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THE IMPLEMENTATION OF EXTENDED REALITY IN HIGHER EDUCATION, EXAMINING STUDENTS' AWARENESS

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Abstract

This research paper describes documents and confirms the benefits of applying extended reality (XR) into Higher education. Challenges that occur in the comprehensive reality (XR) domain (such as virtual reality (VR), augmented reality (AR), and mixed reality (MR)), as well as their causes and solutions, will be further discussed. The upcoming chapters will include perspectives from technology, design, human factors, and various technologies and ideas. XR is primarily or exclusively focused on the display, as it does not include other modalities such as audio, haptic, smell, or touch. Therefore, the primary focus will be on the benefits of using XR, though other disciplines that may intersect with Higher Education, where appropriate. As a whole, the study aspires to provide a comprehensive overview of the XR challenges, opportunities, and future trends that will be applied in educational institutions.

Primary research in the form of survey research (exploratory research) that included 83 subjects showed a high awareness of XR among students of chosen

HEI and usage of this technology in students' daily lives, and whether they use XR depends on the age of the survey respondents. To determine whether there was a correlation between the use of augmented reality and the age of the survey respondents, non-parametric statistics based on the ranks of observations - Spearman's correlation coefficient - were used. IBM SPSS statistical data processing and analysis software was used to calculate Spearman's correlation coefficient. Based on the sample observations and the inference statistics used, it cannot be asserted that there is a direct correlation between the use of augmented reality in everyday life and the age of the survey respondents. However, the results showed that a high rate of respondents is aware of XR (78,31%) but if they use this technology in their daily lives, are almost evenly distributed: use it in daily lives 34,94% of survey respondents do not use it 33,73%) and Maybe (not aware of the same) 31,33% survey respondents.

Keywords: *extended reality (XR); higher education; higher education institutions (HEI); Spearman's correlation coefficient.*

JEL Classification: I23

Introduction

Today's higher education institutions face increased pressure to deliver outstanding learning experiences to an increasingly diverse student population, as well as exceptional, technology-enhanced teaching. Since XR has gained traction in educational settings, it is well-positioned to address some of these issues. However, the opportunities and challenges associated with students and teachers using virtual tools are all examples of evaluation opportunities (e.g., virtual lab instruments and materials) [Ziker, 2020]. Speaking of virtual, it is essential to emphasise that this term refers to Virtual reality (VR), augmented reality (AR), and mixed reality (MR), which are all terms that are used to explain the same thing. Even though they provide significantly different experiences and capabilities, the relative merits and drawbacks of these systems must be weighed against the requirements of any particular application before they can be considered [Allcoat, 2021).

Without a doubt, technology has improved education over decades in the digital age. The fact that collaborative computer networks were widely adopted in the late 1980s and 1990s quickly gave way to internet-based learning delivery. This new XR interaction between visualisation technology and human perception is enthralling and can fundamentally alter the dynamics of teaching and learning [The EdTech Podcast, 2020].

As teaching and learning models are continually being tested during the educational path, these ulterior motives that can significantly alter our perceptions of self, time, and free will, should be further examined (Anđelić, Kuleto, 2013). However, using emerging technologies such as XR in higher educational systems raises many ethical and philosophical concerns about data collection, control, and exploitation in the XR ecosystem. In this paper, the primary focus will be on higher educational personalised learning experience, as it is a significant part of the currently developing XR ecosystem.

Even though the shift in computational capabilities used in Higher education is always welcome, ethical guidelines for XR systems that do not jeopardise an individual's rights through various methodologies should always be further discussed. Social conditioning and the physical environment significantly affect people's personal biases and ideas about social connections and self-identity and how they perceive themselves. As a result of digital technologies and information access, our perception of reality has been fundamentally altered [IEE, 2021].

To mitigate the possibility of increased XR impacts, proactive measures such as identifying solutions, establishing standards, and implementing governance-friendly approaches are required. Rather than waiting to see what the future holds, society should consider practical ways to improve the Higher Educational systems right now, and that is our motivation to conduct this study.

The authors, conducted a survey among students of Information Technology School ITS- Belgrade in Serbia, to understand their familiarity with XR and if they use these technologies in their daily lives. Aldo, this research is explanatory, it has its importance and contribution to the body of knowledge. This research and its added value are primarily due to a dearth of studies on using XR among university students in general and Serbian students in particular.

1. Method

The research used the methodology of participant observation, literature review (document analysis) and survey research. Survey (exploratory) research among 83 students of Information Technology School ITS – Belgrade was conducted to understand the level of awareness of XR among students and if age influences XR usage. In addition, the respondents were asked questions identifying their understanding of XR technologies (by recognising basic definition) and their daily usage of this technology:

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1. "Cross Reality or Extended reality (XR) is a catch-all term for technologies that include virtual reality (VR), augmented reality (AR), and virtual worlds (VWs) [Hooker, 2021] "with options: "true ", "false "and "I do not know "and
2. "Do you use Extended reality in your daily lives? With options: "yes ", "no ", and "I do not know".

The variables analysed in this research is given in table 1.

Table 1. Variable analysed

Code	Variable name
Sex	Gender
Age	Age
Schooling	Already completed
Activity	Type of activity
XRUSE	Use XR in your daily lives
XRDEF	Cross Reality or Extended reality (XR) is a catch-all term for technologies that include virtual reality (VR), augmented reality (AR), and virtual worlds (VWs)

The subject of the research is the connection, i.e. the association between the use of augmented reality as a presentation of digital information through the real world and the age of the respondents from the survey sample. The research will focus on discovering a systematic and consistent connection between the levels, i.e. the names of the mentioned variables (the use of augmented reality in everyday life and the age of the respondents from the survey sample). As the answers to the same questions are presented as non-metric (categorical) data, and as such, as measured on the ordinal scale, we can talk about the modalities (names) of the categories to which the observations from the sample belong. The statistical method to be used in the paper will answer four critical questions related to the research of the connection between the use of augmented reality and the age of the respondents from the survey sample:

1. Is there a relationship between these variables? If a conclusion is made based on statistical significance about the existence of a connection, another question arises.
2. Is the direction of that connection positive or negative, i.e. in the direction of change of one variable followed by the same direction of change of another variable or are the directions of their connections opposite.

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3. After determining the direction of the connection, the strength of the connection is examined, measured by the appropriate indicator-coefficient, whose measured value indicates either that there is no connection or that there is a weak connection, or that the existence of a moderate or strong connection is determined.

4. The last statement concerns the determination of the type of connection between variables, i.e. whether the connection is of linear type (strength and direction of connection are unchanged for the area of the definition of these variables) or nonlinear type (strength and/or direction of connection between variables change in certain parts areas of the definition of the mentioned variables).

To check the existence of a connection between the use of augmented reality and the age of the respondents from the survey sample, non - parametric statistics based on the ranks of observations - Spearman's correlation coefficient were used [Allen, 2017]. Spearman's correlation coefficient was calculated based on IBM SPSS statistical data processing and analysis software. The null and alternative hypotheses of the test are as follows:

H0: The use of augmented reality does not depend on the age of the respondents.

X1: The use of augmented reality depends on the age of the respondents.

2. Results

2.1. Literature review (document analysis)

2.1.1. Responsible innovation in Higher Education Institutions

Innovative thinking provides students at higher educational institutions with new functional abilities, frequently developing entrepreneurial competencies Simović and Ilić points out the importance of developing digital entrepreneurial competencies, using well-known tools for measuring them, as well as motivating students who have a highly developed potential of digital entrepreneurial competencies, to turn to start their own business [Simović, Ilić, 2021]. Therefore, it encourages the establishment of new businesses, creating new job opportunities, and creating a more prosperous economic future for them. As demonstrated by the development of penicillin, safe drinking water, and sanitation, the ability to innovate has also benefited us economically [Kormelink, 2019]. The same goes for cutting-edge technologies. As a result of the innovations in educational systems, there can be seen many benefits among both students and teachers in various ways.

Whether or not these innovations in higher education are acceptable will depend on how we employ these technologies that we have today. Therefore, we must take responsibility for our creations and recognise that technology is never neutral.

There are a variety of social implications associated with each new technological development, both positive and negative.

Even though it is acknowledged that it is necessary to conduct a critical and systematic examination of our technologies' commitment to sustainability, privacy, and accountability, our future innovations must not only contribute to solving the most pressing problems in Higher Education Institutions, but they must also be projects that foster consensus around universally held moral values.

Technology and the scientific foundations upon which it is built are far too important to be ignored at this point. It is insufficient to focus solely on the outcomes of decisions. To foster responsible innovation, we must be proactive in ensuring that the values embedded in today's technologies are made explicit and communicated to those using them [Kormelink, 2019]. Even though students can currently participate in XR projects in their spare time, institutions should provide XR access on campus to enable these projects to be successful. In some cases, projects included everything from short-term research projects like developing an augmented reality app for a journalism class project to long-term educational endeavours like creating an app that can teach students to be responsible innovation drivers. Learning that is initiated and directed by the learner is frequently the most effective type of learning. Student access to virtual reality headsets and powerful computers is only possible if educational institutions make these tools available. Students who do not have direct access to these technologies can still access this technology through university computer labs or studios. Having access to technology through a technology lending program is even more advantageous for these individuals. Accessibility and assistance are essential requirements for encouraging development in the XR field while students are on their formal education path [Educase, 2020].

Students' extracurricular activities can also be an excellent way to pique their interest in XR technology when organising an event that will draw a large number of people, such as a virtual reality game night, because students are more likely to get involved in this kind of event, rather than attending seminars or webinars in the age of global pandemic. As with any new medium, it is necessary to develop new methods of evaluating student work. To incorporate self-directed learning into assessments, instructors must rethink their course assignments and program outcome assessment criteria.

2.1.2. Potential of XR

In other words, students and teachers at higher educational institutions are already influenced by virtual and augmented reality innovations. Moreover, implementation can be seen in various industries, including health-care education, among others. More advanced virtual reality platforms and technologies, such as virtual reality (VR), have been implemented in nursing and medical schools, allowing these devices and platforms to be used to their full potential. Of course, the student's motivation and willingness to work hard are critical to the success of this learning method. Institutes and teachers will understand an increasing number of natural learner profiles through advanced data analytics and the development of highly personalised, enhanced pedagogy. In conjunction with edge computing, immersive visualisation will soon enable this type of personalised learning experience – even live – to be delivered directly to a student's vision. It demonstrates thus that learners' motivation and knowledge retention are strongly correlated, but its true potential lies in its ability to achieve a high degree of personalisation of learning. These data have the potential to revolutionise current educational standards and methods of instruction. However, the program's director should have prior experience with orientation and guiding students through the teaching process to succeed.

It is not uncommon for new methods, products, and technologies to take some time to gain widespread acceptance before they become widely used. Several learning methods, including virtual reality (VR) traditional and video media, were recently investigated by [Allcoat et al, 2018] who found that they were effective. They discovered that virtual reality improved learning and increased engagement, and a higher level of positive emotions in those who participated in the VR experience. Furthermore, it is possible that being in a good mood impacts learning by increasing cognitive flexibility [Seligman et al., 2009]. The researchers have also discovered that positive emotion and high immersion significantly impacted knowledge acquisition in a study they conducted [Olmos-Raya et al., 2018].

By integrating collaborative e-learning, augmented reality (AR). virtual reality (VR]) and mixed reality (MR), the potential of extended reality (XR). can easily be seen. Immersive VR/AR applications combined with collaborative learning enable the "learning-by-doing effect" on deep, comprehensive learning and simulations that engage all five senses [Bucea-Manea-Tonis, 2020].

In the Internet of Things era, e-learning technology and trends [Alfaro, 2021] offers several significant benefits to organisations [Mumtaz, 2017]. Thus far, the best description of XR has been that it enables spatial localisation and experimentation in a variety of subject matter areas while also promoting innovative practices such as informal and ludic activities. In addition, it motivates learning and establishes new value scales.

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When it comes to collaboration and deeper learning, XR has an additional advantage due to its capacity to provide broad education. Respondents perceptions of e-learning and XR immersion were gleaned from an online survey that elicited responses regarding respondents perspectives on the impact and influence of virtual technologies on work, study, and social life. The study enrolled all Serbian, Romanian, and Hungarian college students from public and private higher educational institutions. The study collected data on students' perceptions of XR in the context of online learning in three Eastern European countries. Millennials, like their teachers, are enthusiastic about new technologies. Students are busy, constantly moving, and eager to learn and expand their horizons through new experiences. However, these universities have not yet adopted XR technologies [Bucea-Manea-Tonis, 2020].

Researchers from a wide range of disciplines are becoming increasingly interested in the potential of extended reality as a learning tool. For example, in engineering, computer science, and astronomy, measuring learning outcomes and experimenting with virtual reality (VR) are becoming more common [Hamilton et al, 2020]. In addition, medical education is currently being evaluated for its potential to aid in the comprehension of anatomy and the intricate interrelationships that exist between organs [Alfalah et al., 2018].

Further research is needed to determine whether or not extended reality is practical for teaching and learning and how to design effective learning applications [Parong & Mayer, 2018]. The inconsistency of previous XR learning outcome measures may be due to the program's design rather than the medium itself, as previously suggested [Parong & Mayer, 2018]. For positive educational outcomes to be achieved, improved guidance on best practices in virtual reality design must be developed [Jensen & Konradsen, 2018].

By leveraging XR in lifelong learning, the educational system is being transformed in a way that is complementary to the rapid adoption of online and hybrid learning, both of which are critical to the future of work [University of Waterloo, 2021]. Blended and remote education and working will become more prevalent in the future, with augmented and virtual reality solutions providing unprecedented opportunities for training and community engagement in this environment. It is possible to practice difficult situations and high-risk skills safely and repeatedly by utilising XR technology [Inside Higher Ed, 2021].

From higher educational institutions, working students can use the most of XR (and 3D modelling]. that allows them to collaborate with colleagues in the office from a distance by connecting to the office network and gaining access to the computer of another XR device while being able to do all the curriculums and exams [Inside Higher Ed, 2021]. To put it another way, higher education institutions and industry partners who are committed to ethical innovation and long-term workplace sustainability are seeing unprecedented opportunities for collaborative efforts in the workplace.

2.2. Survey results

The main survey results are displayed in table 2. Most of the respondents are female, 53,01%, while 46,99% are male. Respondents are aged from 18 to 24 years (54.22%) then from 25 to 31 years (26,51%) and 32 to 40 years (19,28). Mainly, respondents have completed Higher education (vocational studies) within 77,11% and high school 22,89%. The respondents are students (master vocational studies). 69,88% or former students (30,12%). Table 2 shows social-demographic characteristics of respondents.

Table 2. Social-demographic characteristics of respondents

Variables	**Code %**	**N**
Please choose your gender	**GENDER**	
Male	46,99	39
Female	53,01	44
I do not want to specify	0,00	0
How old are you?	**AGE**	
from 18 to 24 years old	54,22	45
from 25 to 31 years old	26,51	22
from 32 to 40 years old	19,28	16
Regarding your schooling, please choose only one of the options (already completed)	**SCHOOLING**	
High school	22,89	19
Higher education	77,11	64
Regarding your activity, please choose only one of the options:	**ACTIVITY**	
I am a student	69,88	58
I plan to become a student	0,00	0
I am a former student	30,12	25

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The table 3 shows frequency and percentage of answers regarding the research questions referring to knowledge (familiarity) of XR of the respondents and their usage of those technologies. Respondents are aware of XR (78,31%). and not sure (21,69%), and they use this technology in their daily lives (34,94%), do not use it (33,73%) and Maybe (not aware of the same) 31,33%. Almost distributions among survey respondents regarding their usage of this technology in their daily lives can be explained by the fact that Serbia is a mid-income country and that XR technology is still not commonly used and affordable to most.

Table 3. Frequency and percentage of answers of study respondents

Cross Reality or Extended reality (XR) is a catch-all term for technologies that include virtual reality (VR), augmented reality (AR) , and virtual worlds (VWs].	**XRDEF**	
True	78,31	65
False	0,00	0
I do not know	21,69	18
Do you use Extended reality in your daily lives?	**XRUSE**	
Yes	34,94	29
No	33,73	28
Maybe (not aware of the same].	31,33	26

Table 4. shows results of the correlations analysis between the variables XR USE and AGE and results of Spearman's test.

Based on the obtained results from the survey sample, a statistical conclusion is made that there is no connection between the use of augmented reality in everyday life and the age of respondents from the survey sample since the correlation coefficient is not statistically significant at 5% (probability 0.768]. as the sample was obtained from the population of students of technological sciences (information technology) which is also a feature common to all observations from the sample, the claim that the connection between the use of augmented reality in everyday life and the age of respondents from the sample will be further examined by calculation partial (partial) correlation coefficient. Unlike the previously mentioned correlation, the existence or non-existence of which is indicated by the Spearman coefficient, the partial correlation coefficient shows the correlation

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between two variables of interest, excluding the influence of the third (or more other) variables. Variables whose influence is removed from the total relationship between two specific variables are assumed to impact the relationship of a certain intensity: from negligibly small influence in the overall strength of the relationship to large that can determine or cancel the relationship. Depending on the number of variables the influence is under control, the partial correlation coefficient can be first or higher. The partial correlation coefficient was calculated based on IBM SPSS statistical data processing and analysis software and presented in table 5.

Table 4. Correlations between XR USE and AGE variables

Control Variables					**XR USE**	**AGE**
Spearman's rho	XR USE	Correlation Coefficient			1.000	.029
		Sig. (2-tailed].			.	.768
		N			103	103
		Bootstrap[c]	Bias		.000	.002
			Std. Error		.000	.093
			95% Confidence Interval	Lower	1.000	-.166
				Upper	1.000	.217
	AGE	Correlation Coefficient			.029	1.000
		Sig. (2-tailed].			.768	.
		N			103	103
		Bootstrap[c]	Bias		.002	.000
			Std. Error		.093	.000
			95% Confidence Interval	Lower	-.166	1.000
				Upper	.217	1.000

As the level of the variables of education and current status in education were excluded from the influence of augmented reality in everyday life and the age of the respondents from the influence of the sample, the obtained partial correlation coefficient is of the second order. Therefore, the probability of 0.222 indicates that the null hypothesis cannot be rejected in favour of the alternative, i.e. the conclusion obtained by calculating Spearman's correlation coefficient is confirmed, and that is that there are no statistically significant indications of a relationship between these variables from the obtained survey sample. Thus, the final result is that, based on observations from the sample and after the applied methods of inference statistics, it cannot be claimed that there is a specific connection between the use of augmented reality in everyday life and the age of respondents from the survey sample.

Table 5. Correlations and Bootstrap

Control Variables					AGE	XR USE
SCHOOLING & ACTIVITY	AGE	Correlation			1.000	-.123
		Significance (2-tailed].			.	.222
		df			0	99
		Bootstrap[a]	Bias		.000	.002
			Std. Error		.000	.103
			95% Confidence Interval	Lower	1.000	-.312
				Upper	1.000	.084
	XR USE	Correlation			-.123	1.000
		Significance (2-tailed].			.222	.
		df			99	0
		Bootstrap[a]	Bias		.002	.000
			Std. Error		.103	.000
			95% Confidence Interval	Lower	-.312	1.000
				Upper	.084	1.000

3. Discussion

Most of the respondents are female 53,01%, aged 18 to 24 years old, with completed Higher education (vocational studies) and in the status of student (master vocational studies). within 78,31%. In general, respondents are aware of XR (86,75%) and use this technology in their daily lives (34,94%) do not use it 33,73%. Also, 31,33% of respondents, regarding whether they use XR in everyday lives, chose the option "Maybe (not aware of the same)" that implicates that they are unsure if they use AI in their daily lives.

A second-order partial correlation coefficient was obtained because the variables education level and current educational status were excluded from the influence of augmented reality in everyday life, and respondents' age was excluded from the sample's influence. To put it another way, this probability of 0.222 means the null hypothesis cannot be rejected, favouring an alternative, which confirms our conclusion from calculating the Spearman's correlation coefficient: no statistically significant evidence exists for a link between the variables in the data we collected. Conclusion: Observations from the sample and applied statistical inference methods do not support the claim that augmented reality use in everyday life is associated with respondents' age from the survey sample.

Conclusion

It is not surprising that the research failed to establish a connection between the variables because a strict connection might be a limiting factor. If research shows that the correlation between variables, for example, is negative and strong, we would have a situation in which, for example, our variables of interest (use of XR and age of respondents]. move in opposite directions: with increasing age, the use of augmented reality decreases. Therefore, we should specify that the conclusion made based on the selected sample and characteristics should be added to all existing research as a conclusion that within the sample of information technology students, the variability is explained in such a way, but that further research is needed to make a correct statistical conclusion. the whole population. Of course, determining and testing all types of samples based on which a conclusion about the entire population would be made is expensive and requires huge resources, or testing the entire population without isolation, which is almost impossible to report in most cases. Therefore our statement is in line with sample and limited resources, which represents the limitations of this research study.

Almost even distributions among survey respondents when regarding they usage of this technology in their daily lives can be explained with the fact that Serbia is mid-income country and that XR technology is still not commonly used and affordable to most or that XR is not promoted well enough among the HEI students and that these institutions should explore the possibilities and challenges that introduction of XR in HEI could bring which is the direction of future research.

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