

AR&VR Technology – Revolutionary Technology in Education

MSc. Mentor Rrustemaj

ICT Teacher in Pre-University Education, Albanian – Kosovar

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ABSTRACT

This paper aims to bring the development practices of AR and VR technology in education over the past five years, including the years 2020 - 2025. Using the literature analysis approach, I have selected several different articles, including well-known platforms such as: Education Resources Information Center (ERIC), IEEE Xplore Digital Library, Scopus, Web of Science, Science Direct and ACM Digital Library.

AR and VR technology is a technology in the initial stage in terms of their use in the field of education. Moreover, Virtual Reality Environments and Holograms – are two features of this technology, which as such, rank this technology in the group of revolutionary technologies in education.

This technology has the potential to change the state of education in general. This changes the approach of teachers and students. I say this because, through this technology, the physical classroom is transformed into a virtual e reality environment. The increase in teacher-student interaction in these Virtual Reality Environments, as well as the increase in quality in education through this technology, makes it a revolutionary technology.

Within the framework of this paper, I have raised four research questions and two hypotheses. The data will be collected through an electronic questionnaire (Google form) from, mainly, professionals from different countries of the world, using various social networks such as: LinkedIn, Facebook, etc., and the analysis will be done through the MS Excel 2021 application program.

The hypotheses raised, as such, have been confirmed. From the hypotheses raised, it is proven that AR&VR technology is a technology that affects the increase in quality in education, also, the creation of virtual environments through this technology affects the increase in student-student and teacher-student interactivity! This paper ends with debates about results and some conclusions.

Keywords: AR& VR Technology, Hologram, Virtual Reality Environments, Teachers, Conclusions.

INTRODUCTION

Today, with a simple technological device, if we want, we can make progress in various fields, whether in the individual or social aspect. But when we talk about advanced technologies, then there is no question of doubts. Advanced technologies, in this case, AR&VR technology, are revolutionizing areas of life, including education. The very fact that AR&VR technology is a revolutionary technology in education is evidenced by the fact that such a response was also confirmed by the participants in this research. On the other hand, it has been proven that technology actually affects the increase in quality in education, a problem that is a concern in many countries around the world. On the other hand, this technology, namely the creation of a virtual environment, enables students to be motivated in terms of the teaching-learning process. In this paper, among other things, some characteristics included in the framework of this technology will be discussed. This will include concepts such as Metadata, Holograms, the importance of using various applications and platforms of this technology, and the challenges that this technology presents when included in the learning process.

Although this technology is in its infancy in the field of education, so there is not much research regarding this technology and its use in education, we hope that this paper will be a reference point regarding important issues

in education - including improving quality and the possibility of teacher-student interaction in the learning process.

Research questions:

Within the framework of the topic, we have raised 4 research questions and 2 hypotheses:

1. What are the advantages and challenges of AR&VR technology in the education process?
2. What role does METAVERSE play, as far as AR&VR technology is concerned, in the education process?
3. What does the creation of Virtual Environments and the use of Holograms enable in the teaching-learning process?
4. What are some of the applications and platforms of AR&VR Technology in the teaching-learning process?

Hypotheses:

H1: AR&VR Technology affects the increase in quality in education.

H2: The creation of Virtual Environments enables teacher-student interaction.

METHODOLOGY

This paper uses the desk research method. To carry out this research, i have used the documentation analysis method, the descriptive method and the statistical method. Through the documentation analysis method, I have analyzed articles, mainly, from the Education Resources Information Center (ERIC), IEEE Xplore Digital Library, Scopus, Web of Science, Science Direct and ACM Digital Library. The review of the articles will be based on the years 2020 - 2025 of the publication of various materials in this direction.

Through the method of descriptive analysis, I have analyzed and described the opinions of participants. Then, an electronic questionnaire was used with local and international participants. This group of participants will include teachers, students, university professors, who in one form or another, have different experiences regarding the use of this technology in the education process. For this, various groups on social networks (Facebook and LinkedIn) have been used. The data was administered through the MS Excel 2021 program.

The questionnaire was sent in the form of a link to these interest groups, where as such, it was compiled through *Google Form*. The questions were structured and clearly formulated. Previously, a message was sent to these interest groups, explaining the reason for this questionnaire. Participants in this questionnaire participated voluntarily. The confidentiality of all participants was maintained, with the exception of indicating the country of origin and profession.

AR and VR technology

AR refers to a three-dimensional (3D) technology that presents digital information in the real world. It can enhance users' visualization of the real world with virtual objects through graphical computing and object recognition technologies. (Huang et al., 2021)

Immersive technologies such as augmented reality (AR), virtual reality (VR), mixed reality (MR) and extended reality (XR) are evolving rapidly, presenting significant opportunities for improving user experiences. (Zallio et al., 2024)

In the last decade alone, VR and AR technologies have gained increasing interest due to their accessibility to a wider audience. (Mohamed & Belhaj, 2024)

Virtual Reality technology involves creating environments that users can engage with using devices such as headsets or handheld sensors. This technology aims to enrich users' experiences by transporting them into a world where they can interact with objects and explore scenarios. (Feridun & Bayraktar, 2024)

Augmented Reality (AR) and Virtual Reality (VR) technologies have revolutionized learning approaches through immersive digital experiences, interactive environments, simulation, and engagement. (Al-Ansi & al., 2023)

Augmented reality (AR) is an emerging technology that integrates digital information, such as text, images, videos, and 3D objects, into the real world. (Tan et al., 2022)

Azuma (1997) refers to AR as a technology where virtual objects are blended with the real world, while at the same time real and virtual objects are in interaction with each other. (Yılmaz & Şimşek, May 2023)

Revolutionizing education

The integration of virtual reality (VR) and augmented reality (AR) into the educational environment has opened up new opportunities for engaging and immersive learning experiences. (Lytvynova & Soroko, 2023)

Augmented reality (AR) is a new way to integrate virtual reality into the real world, and integrating AR into education offers opportunities for increasing student performance. Even in e-learning, the use of AR can help make learning more exciting, interactive, and fun. In areas where it has been applied, this approach has improved student outcomes, increased motivation, and fostered collaborative learning. (AlNajdi, 2022)

Our study results show that AR and VR technologies facilitate increased communication, discourse, and peer-assisted learning, fostering collaboration and engagement. Beyond its impact on individual learning, the integration of AR and VR technologies fosters a collaborative and inclusive educational environment. (Bertrand et al., 2024)

Augmented reality technology has the potential to be a powerful educational tool for children with special needs. AR technology can provide an immersive and engaging learning experience that can help children with special needs better understand and retain information. While there are challenges and limitations to consider, educators and policymakers should explore ways to make AR technology more accessible and provide individualized instruction and support for children with special needs. In doing so, AR technology can be used to enhance learning experiences and improve outcomes for children with special needs. (Asatryan et al., 2023)

Therefore, it can be concluded that augmented reality has a positive effect on improving students' learning achievements. (Rahmat et al., 2023)

The Concept of the Metaverse

We have now entered an open phase of development of the Metaverse, which is widely considered to be a collection of 3D virtual worlds connected via the internet and enabled by various immersive technologies, such as augmented reality (AR), virtual reality (VR), and mixed reality (MR), which are often collectively referred to as extended reality (XR). (Cheng et al., September/October 2022)

It has recently gained traction in various sectors by providing immersive and interactive experiences that go beyond traditional digital platforms. The Meta-Metaverse methodology presents the potential to create realistic digital twins, which are virtual representations of physical objects, systems, or processes, and has promising implications for AR and VR educational applications. The multi-layered structure of the metaverse enables increased flexibility and scalability, thus offering unique opportunities for immersive learning environments (Jamshidi et al., 2023), cited in (Zekeik et al., 2025)

Several Metaverse platforms have been created so far (e.g., Second Life, Open Simulator, Minecraft, Fortnite, Roblox, Sandbox, and Decentraland). These platforms are attracting many users every day and the number of members is growing accordingly. As virtual reality platforms become easier to use and more interconnected, Metaverse platforms will promise further improvements in all areas. When virtual reality glasses and accessories acquire a more comfortable design suitable for long-term use, it may become much more feasible to expand their areas of use and adapt them to educational environments. (Saritaş & Topraklıkoğlu, 2022)

Quality in education

Quality in education has become a global phenomenon and is often discussed in transnational and national policies. (Mufic, 2022)

Education 4.0 (E4) aims to improve the teaching and learning process and democratize access to quality education by using Industry 4.0 technologies in educational environments. (Costa et al., 2022)

One of the most widely repeated lists is that provided by the World Economic Forum entitled “10 Skills You Need to Thrive in the Fourth Industrial Revolution: Key Skills in 2020” (World Economic Forum, 2016 and updates) which include:

1. complex problem solving;
2. critical thinking;
3. creativity;
4. people management;
5. coordination with others;
6. emotional intelligence;
7. judgment and decision-making;
8. service orientation;
9. negotiation;
10. cognitive flexibility. (Tikhonova E., 2023)

One of the main conditions for ensuring quality in education is the recognition and acquisition of common values. Values that have been agreed upon and accepted in the education system, their formation in the educational process is a fundamental prerequisite for ensuring the quality of education. Therefore, for a successful education based on agreed values, these values must first be recognized and personally acceptable by educators. Values that have been agreed upon and accepted in the education system, their formation in the educational process is a fundamental prerequisite for ensuring the quality of education. (Tumlovskaja, 2022)

Interaction in education

Interactive – Interactive learning often includes problem-solving activities that encourage students to apply critical thinking skills to analyze information, evaluate results, and solve educational problems. Interaction in the learning process often includes collaborative activities that encourage students to work together and share ideas. Thus, collaborative learning improves communication skills and exposes students to different perspectives, promoting critical thinking through discussions and debates. Interactive learning also emphasizes the application of knowledge in practical contexts. Interactive learning can make the learning process more enjoyable and engaging for students. (BLYZNYUK & KACHAK, 2024)

From the literature analysis, it can be seen that teacher-student interaction, which is one of the evaluation criteria for classroom teaching, has been studied endlessly, but so far, most of the research on teacher-student interaction under traditional teaching has been studied. (HUANG et al., 2022)

Virtual reality environments

Especially in education and training, an increasing number of researchers have begun to implement AR/VR technologies to provide students or trainees with a visual, immersive and interactive environment. (Tan et al., 2022)

Technology can facilitate inclusive learning in environments that are not usually physically accessible to students through 3D models and interactive 360° videos. (Marks & Thomas, 2022)

In particular, virtual reality environments can offer new forms of interaction with visualizations and can trigger motivational, emotional, and perceptual factors that have an impact on learning processes. (Pirker et al., 2021)

Augmented and virtual reality (AR/VR) technologies are opening new doors for visualization and interaction techniques. Despite many recent efforts, the literature lacks a comprehensive system development procedure for CFD simulations with AR/VR. (Solmaz & Van Gerven, 2021)

3D Hologram Technology

The 3D smart hologram is considered the most advanced technology that offers several advantages in education, such as helping teachers and students see devices that cannot be seen in traditional teaching, providing virtual teachers, and keeping teachers and students still connected. It also shows us the object in real size. (Nadila et al., 2023)

The hologram, captured on a digital sensor, can be digitally reconstructed or further processed and displayed on a device called a Spatial Light Modulator (SLM). This subset of the field is called "Digital Holography". (Kaczorowski, 2025)

3D hologram technology not only allows them (students) to stay focused but also increases their interest to learn more. She encourages them to learn as much as they can through this technology. This study has proven that 3D holograms revolutionized the education system with a high percentage of students benefiting from it. (Qazri et al., 2023)

The application of hologram technology in the education system has the potential to revolutionize teaching and learning experiences. (Jafari, 2023)

Challenges

Using AR and VR in educational contexts is not without challenges. (Familoni & Onyebuchi, 2024)

It is important to note that implementing AR and VR in educational institutions may require appropriate infrastructure, technological support, and training for both teachers and students. However, these models offer great potential to enhance participant interaction and improve learning outcomes in an overall educational environment. (Lytvynova & Soroko, 2023)

Regarding the difficulty of using AR/VR systems by users, some users indicated that the interaction features developed in AR/VR systems do not accurately reflect actual activities. Therefore, this may be difficult for the normal user without systematic training, increasing the learning time cost for beginners to get acquainted with the AR/VR system. (Tan & al, 2022)

One of the main challenges of using AR in special education is the cost and accessibility of the technology. AR technology can be expensive, which can limit its availability in schools and classrooms. In addition, not all schools and classrooms may have the necessary equipment and software to support AR technology. (Asatryan et al., 2023)

Platforms and applications in the frame of AR and VR technology

ARLOOPA is an augmented reality and virtual reality application that offers advanced AR services that allow people to overlay digital content (images, sounds, text) on top of a real-world environment. (Yildin, 2022)

Virtual Language Scenarios: Students can participate in simulated job interviews, casual conversations, or business meetings in a virtual environment to overcome language barriers and prepare for real-world language use. (Feridun & Bayraktar, 2024)

GeoGebra AR: Allows users to create and view 3D mathematical objects in the real world, providing enhanced visual support for learning complex concepts in geometry and functions. (Zekeik et al., 2025)

Google Arts & Culture: Provides interactive journeys and virtual tours of historical and cultural sites, using AR and VR technologies. (Zekeik et al., 2025)

Immersive Language Practice: Immerse Me: Students can develop language skills in an authentic and interactive environment by speaking, completing tasks, and exploring virtual environments in the target language. (Feridun & Bayraktar, 2024)

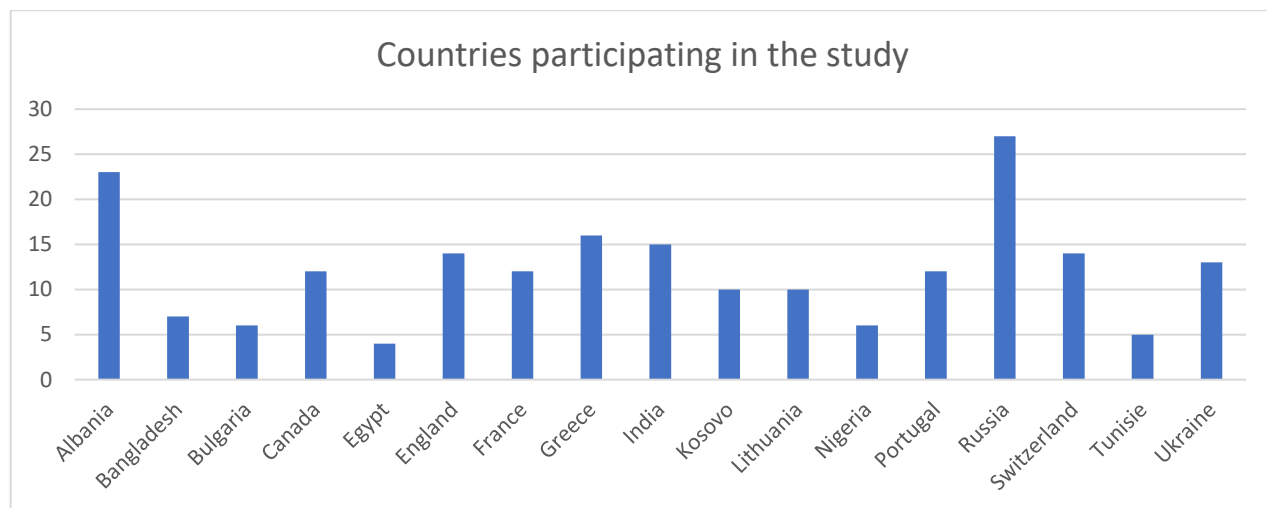
Anatomy Learning–3D Anatomy: Allows users to study human anatomy through detailed 3D models and AR elements. (Zekeik et al., 2025)

Class VR: Provides VR experiences tailored to students with special needs, providing more accessible and engaging learning environments. This app supports diverse learning needs through personalized VR content. (Zekeik et al., 2025)

Osmos VR: Provides virtual science lessons adapted for students with mobility difficulties, enabling them to access and engage in science education in a virtual environment. (Zekeik et al., 2025)

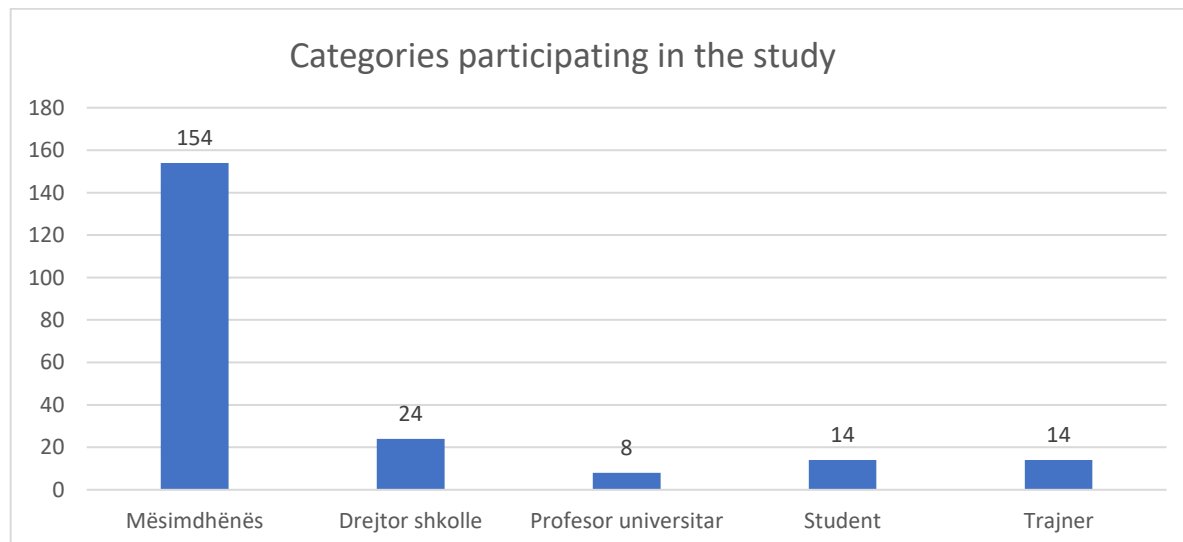
RESULTS

A total of 214 participants from 18 different countries around the world took part in the questionnaire, which was submitted electronically in various groups (Facebook, LinkedIn).



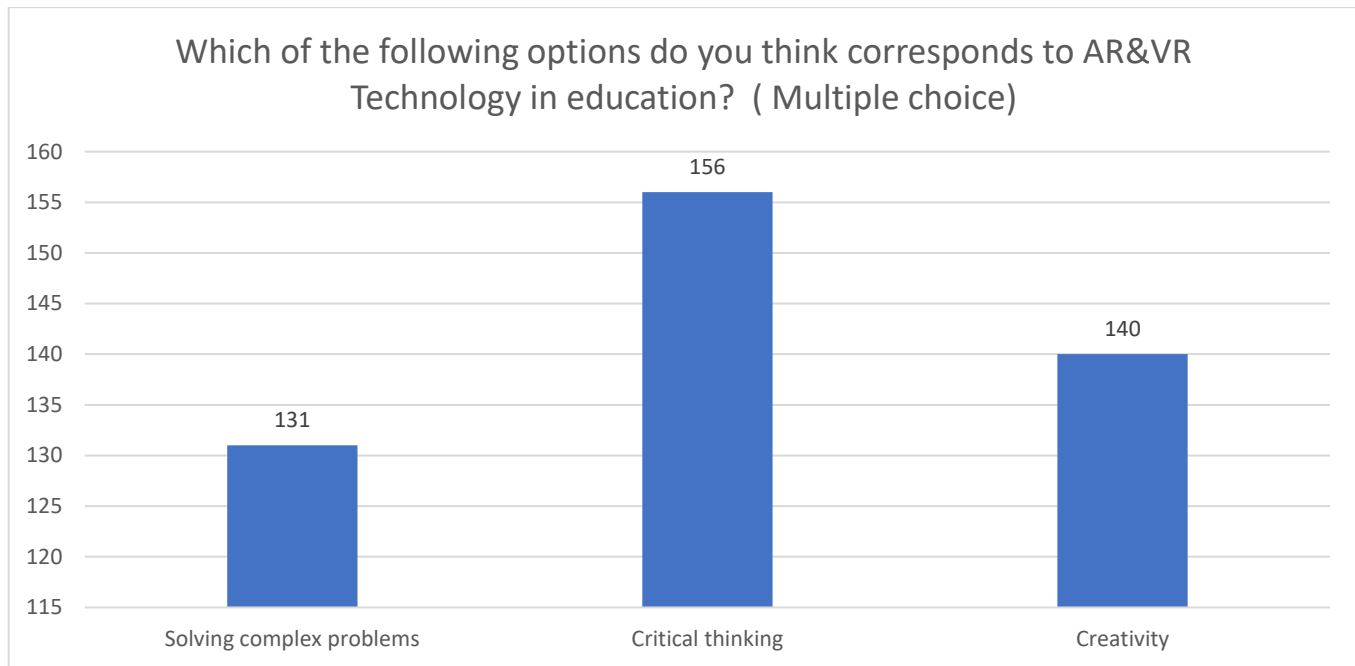
Fig_1. Participant according by their places

The participants are diverse, such as: Teachers (154, 71.96%), school principals (24, 11.21%), university professors (8, 3.73%), students from various Institutes of Technology (14, 6.51.4%), as well as.



Fig_2. Participants by profession

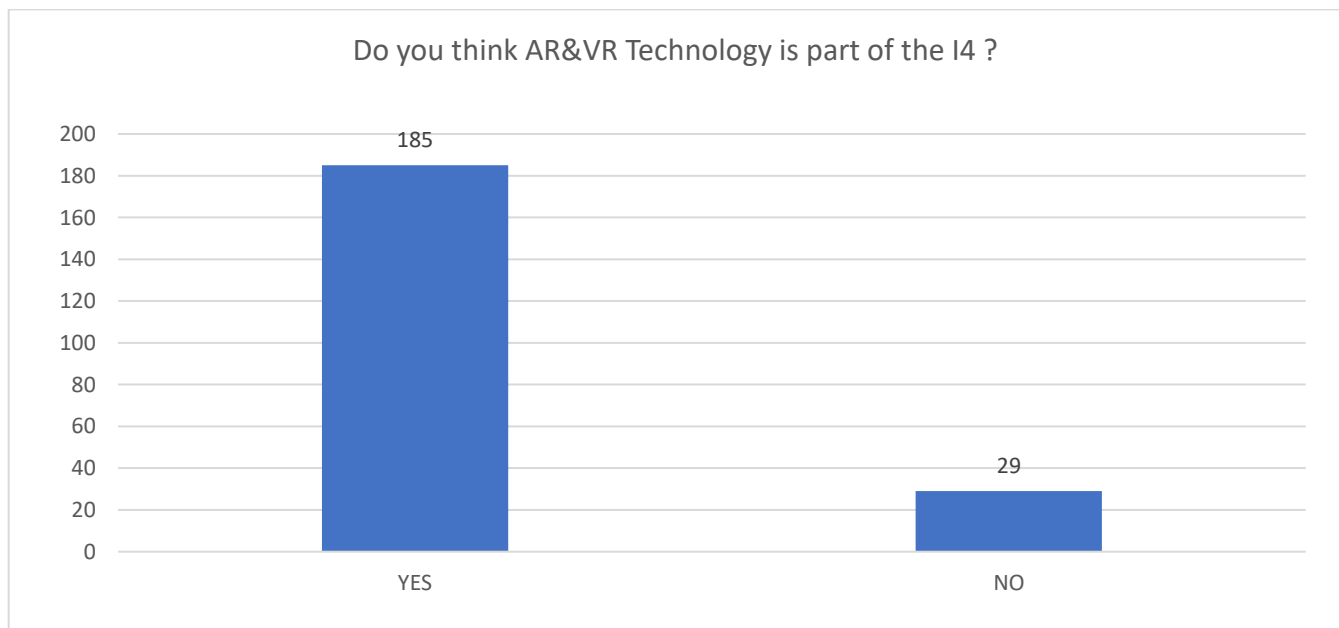
Question one (Q1): Which of the following options do you think corresponds to AR&VR Technology in education? (Multiple choice), we have the answers listed below.



Fig_3. Diagram of responses from correspondents (Q1)

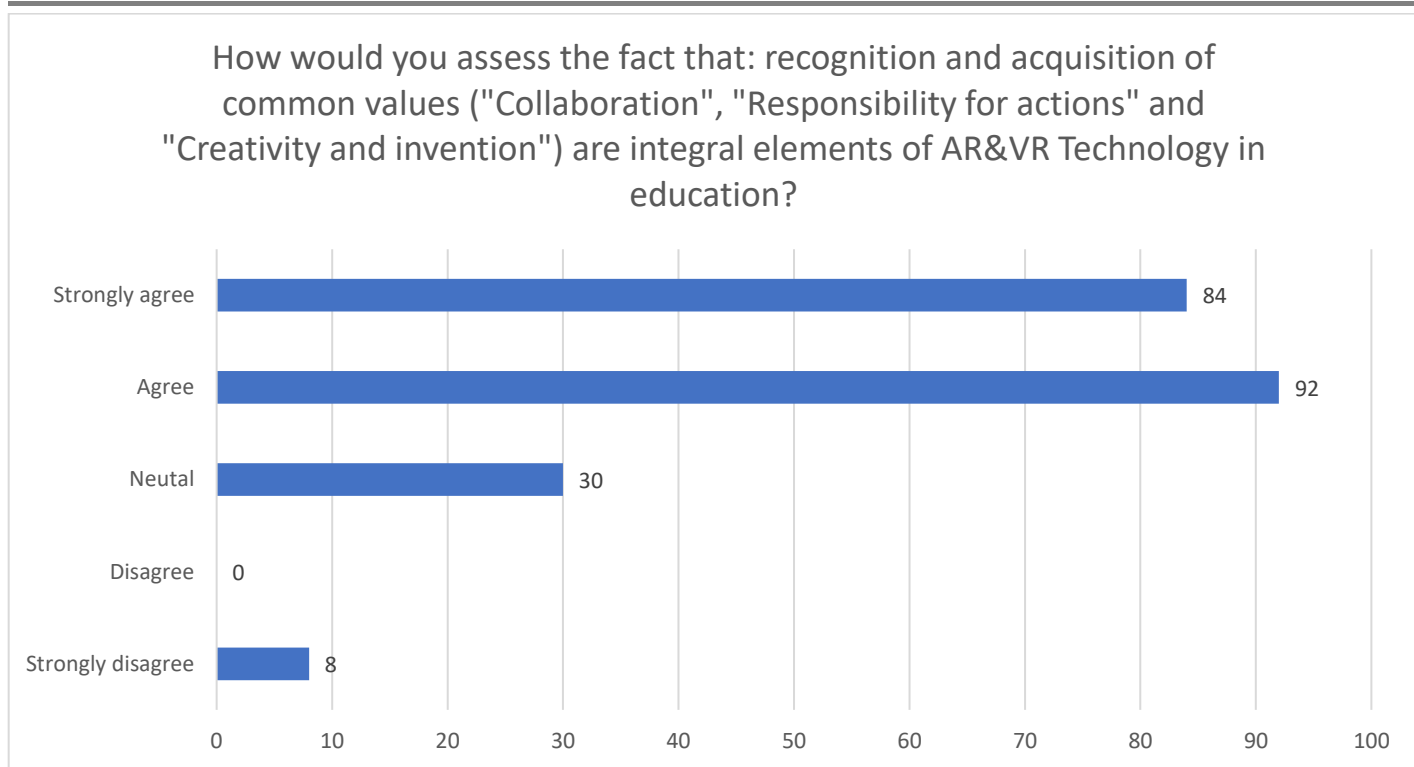
In this graph we see that Critical Thinking (156, 72.89%) dominates compared to the other options. Next comes Creativity (140, 65.42%), and last but not least is Complex Problem Solving (131, 61.21%).

Question two (Q2): Do you think that AR&VR Technology is part of I4? The majority of participants declared YES (185, 86.44%), while (29, 13.55%) of the participants declared NO.



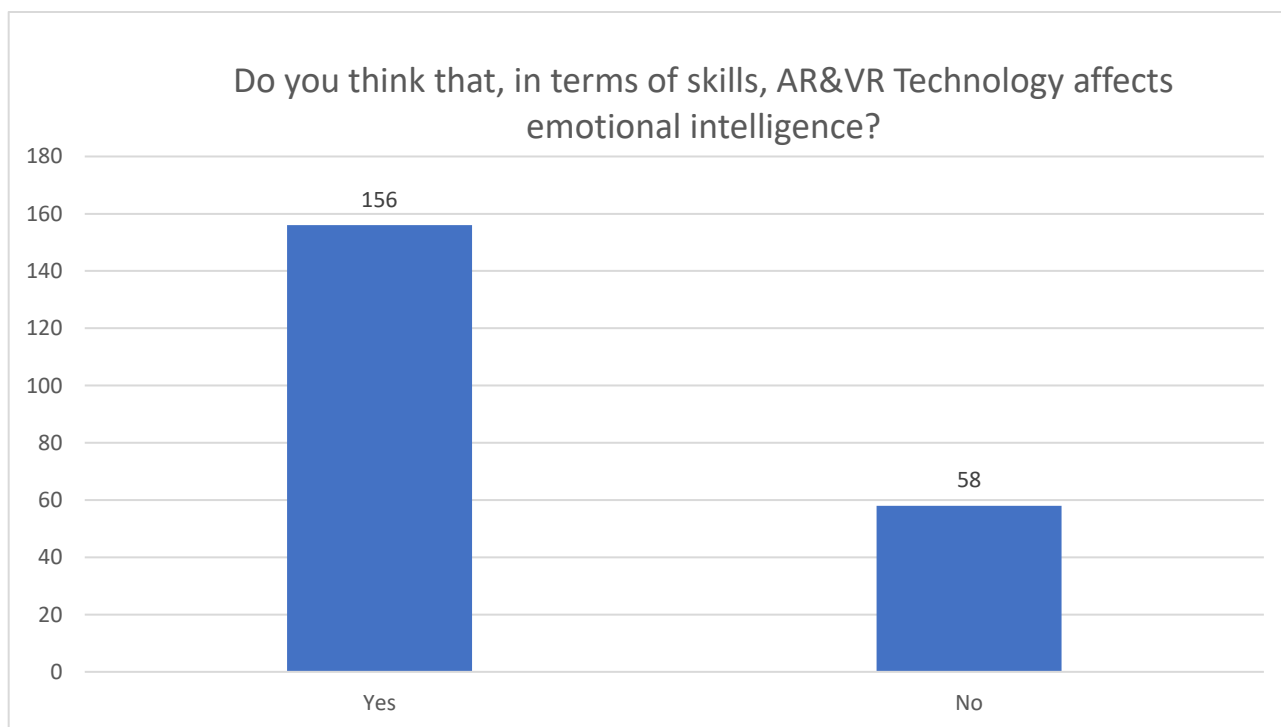
Fig_4. Diagram of responses from correspondents (Q2)

Question three (Q3) : How would you assess the fact that: recognition and acquisition of common values ("Collaboration", "Responsibility for actions" and "Creativity and invention") are integral elements of AR&VR Technology in education? We have the answers as follows: 84 or 39.25% 42.99% of the participants declared with Completely Agree, 92 or 342.99% of the participants declared with Agree, Neutral we have 30 participants, or 14.01%, Disagree we have no participants, while with Disagree at all, we have 8 participants, or 3.73%.



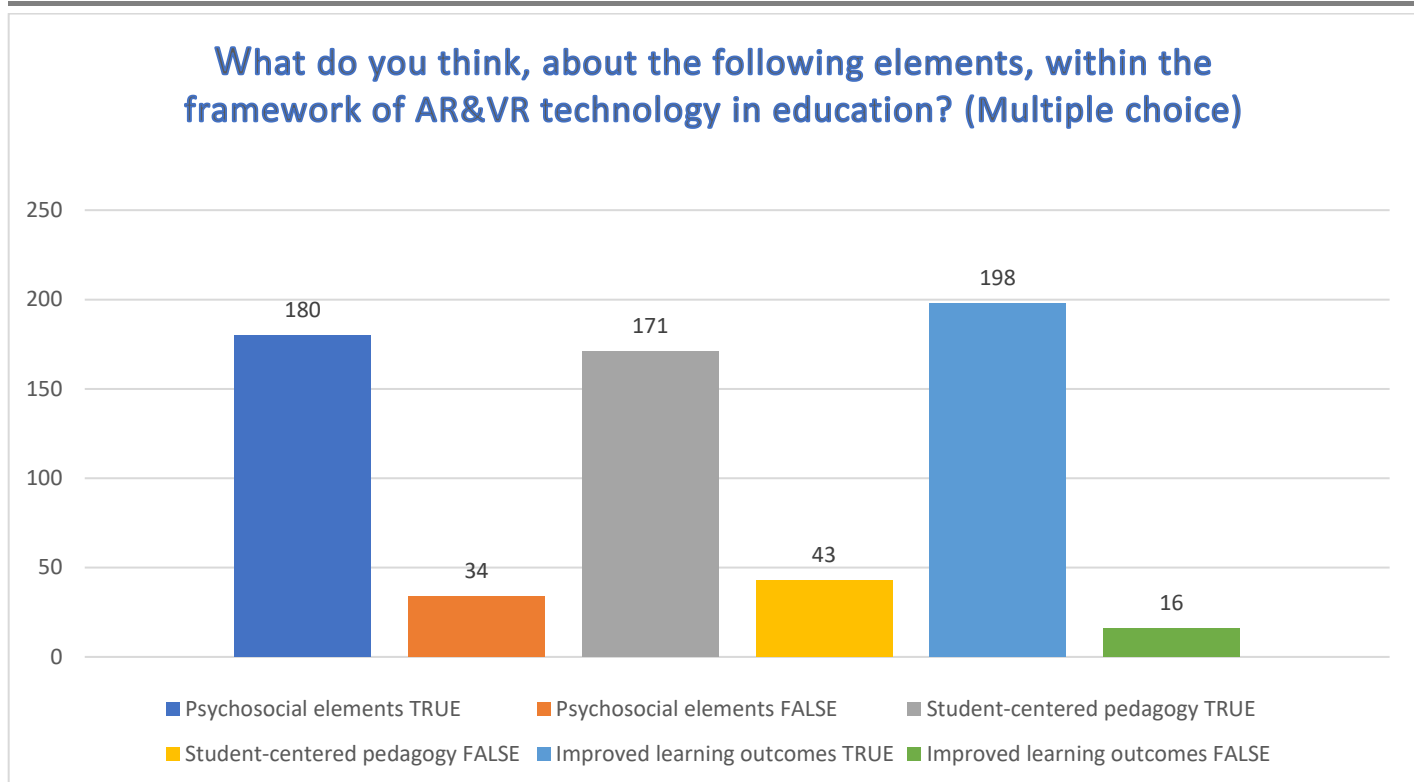
Fig_5. Diagram of responses from correspondents (Q3)

Question four (Q4): Do you think that, in terms of skills, AR&VR Technology affects emotional intelligence? The results of this question are as follows: 156 participants or 73% answered Yes, while 58 participants or 27% answered No.



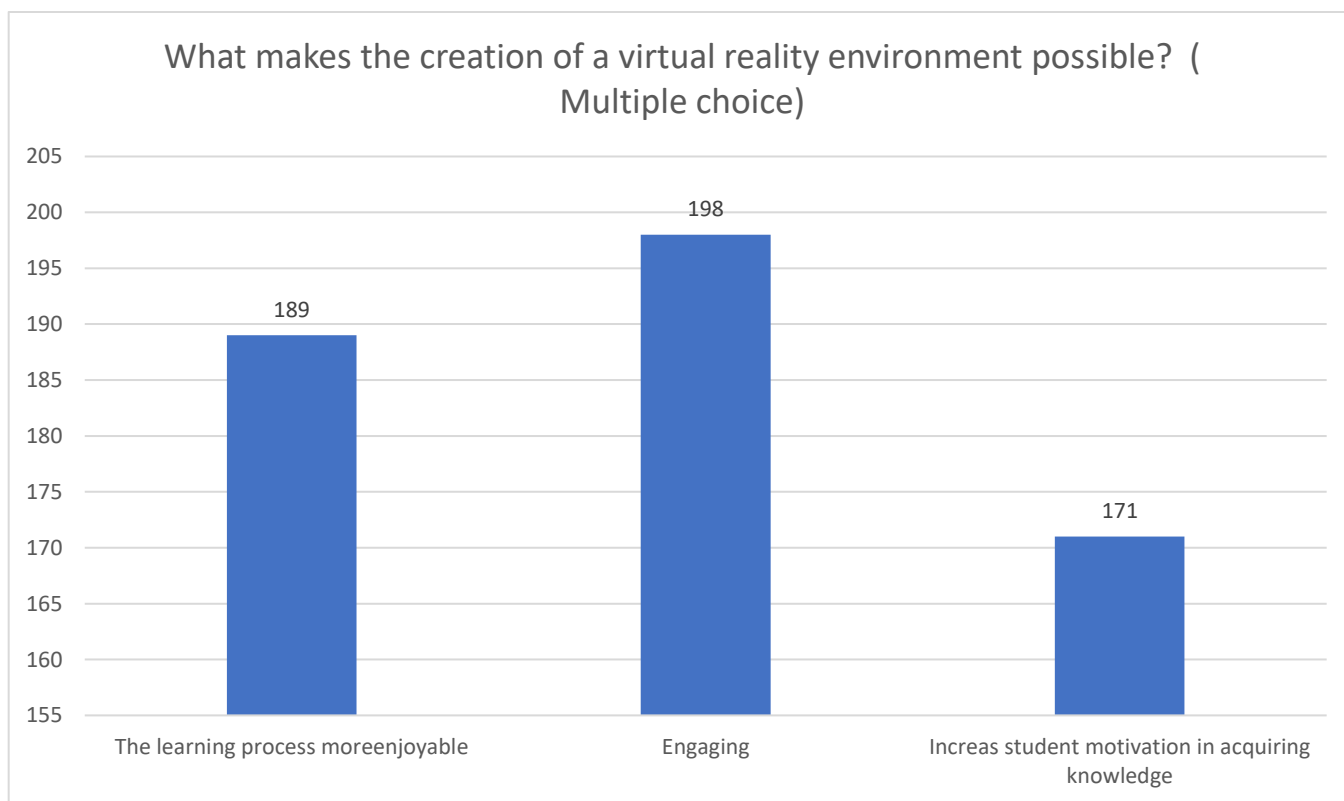
Fig_6. Diagram of responses from correspondents (Q4)

Question five (Q5): What do you think about the following elements, within the framework of AR/VR technology in education? Result: the option Psychosocial Elements, has 180 true and 34 not true, the option Student-centered Pedagogy, 171 - true and 43 - not true, the option Improved learning outcomes, 198 - true and 16 - not true.



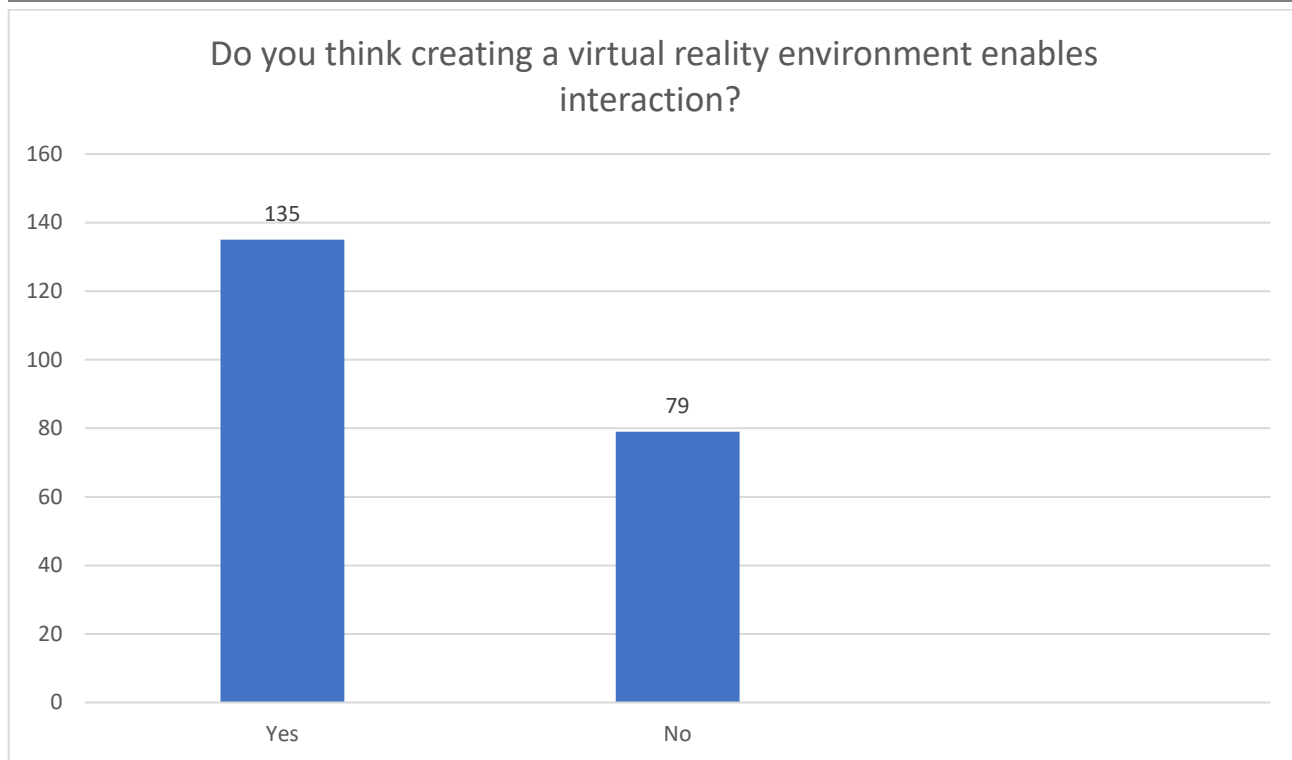
Fig_7. Diagram of responses from correspondents (Q5)

Question six (Q6): What makes it possible to create a virtual reality environment? (Multiple choice). We have the answers as follows: Engagement precedes with 198, then the option The learning process is more enjoyable with 189, and finally with 171, the option Increasing student motivation in acquiring knowledge.



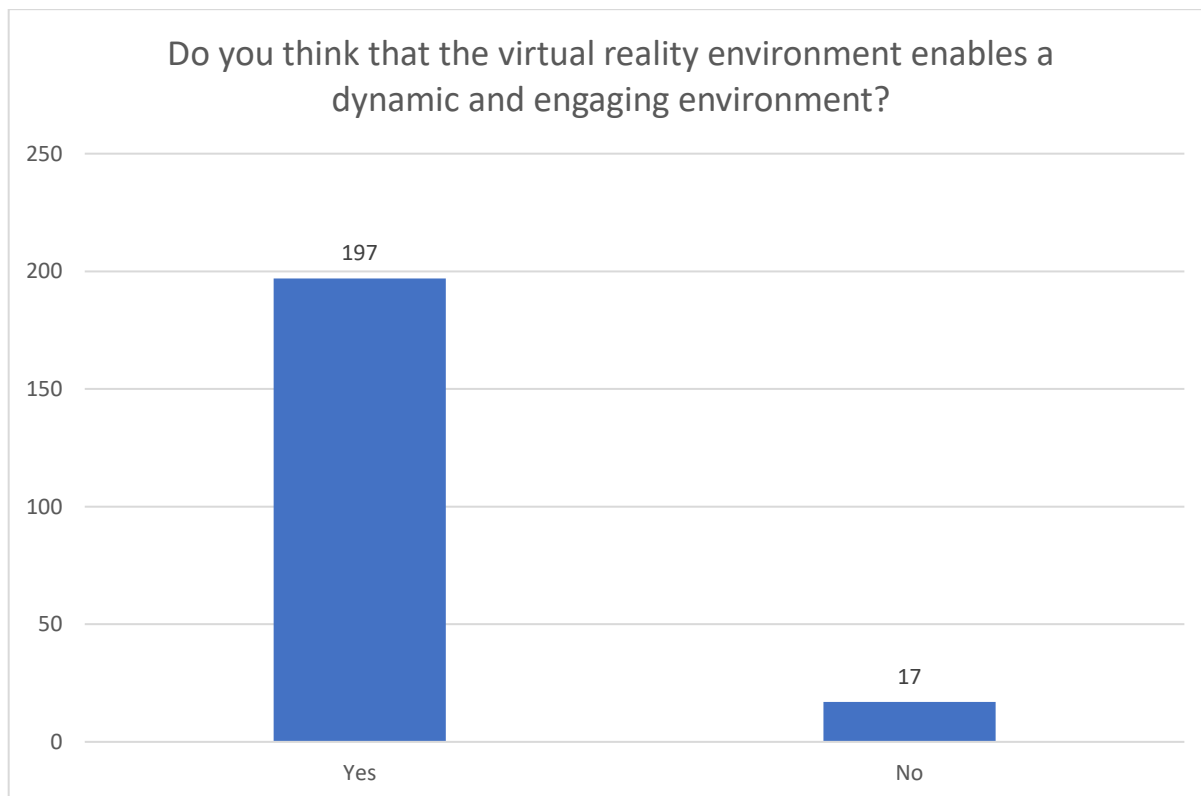
Fig_8. Diagram of responses from correspondents (Q6)

Question seven (Q7): Do you think that creating a virtual reality environment enables interaction? Result: 135 respondents, or 63.08%, answered Yes. 79 respondents, or 36.91%, answered No.



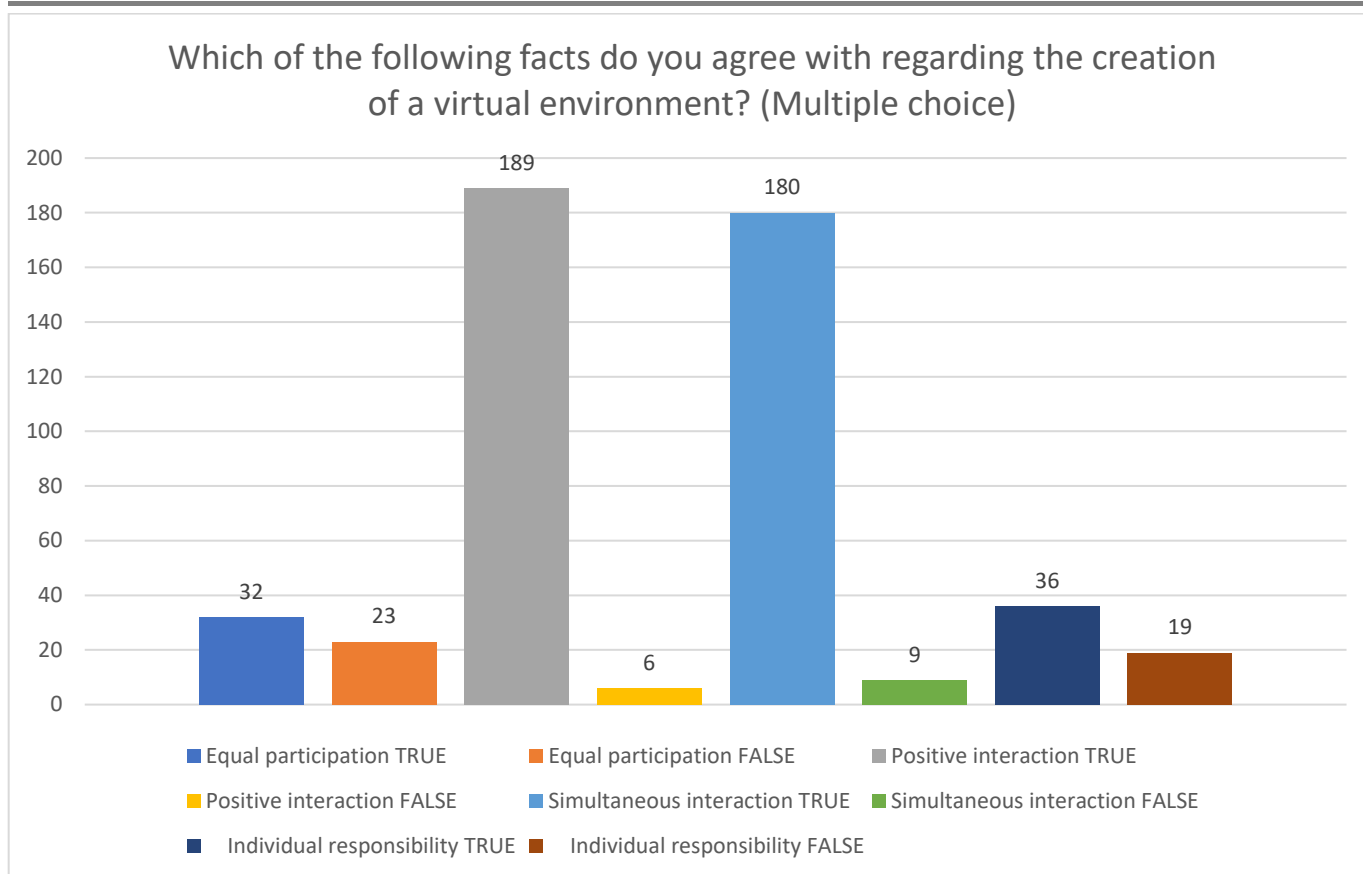
Fig_9. Diagram of responses from correspondents (Q7)

Question eight (Q8): Do you think that the virtual reality environment provides a dynamic and engaging environment? Result: 197 participants, or 92.05%, declared Yes, while 17 participants, or 7.94%, declared No.



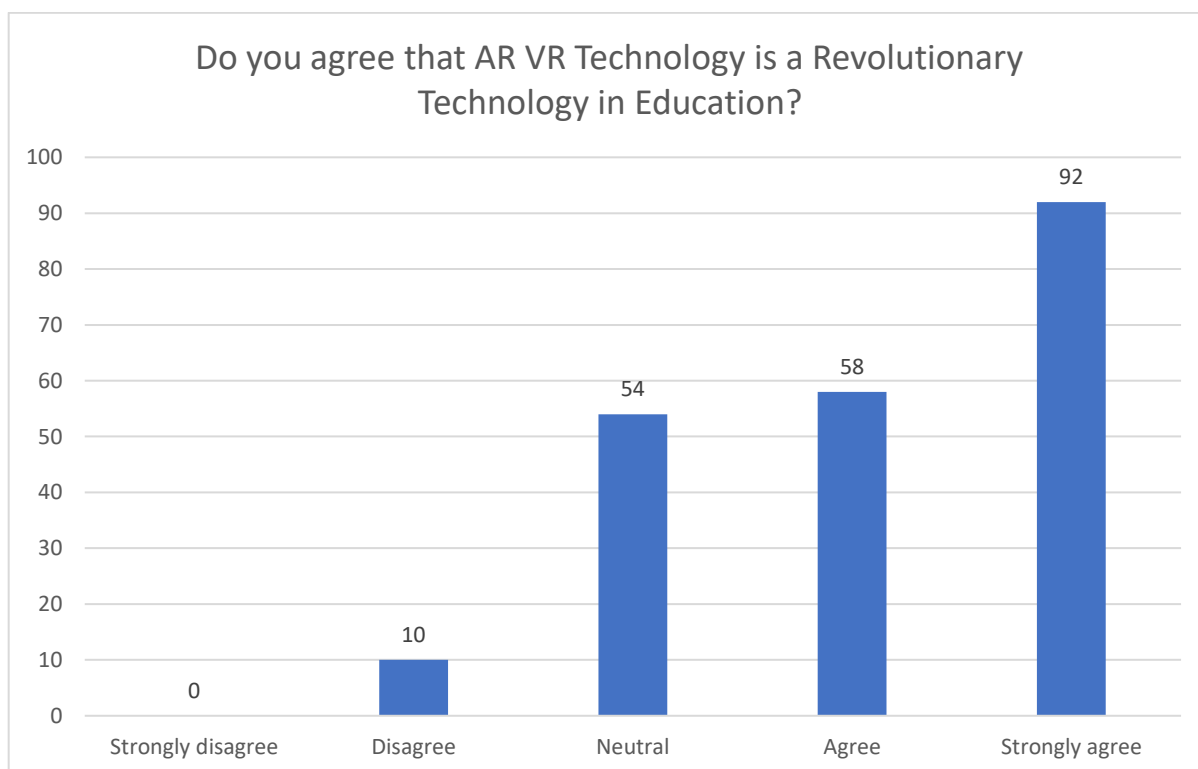
Fig_10. Diagram of responses from correspondents (Q8)

Question nine (Q9): Which of the following facts do you agree with regarding the creation of a virtual environment? Results: the Equal Participation option has 32 true and 23 false, the Positive Interaction option has 189 true and 6 false, the Simultaneous Interaction option has 180 true and 9 false, the Individual Responsibility option has 36 true and 19 false.



Fig_11. Diagram of responses from correspondents (Q9)

Question ten (Q10): Do you agree that AR&VR Technology is a Revolutionary Technology in Education?
Results: In the option I completely agree, 92 participants, or 42.99%, responded, the option I agree, has a percentage of 27.10%, or 58 participants, 54 participants declared Neutral, or 25.23%, with the option I disagree, 10 participants declared, or 21.4%.



Fig_12. Diagram of responses from correspondents (Q10)

Hypothesis testing

Excel is a powerful tool for managing and analyzing data. It is a spreadsheet program that allows users to organize and manipulate data in various ways. (Holloway, 2023).

With the Excel program, we can perform various mathematical and statistical calculations. Within the framework of statistical calculations, which are found in the Data Analysis option, we have: Histogram, F-test, T-test, z-test, etc.

In this paper, we will use the t-test: Two Sample Assuming Equal Variances.

In the first hypothesis, or otherwise known as the alternative hypothesis, we have: H1(a): AR&VR technology affects the increase in quality in education. Whereas, as for the zero hypothesis, or otherwise known as the Status quo, we have: H0: AR&VR technology does not affect the increase in quality in education.

Table 1: Testing the first hypothesis

t-Test: Two-Sample Assuming Equal Variances							
	Do you think AR&VR Technology is part of the I4 ?	Do you think that, in terms of skills, AR&VR Technology affects emotional intelligence?					
Mean	9.135514019	9.271028037					
Variance	0.117699969	0.198499408					
Observations	214	214					
Pooled Variance	0.158099688						
Hypothesized Mean Difference	0						
df	426						
t Stat	-3.525417908						
P(T<=t) one-tail	0.000234333						
t Critical one-tail	1.648438388						
P(T<=t) two-tail	0.000468666						
t Critical two-tail	1.965548282						

RESULT

Test statistic - t Stat (-3.52),

Degrees of freedom – df (426) and

Raw data – Mean (0.13).

Two-sided p-value of 0.000468666.

The p-value is less than 0.05, so, according to the results of the T-test, we say that the null hypothesis does not hold, and as such the first hypothesis holds.

With this, the first hypothesis, or the alternative one, is confirmed, AR&VR Technology affects the increase in quality in education.

Testing the second hypothesis:

H2(a): The creation of Virtual Environments enables teacher-student interactivity.

H0: The creation of Virtual Environments does not enable teacher-student interactivity.

Table 2: Testing the second hypothesis.

t-Test: Two-Sample Assuming Equal Variances		
	Student-centered pedagogy	Positive interaction
Mean	1.200934579	1.11682243
Variance	0.161313676	0.103659339
Observations	214	214
Pooled Variance	0.132486508	
Hypothesized Mean Difference	0	
df	426	
t Stat	2.390368154	
P(T<=t) one-tail	0.008632521	
t Critical one-tail	1.648438388	
P(T<=t) two-tail	0.017265041	
t Critical two-tail	1.965548282	

RESULT

Test statistic - t Stat (2.39),

Degrees of freedom – df (426) and

Raw data – Mean (0.09).

Two-sided p-value of 0.017.

The p-value is less than 0.05, so, according to the results of the T-test, we say that the null hypothesis does not hold, and as such the hypothesis raised stands.

With this, the second hypothesis is also confirmed, Creating Virtual Environments Enable Teacher-Student Interactivity.

DISCUSSIONS

214 participants from 18 different countries around the world participated in this work.

All participants who participated in this research, in one form or another, have different experiences regarding the use of AR&VR Technology, with special emphasis on its use in education.

Among the aforementioned questions, which were posed to the participants, there are a total of 10 of them. The questions mainly concern three issues, where AR&VR Technology has been tested in the field of education. The questions are mainly about the issue of improving quality in education, then the importance of creating virtual reality – with particular emphasis on the impact of this reality on the interaction between teachers and students and vice versa, and finally, the verification of whether AR&VR Technology is a revolutionary technology in education! As for the issue of improving quality, we have a dominant critical opinion. Interestingly, this technology, according to respondents, also affects Emotional Intelligence, as an important factor in the issue of education. In the continuation of these answers, we also have the fact that this technology is part of the I4, that is, the Industrial Revolution, where education is linked to the labor market. This is a feature that shows that this technology is a technology that affects the increase in quality in education, in addition to the answers received from the respondents, how technology affects the improvement of learning results.

Regarding the issue of creating a virtual environment and its impact on interaction, based on the respondents' answers, several elements have been identified, which as such are important in the teaching-learning process.

On the other hand, these elements are important psychological elements, which as such positively affect the teaching and learning process. The main element in this case is engagement, a more enjoyable learning process, an attractive and dynamic environment, etc.

From the answers received from the respondents, based on their experiences, AR&VR Technology is a revolutionary technology in education. The very fact that this technology is part of I4, there is no doubt that this represents a revolution in education.

CONCLUSIONS

Based on the findings, I conclude that AR&VR technology is the technology of the future in education. As such, I say that it is a revolutionary technology, with a special emphasis on education. Although there are not many studies on these technologies, there are some characteristics of this technology that make it the technology of the future in the field of education.

AR VR technology is a multidimensional and wide technology. Multidimensional in itself, it enables the development of critical thinking, then creativity, engagement, enabling students to prepare for the new industrial format known as I4.

The creation of a virtual reality, holograms, applications, platforms and many others, raise these technologies to another level, compared to other technologies, in the field of education. In terms of quality improvement, teacher-student interaction and vice versa, access or surfing in different places for educational purposes, the use of holograms, Metadata, make these technologies innovative, or in other words Revolutionary, in terms of the field of education.

Although this technology has a cost, then it requires training for teachers, this issue does not present a challenge that cannot be realized. On the other hand, the use of applications and platforms of this technology, some of them, does not require complicated equipment or any advanced training. While the creation of virtual reality, using advanced AR&VR equipment, of course, has its benefits in terms of educational purposes.

I think that policymakers in the field of education, institutional educational leaders, and even teachers, should prioritize these technologies if they want to deliver education at a higher level, in terms of improving results.

Investing in this technology is not in vain! This is an innovative technology and as such, it coincides with the current demands of the education field.

For the end, this technology is the present technology, because it fulfills the demands of the education in the century of the information.

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