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The Trends and Challenges of Virtual Technology Usage in Western Balkan Educational Institutions

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Abstract: Higher educational institutions in Western Balkan countries strive for continuous development of their teaching and learning processes. One of the priorities is employing state-of-the-art technology to facilitate experience-based learning, and virtual and augmented reality are two of the most effective solutions to providing the opportunity to practice the acquired theoretical knowledge. This report presents (apart from the theoretical introduction to the issue) an overall picture of the knowledge of AR and VR technology in education in Western Balkan universities. It is based on a semi-structured online questionnaire whose recipients were academic staff and students from universities in Albania, Kosovo, and North Macedonia. The questionnaire differed for each target group; the version for academics comprised 11 questions for 710 respondents, and the version for students comprised 10 questions for 2217 respondents. This paper presents and discusses the results for each question with the aim to illustrate Western Balkan countries' current state of VR and AR application in education.

1. Introduction

The entertainment industry was the first one that tried to utilise the opportunities given by the development of virtual reality. While the initial use of virtual reality (VR) was nothing more than a gimmick, the technology has come a long way. Now, it has been established as an important and valuable tool applied professionally in various industries, from the military [1] and medicine [2] through mental health [3], sport and rehabilitation [4], and up to fashion [5]. However, it is the application in education [6] that is of particular interest for the purpose of the following article. As established in [7], the quality of education is improved by implementing modern technologies into the process. Educators have been early adopters of many new solutions, and researchers have been searching for creative and advanced ways to facilitate the knowledge transfer. They are constantly aiming to improve the efficiency of teaching and learning (specifically the understanding of new information and applying it in practice), in contrast to simple regurgitation during a standardised test [8]. VR has been successfully used in numerous educational applications. It involves creating an interactive computer-generated environment which simulates the physical presence of the user in an artificially generated interactive world. Studies and educators' testimonials indicate that it presents a great opportunity to improve the efficacy of the

learning and teaching process. For example, VR can be used as a training environment for teachers, allowing them to improve their practical skills via hands-on scenarios [9]. Such a solution has many advantages over traditional types of training (e.g., a possibility to include very rare cases, lack of consequences for wrong actions, no equipment to wear, and no distractions). Although the domain is still in its infancy, there are already many applications that have been proven to have a significant impact on improving both the teaching and learning processes [10]. Virtual reality refers to a computer-generated simulation imitating an interactive three-dimensional environment comprising a virtual space, events, objects, and people (avatars). VR, as previously stated, is usually three-dimensional, represents the real world, follows similar or identical laws of physics, and its visual aspect is close to the appearance of the real world. A reality–virtuality continuum [11] has been used to describe and define applications based on the level of immersion. The key points on the scale are virtual reality (VR) and augmented reality (AR), as seen in Figure 1.
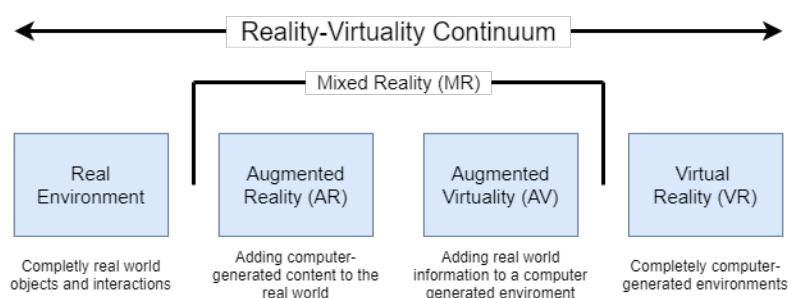
Figure 1. Reality–virtuality continuum.

Virtual reality is usually experienced by using head-mounted display (HMD) virtual reality helmets. While the attempts to create one that would be commercially viable span many years, the product that paved the way was the Oculus Rift (2010). Nowadays, many companies have an HMD in their portfolio, with the most recognisable being HTC, Meta, and Google, and most VR applications are designed for HMDs. The goal is to create affordable yet powerful hardware that would popularise VR. The simplest solutions, such as the one created by Google, were based on cheap cardboard frames that were used to hold a smartphone, which served as a screen. More advanced solutions, and therefore more expensive ones, utilise not only a specially designed HMD with its own audio and video outputs but sometimes a robust infrastructure to be used in laboratories or specially designed rooms. These types of VR platforms do not require additional hardware for interaction, as they come equipped with headsets and controllers with built-in sets of sensors.

Augmented reality differs from VR in the fact that a user is not completely disconnected from the real world. Using, for example, translucent glasses, 3D graphics are superimposed in real time upon the real environment. Such applications found their place in engineering by having access to a visualisation of the structure of the device or machinery to facilitate the work of specialists and providing assistance or information which could not be received any other way without losing focus on the machine.

This paper aims to assess the knowledge regarding virtual technologies and their implementation in the teaching and learning processes among academic staff and students from Western Balkan higher educational institutions (HEIs). The authors seek to answer the following questions based on the subjective opinions of academics and students:

- What is the actual use of modern technologies such as VR or AR in education?
- Would both target groups like to use modern technologies such as VR or AR in the classroom?
- Would both target groups see the potential in this technology in education?

Additionally, this paper provides a short overview of virtual and augmented reality applications in education concerning some of the most important areas. It analyses the user

experience of educators and students and discusses possible risks and challenges. Finally, the technological potential and future development of VR and AR applications used for improving teaching and learning are summarised and briefly discussed.

2. Background

2.1. AR and VR Immersive Tools

As VR solutions were introduced chronologically earlier than AR, the assumptions of VR provide for the transfer of the user to a computer-generated virtual space, so the most straightforward solutions were based on relatively simple visual projections enriched with stimulation of auditory sensations. A good example of the early implementation of the VR idea is first-person RPG games. The monitor in them acts as the user's viewing window. The user moves in the imaginary space with the use of various controllers (keyboard, mouse, pad, joystick, etc.), and the system presents the effects of their interaction on the monitor screen in the form of an audiovisual message. Anyone who has played such games has probably noticed that the level of immersion into the virtual world increased significantly in dark or nighttime environments. The separation of the day world greatly enhances the immersion, as the user is visually and audibly separated from the real world. At night, they see only the computer monitor and hear only the speakers. The entertainment industry has recognised this dependency with the launch of capsule simulators. The capsule was designed to separate the user from the real world visually and acoustically. These solutions contributed to the creation of professional digital trainers, the level of immersion of which was increased thanks to the use of actuators for the stimulation of overload sensations and a significant expansion of visual sensations with the use of large and multi-monitor systems. A large-format variety of such solutions is 3D caves. The user is placed in the vicinity of large-format vision screens, and he or she can move freely inside, being surrounded by the generated visualisation. CA systems are often equipped with systems that recognise the user's movement (such as Kinect) so that they can interact. The solutions discussed above are presented in Figure 2.

Figure 2. CAVE immersive virtual reality (**left**), professional tank trainer [12] (**middle**), and wiring process of Boening 777 aircraft [13] (**right**).

The real breakthrough in VR development was the introduction of integrated headsets. The first solutions were heavy and inconvenient to use. At present, the offered sets are much more convenient to use as they are smaller and lighter. Currently, the market is dominated by two solutions that ensure tracking the position of the goggles in space. The first one, which is applied, among others, by the HTC Vive (see Figure 3), utilises IR detection with the use of two tracking base stations. The other solution is dedicated to being used in a limited interior environment based on visual mapping combined with precise distance detection.

An observable new approach to VR is the creation of complex installations affecting many senses. More and more often, haptic solutions are used, which are not limited only to the sense of direct touch, such as vibrations of the controllers used, but also to the sensations of identifying the structure of the virtually touched object and the general impact on the human senses, such as wind or rain, but also other senses, such as smell and even taste.

There is a consensus that the pioneer of augmented reality is Tom Caudell, who in 1990 created a visual system supporting the wiring process of the Boening 777 aircraft

(see Figure 2). The proposed system displayed wiring diagrams to employees, which significantly increased their work efficiency. AR technology took off significantly in 1999 with the advent of the first open-source ARToolKit library by Hirokazu Kato (The University of Washington Human Interface Technology).

AR technology was increasingly concerned with the graphic design of events. Its application made it possible to observe the event simultaneously on large-format projection screens as a mixture of real images captured by a camera with artificially generated objects. For example, fashion shows (photography) were realised in this way. Mobile devices have become a very useful vehicle for the implementation of AR solutions. Thanks to a built-in rear camera, tablets and smartphones made it possible to view the surroundings naturally through the screen of this device (see Figure 3). The generated view, which was a mixture of the video image captured by the camera and overlaid additional visual data, made it possible to provide the user with contextual tips, descriptions, and even artificially created objects.

Such solutions have been widely used as virtual tourist guides, outdoor games, or applications, increasing the possibilities of presenting museum spaces. The first AR solutions allocated artificially generated objects using the so-called graphic markers, which were specific high-contrast markers placed in real space [14].

Figure 3. HTC Vive (**left**) and tablet with AR application (**right**).

The AR application recognises the positions of markers and places artificial spatial objects in their place. The disadvantage of this method is the need to prepare and arrange markers. While solutions based on devices such as smartphones or tablets are quite good for entertainment applications, for applications requiring greater manual involvement of the user, other solutions have been searched for. Head-up display (HUD) projection systems have become a widely used modern AR solution in the automotive industry. The onboard computer cooperating with the camera acts as a driver's assistant, displaying directions and prompts in the space of the road observed by the driver (usually as an image located a few meters in front of the windshield of the car). In recent years, a number of solutions have appeared on the market based on the idea of placing a transparent display in glasses. In this way, the natural image that surrounds us can be supplemented with additional generated images. The first such market solution was the Google Glass project, which was controversial in many countries. Currently, the most popular solutions are HoloLens and Magic Leap (see Figure 4).

Figure 4. Magic Leap (**left**) and HoloLens 2 (**right**).

These solutions, thanks to built-in cameras, can map the space of the real internal environment, which can become an element of interaction with the user. Scientific publications show that intensive work is currently underway to produce AR displays in wireless contact lenses [15]. This will undoubtedly revolutionise the area of AR applications. It is also worth mentioning the new hardware trends that aim to blur the differences between AR and VR. Thanks to built-in cameras, the latest VR goggles enable the smooth transfer of the user from VR to AR space.

2.2. Immersive Technology in Education

In the digital world, we have an opportunity to improve the learning process with advanced technology. Virtual reality (VR) seems to be the natural next step for the evolution of education, since it has started to be used in various applied fields such as psychological therapy and education [6,16,17]. Earlier investigations have shown there has been substantial research for developing methods for measuring presence and research regarding factors that contribute to presence. Such knowledge can play an essential role in the development of new VR applications. Wickens [18] conducted an investigation on the five main components of VR in education, which are a 3D perspective, dynamic rendering, closed-loop interaction, an inside-out perspective, and enhanced sensory feedback [19]. He concluded that learning to direct users' attention to the link between the VR perspective and a more artificial perspective is essential to understand the potential use cases of VR in education.

Similar to VR, AR is reported to be more effective at small-to-medium scales with students who have low-to-average academic achievements [20,21]. For students with high academic achievements, it proves to be less effective. AR also improves motivation [22–24], ensures positive attitudes towards learning [25,26], increases students' willingness to learn [27], reduces cognitive load, and improves spatial ability, among other positive impacts [28].

Garzon et al. [29] Studied the pedagogical impact of AR in education based on previous studies. The results showed a moderate impact, but different variables might have influenced this. They explored the effects of various factors, namely the pedagogical approach, the learning environment, and the intervention duration. They found that collaborative learning (CL), problem solving, and evaluation in small peer groups has the best impact when it comes to AR. Cognitive theory multimedia learning (CTML), or the multimedia principle, is based on the principle that people learn from words and pictures instead of words alone. Multiple publications have stated either long- or short-term intervention as being the more beneficial means. Still, in this study, they concluded that interventions lasting between a week and a month, especially when paired with CL learning methods, were shown to be the only intervention method that had a significant effect on students' learning outcomes. In terms of learning environments, formal settings such as classrooms, informal environments such as museum trips, and unrestricted settings have all been tested, but there are no significant differences [29]. AR significantly improved student interaction with environments if they allowed real-time engagement [28].

Thanks to rapid access to information, the current approach to education is facing two main issues [30–32]:

- Education is based on facts according to the traditional learning format. However, having access to and using a huge amount of information is not learning. It is important to recall that having information about something is not the same as education.
- Providing a huge amount of information in a short period of time usually leads to overwhelming students. Hence, they become disengaged and feel lost on the reasoning of why they are learning those topics.

This is the place where VR can be used to enhance student learning by improving his or her engagement [33,34]. VR education is used to transform the way educational content is achieved by working on creating a virtual world, enabling students to not only see things but also interact with them. Researchers have shown that being immersed in what one is learning usually motivates him or her to properly understand it [35–37].

Kavanagh et al. conducted a systematic literature review to describe what the issues of VR in education are and what it is that educators hope to gain by using VR technologies [38]. They reported that the majority of researchers use VR too much to increase the intrinsic motivation of students and hardly address topics such as constructivist pedagogy, collaboration, and gamification in the design of their experiences [39–44]. Furthermore, they introduced a multitude of some VR technologies, discussing their potential to overcome several of the problems identified in our analyses, including cost, user experience, and interactivity.

Sirakaya et al. systematically reviewed multiple AR-related research publications on education in STEM fields and found that there are multiple problems that come with AR-based learning as well. AR problems mainly extend to difficulties tracking markers, dimly lit classrooms, slow internet connection speeds, and insufficient features in student devices, but these are all hardware issues that will improve with new developments [28].

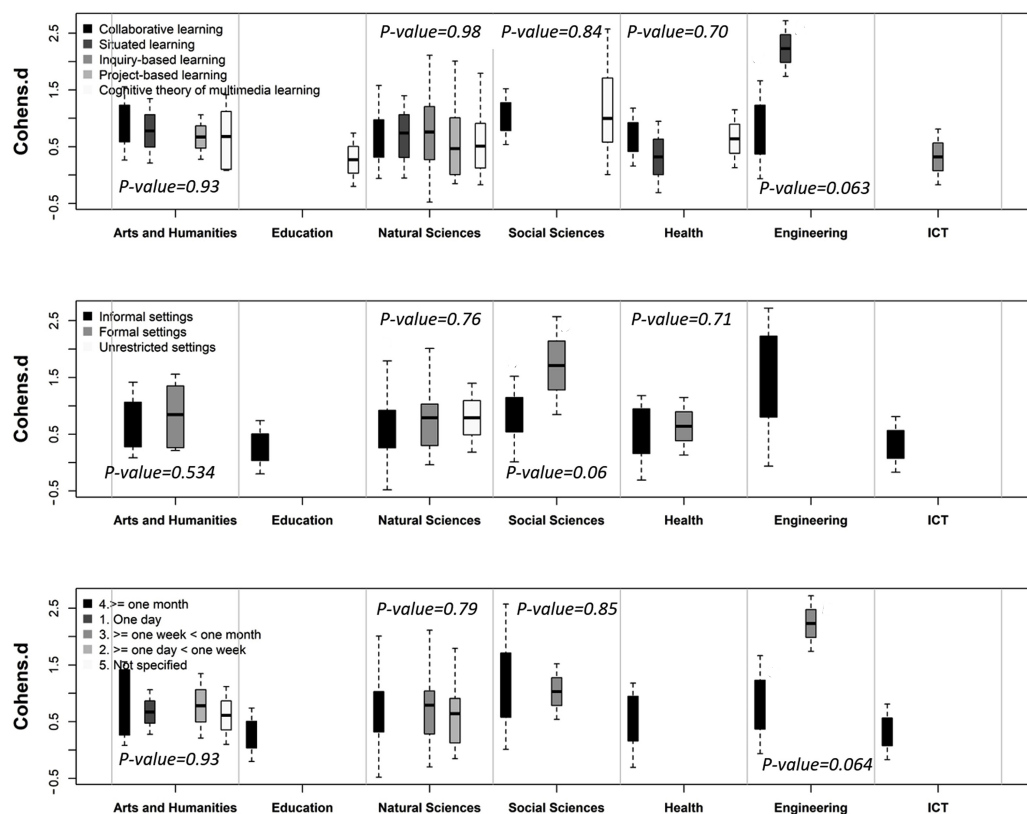More comparable effects of AR and integration methods in different fields of education can be seen in Figure 5.

Figure 5. Cross-analysis between different fields of education and the effect of AR integration [29].

Elmqaddem conducted deeper research on the use of augmented reality (AR) and VR in education and explored how such technologies have been relaunched with new promises that were previously unimaginable [45]. He concluded that when AR and VR technologies are appropriately applied, they can create enhanced contemporary educational environments, which will lead to enriching learning opportunities for students.

More information on this topic can be found in the author's previous paper [6], where they presented new opportunities in VR and put together the most interesting and recent virtual reality applications used in several education areas, such as general, engineering, and health-related education.

2.3. User Experience: Risks and Challenges

The term user experience (UX) signifies the "totality of the effect or effects felt (experienced) internally by a user as a result of interaction with, and the usage context of, a system, device, or product". As such, it encompasses the aspects of the effects experienced due to usability [46], usefulness [47], and emotional [48] impact factors. Usability, being an important user experience aspect, according to [47], is denoted "as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use". Aside from usability, the emotional aspects of the overall user experience are important. According to [48], the experience is critical, for it determines how fondly people remember their interactions with a particular system or product. It determines whether the overall experience was positive or if it was frustrating and confusing. Thus, cognition and emotion are tightly intertwined, which means that the designers must design with both in mind, with the goal of increasing VR product acceptance.

Virtual reality, as a new medium, presents unique challenges as well as opportunities when designing user interfaces, interactions, and experiences. It offers a new and rapidly developing field and is receiving enough attention to be considered as having its revival age in both the industrial and academic areas. Since VR systems have various types of interaction with users, such as gestures, controllers, and voice control, and new kinds of interaction are constantly being developed, multiple studies investigating the user experience (UX) of VR systems are continuously needed [49]. One of the challenges is to make interactions as comfortable as possible, which requires making the interactive objects reachable, distinctive, and visible, limiting the angles of movement and putting the user in control. Designing an excellent user experience in VR is additionally challenged by ensuring similar user experiences across different platforms and headsets.

Virtual reality is, according to [50], defined as a technology that induces targeted behaviour in an organism by using artificial sensory stimulation while the organism has little or no awareness of the interference.

A significant challenge when using VR presents the interactions and VR locomotion (movement) within the virtual environment [51]. VR locomotion can be motion-based [46], supporting the continuous motion in open VR spaces. This is usually achieved by techniques as walking-in-place, redirected walking, arm swinging, gesture-based locomotion, and reorientation. Another example [47] is room scale-based VR locomotion, where the interaction takes place in VR environments whose sizes are limited by the natural environment's size. This can be controller-based [48], where handheld controllers are utilised to move the user artificially in the VR environment. Finally [49], it can be teleportation-based, where the user's virtual viewpoint is instantaneously teleported to a predefined position by utilizing visual "jumps" by aiming at the target position in the form of an arc instead of a straight line, representing a better user experience.

While virtual environments can be more and more realistic in terms of graphical and auditory simulation, the sense of touch is still somewhat lacking. To simulate immersive interaction with virtual objects in virtual reality scenarios, haptic devices are desired to reproduce the properties of virtual objects, support the gestures of human hands to perform fine manipulation, produce haptic stimuli for simultaneously stimulating the multireceptors (including cutaneous and kinesthetic receptors) of the human haptic channel, and thus invoke realistic compound haptic sensations [52].

Closely related to VR locomotion, VR-related sickness effects present one of the critical risks when using VR systems and speaking of broader adoption of the technology. Users can experience symptoms of motion sickness, which is referred to as VR sickness [53]. Other terms, such as cybersicknesss, VR-induced symptoms and effects (VRISE), visually induced motion sickness (VIMS), and simulator sickness, can be used to describe those side effects and are often used interchangeably. The symptoms include but are not limited to dizziness, disorientation, eyestrain, fatigue, and nausea, and they manifest during and after exposure to a virtual environment. These effects can, in some cases, last for a prolonged

time (hours or days) and can manifest as disembarkment syndrome, recurrence of travel sickness, troubled hand-eye coordination, a worsened vestibulo-occular reflex, and postural instability [53]. Studies have shown these effects are common and can manifest in from 30% to over 80% of user experience cases in VR usage [54]. As shown in [55], the use of head-centric rest frames can alleviate VR sickness symptoms.

Finally, the VR technology should be used for immersive and effective storytelling [56]. Focusing on the energy, or the emotional journey of the audience through the experience, and perception, or how the viewer is experiencing the world, should drive the technical decision making in VR storytelling.

3. Materials and Methods

The methodology used for this paper was direct questioning to gather primary data. Two questionnaires were prepared for academic staff and students, with a total of 13 questions. A semi-structural questionnaire type was used, since both closed and open-end questions were included. The questionnaires were distributed online among universities in Albania, Kosovo, and North Macedonia to obtain an overall picture of the knowledge and use of AR and VR and to measure the level of implementation of interactive learning methods within the existing study programs in Western Balkan universities.

The survey collected data for the gathering of information regarding the researchers' (teachers') knowledge about virtual and digital technologies, including the use and impact of virtual technologies in relevant study fields. In addition, the survey also gathered information regarding the frequency of laboratory usage in specific universities. There was also a field where the survey participants could give a suggestion about the types of virtual technologies that they desire to be implemented in their respective classes.

On the other hand, the students' knowledge about virtual and digital technologies was evaluated through the students' survey, where they gave feedback about the level of implementation of virtual technologies and the impact of these technologies in their specific fields of study. Furthermore, the students gave their suggestions about the kinds of technologies that they would like to have implemented in their respective faculties or departments.

From Albania, 11 public and private universities operating in the country participated in the study, with a total of 375 staff members and 641 students. From North Macedonia, the total number of responses gained from the academic staff and researcher questionnaire was 60, and the number of responses from the student questionnaire was 287. In addition, 275 staff and 1289 students participated in the surveys distributed in the universities in Kosovo.

The data collected from the questionnaires were processed with Excel by categorizing and sorting them to calculate the average and percentage values for the respective questions.

4. Results

In this section, we present the results of an assessment of knowledge regarding virtual technologies and their implementation in teaching and learning processes among academic staff and students from different HEIs in Western Balkan countries, namely Kosovo, Albania, and North Macedonia. The results were derived from a questionnaire that was delivered electronically to students and teachers or researchers in different universities country-wide in the three aforementioned countries. The staff questionnaire consisted of 11 questions with 710 staff members participating (275, 375, and 60, respectively), and the student questionnaire consisted of 10 questions with 2217 students participating (1289, 641, and 287, respectively).

We will present and discuss the results for each question accordingly.

4.1. Staff Results

The first question for the academic staff was about their experience in teaching. As shown in Figure 6a, the participants were teachers with different teaching experiences.

We divided the years of experience into eight chunks presented in different colors. The results show that 1% of the participants had 35–40 years of experience, 2% had 30–35 years of experience, 4% had 25–30 years of experience, 7% had 20–25 years of experience, 8% had 15–20 years of experience, 16% had 10–15 years of experience, and 15% had 5–10 years of experience. The majority of the participants were in the group corresponding to less than 5 years of experience. This is a good indicator that the teaching staff was relatively new and more willing to contribute and adopt technological innovation by applying digital technologies in the teaching and learning process.
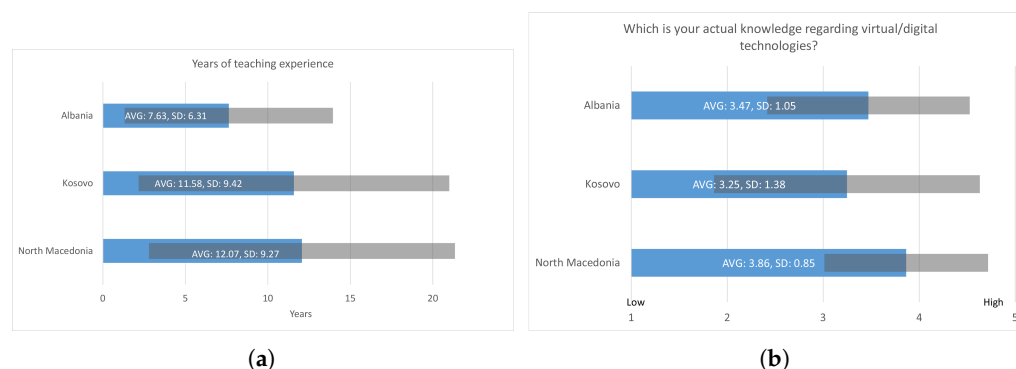
Figure 6. (**a**) Years of experience in teaching. (**b**) Knowledge regarding virtual and digital technologies.

The second question reflected the knowledge of teachers regarding virtual technologies. As presented in Figure 6b, only 12% of the teachers stated that they were not familiar with virtual technologies, while 8% had some knowledge about this. Most of them had above-average technological knowledge of virtual and digital technologies, with level 3 and 4 being 25 and 33%, respectively. Promisingly, 22% of them stated that they were fully knowledgeable about virtual technologies.

The third question provided information about the frequency of usage of virtual reality in the teaching process. From Figure 7a, we can see a low level of implementation of virtual reality in different teaching courses. Only 9% of them stated that they had regularly used VR technologies in their teaching courses. The majority of the teachers (19% + 24% + 15%) stated that they had the opportunity to use or test these technologies at some time in their teaching processes, and 33% of them never had any experience with using these technologies.
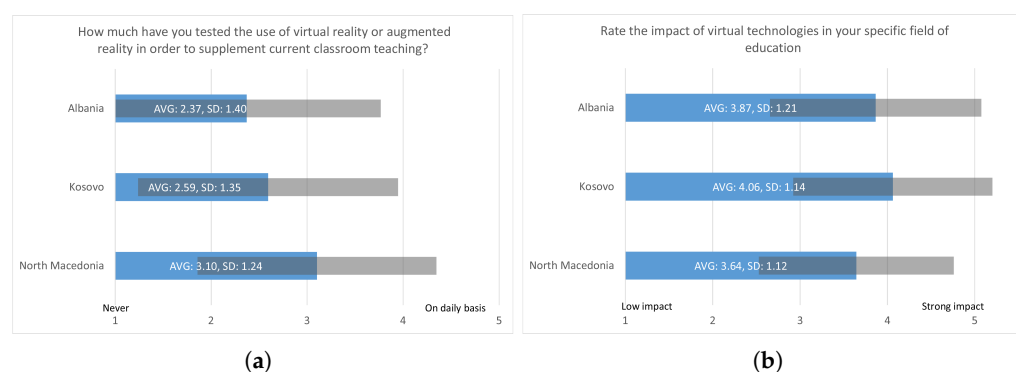

Figure 7. (**a**) Supplementing teaching with AR or VR. (**b**) Impact of virtual technologies in specific field of education.

This fourth question evaluated the impact of virtual technologies in the relevant fields of education (Figure 7b). Almost half of the participants (40%) evaluated that these technologies have a strong impact in their specific fields. The majority of them (26% + 22%) thought that these technologies' impact was above average, with 8% saying that VR has a

low impact and only 4% of them stating that these technologies have very low or no impact in their specific fields of education.

The sub-question of the fourth question regarded the participants' teaching fields. The user teaching fields are very heterogeneous, including engineering, computer science, architecture, mathematics, environmental science, civil law, tourism, economics, and management.

The fifth question reflects the teachers' opinions about the speed of the implementation of virtual technologies into the teaching process. From Figure 8a, it is clear that most of the participants were positive that these technologies will be implemented in a couple of years, with 19% of them stating that this technology can be implemented within a short period of time, and 24% of the respondents were optimistic about VR being in their schools within a year or two. The majority of the respondents, consisting of 32%, were at level 3, meaning within approximately 5 years, and only 10% of them thought that these technologies could be implemented in their schools within 10 years.


(a)   (b)
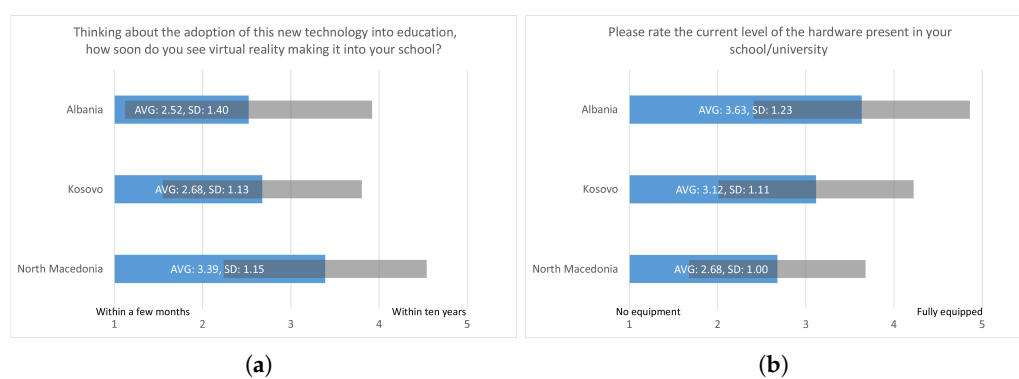
Figure 8. (**a**) Future timeline of adopting new technologies in teaching. (**b**) Possession of hardware at the university.

In the sixth question, the participants gave their feedback about the level of hardware present in their university (see Figure 8b). Only 15% of the teachers stated that their institutions had a high level of hardware infrastructure. The majority of them (79%) stated that their institutions were considerably equipped with hardware (levels 2–4). Only 6% thought that the level of the hardware at their institution was very low.

The seventh question was a textual question. The participants expressed their interest in the kinds of digital technologies that they wanted to learn. Most of the teachers stated that they were very interested in having a VR laboratory at their universities and learning more about AR and VR technologies. Some of the mentioned technologies were VR technologies, IoT technologies, artificial intelligence technologies, Matlab, and Labview.

The eighth question evaluated the level of the teachers' confidence while implementing the virtual technologies into their classes. From Figure 9a, we can see that 2% of the participants were not confident in implementing these technologies in the teaching process, 10% stated that they were a little confident about implementing these technologies without training, 28% of them were at the medium level of confidence, 31% were very confident, and 29% were fully confident.
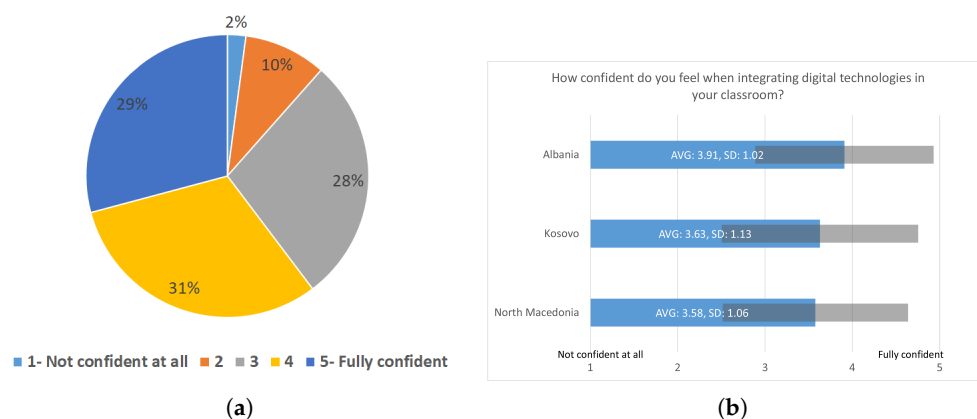
Figure 9. (**a**) Level of confidence in digital technology implementation in teaching. (**b**) Frequency of laboratory usage.

The frequency of usage of the dedicated laboratories in relevant universities was stated in the ninth question. Figure 9b shows that 13% of the teachers used the laboratories daily, 21% used the laboratories 2–3 times per week, 28% used them very often, and 20% of them did not use them as much. Meanwhile, 18% of them stated that they never used their school laboratories in their teaching processes. It should be noted that the usage of laboratories was restrained this year due to a pandemic situation that may have affected this question's results.

In the tenth question, the teachers gave their suggestions for the technologies that they would like to implement in their institutions. Some of the suggested technologies were VR technologies, networking technologies, LabVIEW Toolkit, simulation tools, software that would support the topics delivered, math programs, creating a video practicum for more accessible intercommunication with students, 3D printing technologies, 5G, a fully integrated smart mix technology, and AI in research.

Some of the examples where implementation of VR technologies is useful were given in the eleventh question. Most of the participants in the survey stated that the implementation of virtual technologies in the teaching process for different courses would be very useful in complementing the theoretical part with practice.

4.2. Students' Results

The first question of this questionnaire reflected the knowledge of students regarding virtual technologies. As presented in Figure 10a, the students were familiar with virtual technologies, as 18% of the students stated that they were fully knowledgeable of virtual technologies, 32% had high knowledge, 31% were at a medium level, 10% had some knowledge, and 9% of them had no knowledge regarding virtual technologies.

The second question indicated the students' experience regarding virtual technologies. From Figure 10b, we can see that 48% of the students had never been introduced to or received any training in virtual technologies. The rest stated that they had some experience with VR technologies, as 20% had heard of VR technology, 18% had some experience with VR, and 9% had more experience or had participated in some course that used these technologies. However, only 5% of them stated that they were trained and used these technologies on a daily basis.
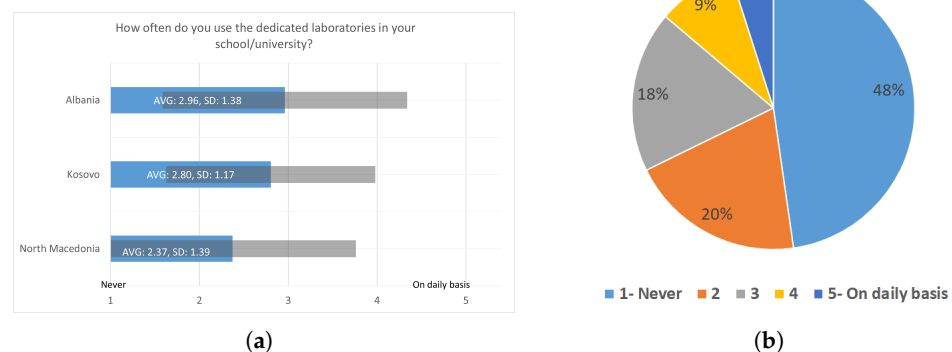
Figure 10. (**a**) Knowledge of virtual and digital technologies. (**b**) Training with AI or VR technologies.

The third question expressed the frequency of engagement of students in digital learning activities (see Figure 11a), where 16% of the students claimed that they had never been engaged in these activities, 16% stated that they rarely used these technologies, 23% were at a medium level, 21% used these technologies very often, and 24% stated that they were engaged in digital learning on a daily basis (reflecting the online learning due to the pandemic situation).

There was also a sub-question regarding which activities the students were engaged in. Some of the activities that the students mentioned were online learning or classes, programming, and coding.

The fourth question rated the impact of virtual technologies in specific study fields. The majority of the students thought that virtual technology had a significant impact on their study field, while 34% of them stated that virtual technologies had a very high impact, 24% of them thought virtual technologies had a high impact, 22% perceived a medium impact, 11% saw a low impact, and only 9% of them thought that virtual technologies had very little or no impact at all on their fields of education (see Figure 11b).
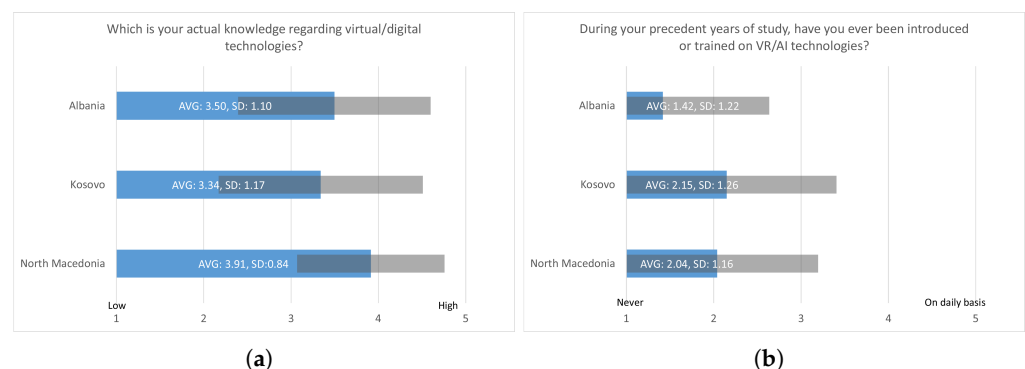

Figure 11. (**a**) Frequency of engagement in digital learning activities. (**b**) Impact of virtual technologies in specific field of education.

Some of the study fields that the survey participants (students) were engaged in were engineering, computer science, programming, architecture, medicine, the English language, preschool education, the Albanian language, and nursing.

The fifth question evaluated the level of information shared between professors and students regarding virtual technologies. As we can see in Figure 12a, there was not a satisfying level regarding this activity. Only 16% of the students stated that the level of information sharing regarding virtual technologies was fully satisfying. This result can also be interpreted as initiative for specific professors to possibly include any available

technology in their teaching processes. The rest stated that they were not very satisfied with shared information regarding these technologies, with 14% completely unsatisfied.

The sixth question took the students' feedback about the implementation of virtual technologies in their learning processes (see Figure 12b). In this regard, 59% of the responses were very positive, with 29% at level 5 and 30% at level 4. Level 3 had 24% of the respondents, and a lower percentage of 17% (11% at level 2 and 6% at level 1) did not think they could implement such technologies in their learning processes. These results could be related to the level of knowledge and information they had about these technologies and the profile of the study fields they come from.
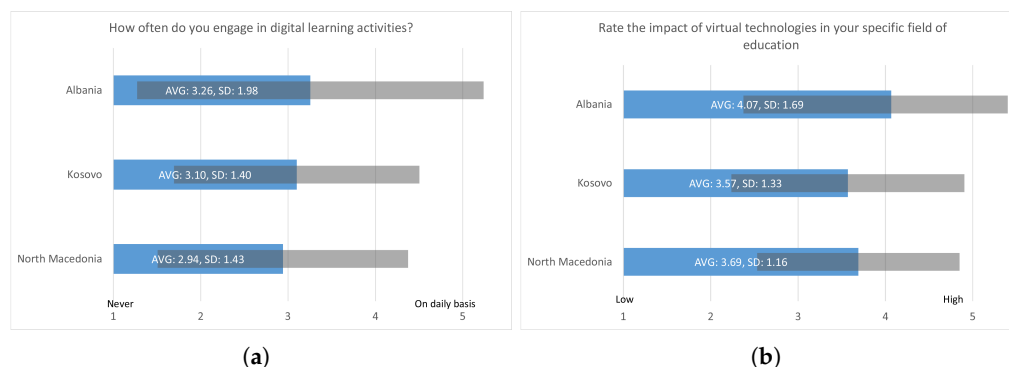

Figure 12. (**a**) Information regarding VR technologies in schools. (**b**) Students' feedback about implementation of VR technologies in the learning process.

The seventh question measured the frequency of usage of digital technologies by students in their free time (see Figure 13a). Almost half of the students (47%) claimed that they used these technologies in their free time daily, indicating that there is high interest from students regarding these technologies. Only 7% stated that they never used digital technologies in their daily activities or free time.

Disappointingly, almost all of them declared that the kind of technology they mostly used was smartphones for very popular social networks or computers for entertainment (gaming). Very few of them at least mentioned the use of a computer, online courses, or Google classrooms.

The eighth question evaluated the interest of the students in receiving training in the field of virtual technologies. From Figure 13b, we can conclude that there was high interest from the students in learning about and getting trained to use virtual technologies. Almost 87% of them had interest that was above average (level 3–5), with 42% of them showing a very strong interest. Only 5% of the students showed weak interest in these technologies.
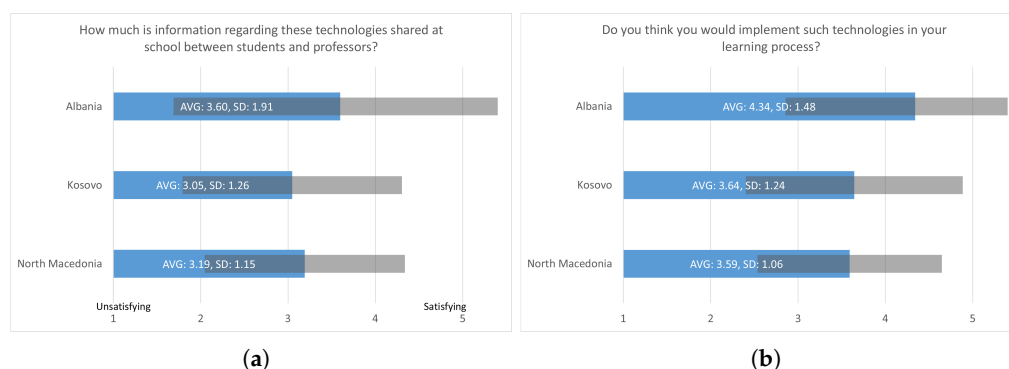

Figure 13. (**a**) Usage of digital technologies in free time. (**b**) Interest for training in digital technologies.

The ninth question measured the frequency of usage of dedicated laboratories in universities. From Figure 14, we can see a very high percentage (51%) of students who

never or very rarely used dedicated laboratories in their schools or universities, where 24% of them were at level 3, indicating that they had some specific lab activities in their courses, and 25% of them stated that they used dedicated laboratories very often or daily (15 and 10%, respectively). The high percentage of students that claimed that they had never been in their university laboratories could be due to the activities in laboratories being canceled or restricted under strict measures from the beginning of the pandemic situation.
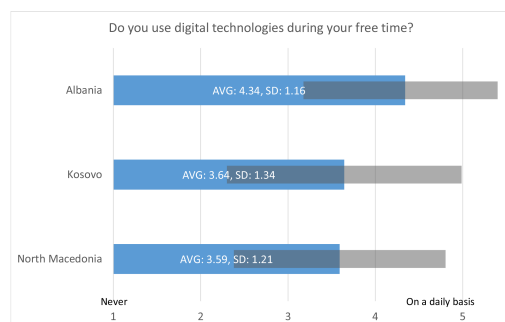
Figure 14. Frequency of usage of dedicated laboratories in universities.

In the tenth question, the students gave their opinions about the kinds of technologies they wanted to implement in their universities. The overall message from their responses is that they would like to follow the trends, to have more practical and lab activities, and possibly start implementing VR in their learning processes.

4.3. Statistical Analysis

This research investigated the staff's confidence and expectations in using VR technologies. Thus, it employed the ordinary least square (OLS) regression model, which is based on the assumption that there is an unobserved continuous variable Y_i, the value of which is determined by the explanatory variables X_i:

$$Y_i = \beta_0 + \beta_i * X_i + u \tag{1}$$

The statistical software STATA was used, and the respective command for the estimation of this model was reg. In this regard, we investigated three models. For all models, we checked that there was no correlation between the independent variables (see Table 1).

For the first two models, the dependent variable was *confidence_vr_dg*, and independent variables were *knowledge_vr_dg*, *teach_exp*, *curr_level_hw*, and *freq_use_vrlab*.

The first model (Model I) was run using all the observations (in the three countries) in the sample. The idea was to identify the factors that were impacted the most when using VR technologies in teaching. The results given in Table 2 provide evidence that the teaching experience, the current level of hardware at the school, and the frequent usage of laboratories in the teaching process all had statistically significant impacts on the staff's confidence in deploying these new technologies in the teaching process. Next, we investigated the same model to compare the situations between the countries. North Macedonia is a program country (in terms of EU projects) but geographically located in the Balkans near partner countries Albania and Kosovo. Hence, we included dummy variables for the countries (Albania and Kosovo) and used North Macedonia as a base category. Model II (Table 2, column 2) shows the results. They provide evidence that there was not any significant difference in the countries in the region in terms of the factors that impact the staff's confidence in using VR.

Table 1. Descriptions of the variables employed in the model.

Variable Name	Variable Definition or Unit of Measurement	Sign
teach_exp	How many years have you been teaching?	$+/-$
knowledge_vr_dg	What is your actual knowledge regarding virtual and digital technologies?	$+/-$
curr_level_hw	Please rate the current level of the hardware present in your school or university.	$+$
curr_level_hw	How often do you use the dedicated laboratories in your school or university?	$+$
confidence_vr_dg	How confident do you feel when integrating digital technologies in your classroom?	
expected_time__vr	Thinking about the adoption of this new technology into education, how soon do you see virtual reality making it into your school?	
Kosovo	Dummy variable = 1 if the respondents are from Kosovo.	$+/-$
Albania	Dummy variable = 1 if the respondents are from Albania.	$+/-$

Table 2. Statistical analysis for academic staff. Robust standard errors are in parentheses. *** $p < 0.01$ ** $p < 0.05$.

	Model I	Model II	Model III
Dependent variables	confidence_vr_dg		expected_time__vr
Independent variables			
knowledge_vr_dg	0.192 ***	0.193 ***	0.102 **
	(0.0396)	(0.0407)	(0.0425)
teach_exp	0.00364	0.00415	
	(0.00500)	(0.00510)	
curr_level_hw	0.188 ***	0.185 ***	−0.173 ***
	(0.0432)	(0.0439)	(0.0508)
freq_use_vrlab	0.180 ***	0.179 ***	−0.0249
	(0.0353)	(0.0360)	(0.0440)
Kosovo		−0.00540	−0.563 ***
		(0.141)	(0.168)
Albania		0.0316	−0.521 ***
		(0.139)	(0.174)
Constant	1.887 ***	1.880 ***	3.519 ***
	(0.187)	(0.216)	(0.236)
Observations	623	623	623
R-squared	0.211	0.211	0.059

In Model III (Table 2, column 3), we aimed to check the same independent variables from the previous models and investigate their impacts on the expected time when the staff considered that VR technologies would be part of the teaching process (*expected_time_vr*), as well as compare the expectations between the countries. The results provide evidence that the dependent variables of the knowledge of VR had an impact with a 5% level of significance, and all the other dependent variables, including the teaching experience,

the current level of hardware at the school, as well as the frequency of lab usage in the teaching process, all had significant impacts at a 1% level of significance on the staff's expectations for the time when VR would be part of their teaching processes.

Similar to the empirical investigation of the staff, we continued with the OLS model to empirically investigate the student data. In this regard, we investigated two models and checked whether there was no correlation between the independent variables (see Table 3).

Table 3. Description of the variables employed in the model.

Variable Name	Variable Definition or Unit of Measurement	Sign
knowledge_vr_dg	What is your actual knowledge regarding virtual and digital technologies?	$+/-$
intro_train_VR	During your precedent years of study, have you ever been introduced to or trained on VR or AR technologies?	$+/-$
freq_dg_act	How often do you engage in digital learning activities?	$+$
impact_VR_field	Rate the impact of virtual technologies in your specific field of education.	$+$
awarness_VR_school	How much is information regarding these technologies shared at school between students and professors?	$+$
freq_use_lab	Do you use digital technologies during your free time?	$+$
apply_VR_learning	Do you think you would implement such technologies in your learning process?	
Kosovo	Dummy variable = 1 if the respondents are from Kosovo.	$+/-$
Albania	Dummy variable = 1 if the respondents are from Albania.	$+/-$

The dependent variable for both models was *apply_VR_learning*, and the independent variables were *knowledge_vr_dg*, *intro_train_VR*, *freq_dg_act*, *impact_VR_field*, *awarness_VR_school*, and *freq_use_lab*.

The first model (Model I) was run using all the observations, and the idea was to identify the factors which influenced the application of VR technologies in the learning process by students. The results given in Table 4 (column 1) provide evidence that the knowledge of VR technologies, training on VR and AR, frequent engagement in digital learning activities, awareness of VR, as well as frequent use of digital technologies in the students' free time all had statistically significant impacts on their confidence in using these new technologies in the learning process.

Next, to compare the situation between the countries, we investigated the same model between the countries. Model II (Table 4, column 2) shows the results. Contrary to the staff's results, in the student investigation, we found evidence of significant statistical differences between countries. The positive statistically significant sign of the dummy variable for Kosovo indicates that the students in Kosovo tended to be more optimistic in applying VR in the learning process compared with the students in North Macedonia, whereas the negative statistically significant sign at a 5% level of significance of the dummy variable for Albania indicates that the students in Albania tended to show lower expectations for applying VR in the learning process compared with the students from North Macedonia.

Table 4. Statistical analysis of students. Robust standard errors in parentheses. *** $p < 0.01$ ** $p < 0.05$.

Dependent Variable	Model I	Model II
	Apply_VR_Learning	
Independent variables		
knowledge_vr_dg	0.137 ***	0.135 ***
	(0.0257)	(0.0256)
intro_train_VR	0.0436 **	0.0434 **
	(0.0193)	(0.0192)
freq_dg_act	0.0543 ***	0.0518 ***
	(0.0190)	(0.0189)
impact_VR_field	0.312 ***	0.300 ***
	(0.0219)	(0.0220)
awarness_VR_school	0.114 ***	0.128 ***
	(0.0228)	(0.0230)
freq_use_lab	0.0608 ***	0.0660 ***
	(0.0180)	(0.0180)
Kosovo		0.203 **
		(0.0815)
Albania		−0.133 **
		(0.0647)
Constant	1.269 ***	1.343 ***
	(0.0935)	(0.106)
Observations	2206	2206
R-squared	0.292	0.301

5. Conclusions

The Gen Z generation is inevitably flowing into the ranks of the academic community in an ever-widening stream. As responsible creators of academic education, we recognise and respect the new generation of students' behavioural and cognitive differences. From the point of view of curriculum organisation, matching educational methods and techniques plays a key role. New technology, forms of communication, and information processing are entering the fertile ground of the latest adult generation. The loud echo of last year's digital world events was the announcement of implementing a high-immersion social communication system. The Meta project is primarily focused on finding new forms of presentation and transmission of information and creating new solutions for user interaction with the system. New environmental mediums and advanced technological solutions require creating more customised and intuitive solutions.

Higher educational institutions in WB counties are giving maximum efforts to pursue continuous progress in the teaching and learning processes. One of the main objectives is the integration of modern technology equipment to enable experience-based learning. In addition, virtual and augmented reality technologies are considered to be important tools for complementing the theoretical part with practice.

According to the staff results, it is obvious that teachers have a moderate level of background on virtual technologies, and they do not use these technologies in their teaching processes yet. Still, most of them agree that these technologies can and will have a strong impact on their specific fields. Consequently, they are very interested in learning more about virtual technologies and integrating them into the teaching process, which is a

requirement for the modernisation of the teaching process. The majority of the teachers are at least reasonably confident that VR technology will be implemented.

The students' results show that even though they do not have much knowledge on VR technologies, they also think that these technologies will have a high impact in their specific study fields. The students also declared that they use virtual technologies in their free time, and they think these technologies will enhance their learning processes. As expected, they use mostly mobile phones, but we can reasonably expect that they will use VR technologies when they are available to them during the study process.

Future works should focus on the following:

- Developing institutional capacities and modernizing them by introducing VR and AR in the teaching and learning processes at Western Balkan educational institutions.
- Building and strengthening the capacities of lecturing staff concerning the use of the latest tech in VR and AR, which will carry on knowledge to the new generations. The capacity-building activities should focus on training, visits, and staff exchanges between partner and program partner HEIs.
- Introducing AR, VR, and mixed reality will create compelling learning experiences across an offered curriculum. Therefore, the first step should be to identify content examples, emerging practices, and strategies that can be used in individual courses, curricula, and institutions.

We can conclude that both students and teachers are very enthusiastic and willing to participate in training for these technologies to further develop their knowledge and integrate them into their learning and teaching processes. This is also the main goal of the Erasmus+ VTech project, in the scope of which both students and teachers gained access to VR equipment and knowledge to develop different educational content. Of course, the acceptance of these solutions and implementations also depends on their user experience and their suitability, which will be evaluated in the scope of the project. Nevertheless, we strongly believe that such implementation will increase students' learning capabilities and enthusiasm and improve the educational system.

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