing rules when using VR/AR technologies for teaching and learning.	In our university, we apply ethics, and licensing rules when using VR/AR technologies for teaching and learning.	
COLLABORATION AND NETWORKING			
B1.	In our university, we review our progress in teaching and learning with VR/AR technologies.	In our university, we review our progress in teaching and learning with VR/AR technologies.	
B2.	B2.In our university, we discuss the advantages and disadvantages of teaching and learning with VR/AR technologies.	In our university, we discuss the advantages and disadvantages of teaching and learning with VR/AR technologies.	In our university, we talk with faculty members about the advantages and disadvantages of teaching and learning with VR/AR technologies.
B3.	In our university, we use VR/AR technologies in our partnerships with other organisations.	In our university, we use VR/AR technologies in our partnerships with other organisations.	
B4.	In our university, we collaborate with other Higher Education Institutions to support the use of VR/AR technologies.	In our university, we collaborate with other Higher Education Institutions to support the use of VR/AR technologies.	
INFRASTRUCTURE AND EQUIPMENT			
C1.	In our university, the digital infrastructure supports teaching and learning with VR/AR technologies.	In our university, the digital infrastructure supports teaching and learning with VR/AR technologies.	
C2.	In our university, there are VR/AR devices to use for teaching.	In our university, there are VR/AR devices to use for teaching.	
C3.	In our university, there is access to the Internet for teaching and learning.	In our university, there is access to the Internet for teaching and learning.	In our university, I have access to the Internet for learning.
C4.	In our university, technical support is available in case of problems with VR/AR technologies.	In our university, technical support is available in case of problems with VR/AR technologies.	In our university, technical support is available when I face problems with VR/AR technologies.

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C5.	In our university, there are data protection systems in place.	In our university, there are data protection systems in place.	
C6.	In our university, there are university-owned/managed VR/AR devices for students to use when they need them.	In our university, there are university-owned/managed VR/AR devices for students to use when they need them.	In our university, there are university-owned/managed VR/AR devices for me to use when they need them.
C7.	In our university, there are university-owned/managed VR/AR devices for students can take home when they need them.	In our university, there are university-owned/managed VR/AR devices for students can take home when they need them.	In our university, there are university-owned/managed VR/AR devices for me to take home when they need them.
C8.	In our university, we have a plan in place to help faculty members identify and deal with challenges that arise with VR/AR learning, related to students' learning needs and socio-economic background.	In our university, we have a plan in place to help faculty members identify and deal with challenges that arise with VR/AR learning, related to students' learning needs and socio-economic background.	
C9.	In our university, students bring and use their own VR/AR devices during lessons.	In our university, students bring and use their own VR/AR devices during lessons.	
C10.	In our university, physical spaces support teaching and learning with VR/AR technologies	In our university, physical spaces support teaching and learning with VR/AR technologies.	
C11.	In our university, there are online libraries or repositories with teaching and learning VR/AR materials.	In our university, there are online libraries or repositories with teaching and learning VR/AR materials.	In our university, there are online libraries or repositories with teaching and learning VR/AR materials.
CONTINUING PROFESSIONAL DEVELOPMENT			
D1.	We discuss with our faculty members their CPD needs for teaching with digital technologies such as VR/AR.	Our university leaders discuss with us our CPD needs for teaching with digital technologies such as VR/AR.	
D2.	Our faculty members have opportunities to participate in CPD for teaching and learning with VR/AR technologies.	I have opportunities to participate in CPD for teaching and learning with VR/AR technologies.	
D3.	We support our faculty members to share experiences within the university community about teaching with VR/AR technologies.	Our university leaders support us to share experiences within the university community about teaching with VR/AR technologies.	
PEDAGOGY: SUPPORTS AND RESOURCES			
E1.	Our faculty members create VR/AR educational material to support their teaching.	I create VR/AR educational material to support their teaching.	
E2.	Our faculty members utilize AR technology to support their teaching.	I utilize AR technology to support their teaching.	
E3.	Our faculty members use virtual environments to support their teaching.	I use virtual environments to support their teaching.	
E4.	Our faculty members use VR/AR technologies for university-related communication.	I use VR/AR technologies for university-related communication.	
E5.	Our faculty members use VR/AR open educational resources.	I use VR/AR open educational resources.	
PEDAGOGY: IMPLEMENTATION IN TEACHING			
F1.	Our faculty members use VR/AR technologies to tailor their teaching to students' individual needs.	I use VR/AR technologies to tailor their teaching to students' individual needs.	In our university, our faculty members give us different activities with VR/AR

			technologies that suit our needs.
F2.	Our faculty members use VR/AR technologies that foster students' creativity.	I use VR/AR technologies that foster students' creativity.	In our university, I participate more when we use VR/AR technologies.
F3.	Our faculty members set learning activities with VR/AR that engage students.	I set learning activities with VR/AR that engage students.	In our university, we use VR/AR technology for group work.
F4.	Our faculty members use VR/AR technologies to facilitate students' collaboration.	I use VR/AR technologies to facilitate students' collaboration.	In our university, our faculty members give us different activities with VR/AR technologies that suit our needs.
F5.	Our faculty members engage students in using VR/AR technologies for cross-curricular projects.	I engage students in using VR/AR technologies for cross-curricular projects.	In our university, I participate more when we use VR/AR technologies.
G1.	Our faculty members use VR/AR technologies to assess students' skills.	I use VR/AR technologies to assess students' skills.	
G2.	Our faculty members use VR/AR technologies to provide timely feedback to students.	I use VR/AR technologies to provide timely feedback to students.	
G3.	.Our faculty members use VR/AR technologies to enable students to reflect on their own learning.	I use VR/AR technologies to enable students to reflect on their own learning.	
G4.	Our faculty members use VR/AR technologies to enable students to provide feedback on other students' work.	I use VR/AR technologies to enable students to provide feedback on other students' work.	
STUDENT DIGITAL COMPETENCE			
H1.	In our university, students learn how to behave safely and responsibly online.	In our university, students learn how to behave safely and responsibly online.	In our university, I learn how to behave safely and responsibly online.
H2	In our university, students learn to create digital content.	In our university, students learn to create digital content.	In our university, I learn to create digital content.
H3.	In our university, students learn to communicate using digital technologies.	In our university, students learn to communicate using digital technologies.	In our university, I learn to communicate using digital technologies.
H4.	We ensure that students develop their digital skills across subjects.	We ensure that students develop their digital skills across subjects.	In our university, I use technology in different subjects.
H5.	In our university, students learn how to solve technical problems when using digital technologies.	In our university, students learn how to solve technical problems when using digital technologies.	In our university, I learn how to solve technical problems when using digital technologies.