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Modern Tendency to Practice-Oriented Learning: The Effect of Virtual Reality Technology on Students' Academic Performance

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Abstract

Today, technology is changing quickly and apparently affects all parts of life. Compared to a few years ago, many things have changed, including thoughts, habits, social activities, and ways of life. Thus, this study determined the impact of virtual reality technologies as practice-oriented learning stimuli on the development of information competence and academic performance of future primary school teachers. One hundred eighteen students from the Pedagogy Faculty of the M. Utemisov West Kazakhstan University and 105 students from the Kyrgyz National University majoring in the same field were divided into two groups for the research. Respondents in the experimental group took virtual reality courses, and their progress was evaluated by contrasting their grades before and after the programme. Based on the preliminary analysis of the student's academic performance, it should be noted that most of them performed mediocrely. However, observations by tutors and teachers revealed that when classes were taught using virtual reality platforms such as EyeJack and CoSpaces Edu, students in the experimental group were more willing to participate in tasks and seminars. Furthermore, according to the results of Content Module 2, students in the experimental group performed significantly better than students in the control group in terms of their overall academic performance ($p = 4.187$). The article's practical significance comes from considering how virtual reality technologies might enhance Kazakhstan's and Kyrgyzstan's educational systems.

Keywords: *Academic Performance, Information Competence, Practice-oriented Learning, School Teachers, Virtual Reality Technologies.*

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1 Introduction

Technology has evolved dynamically in recent years, visibly affecting various aspects of life; our thinking, habits, social activities, and lifestyles have changed in different ways compared to decades ago. The goal of technology, regardless of its benefits or drawbacks, is to boost economic productivity, ease daily life, or advance education. Accordingly, developing new educational systems and teaching methods is always part of research programmes involving new technologies to address educational issues. Furthermore, imperfections and problems in current educational systems, such as accessibility, funding, autonomy, universalism, and significant changes in future activities, suggest that teachers use new methods to improve education [3].

Education refers to facilitating learning, acquiring knowledge, skills or positive values to prepare students for life, work, and being good citizens [17]. Virtual platforms frequently resemble classrooms and can provide a safe environment for testing experiments that would be dangerous in real life. Learning processes are thus revolutionised, although training and research are still required to facilitate innovation processes and develop new knowledge to meet the challenges posed by the modern world. Digital technologies are being used at all academic levels, and educators use them to improve their students' learning experiences [21].

Many nations' educational systems have undergone dramatic shifts to adapt to the evolving needs of society. Consequently, the COVID-19 pandemic and other global challenges are influencing the paradigm of educational processes [7]. Various types of cutting-edge technologies have begun to emerge and be implemented worldwide, necessitating a shift towards distance learning. Technology advancements impact learning and teaching processes, as they have in all aspects of life. Increases in the amount of information, the complexity of the content, the demand for education, the number of students, and the desire for the benefits of learning situations are the primary reasons why universities use educational technology [20]. Virtual reality (VR) and augmented reality (AR), both forms of virtual technology, are the newest practices that have only recently begun to be actively implemented in improving educational processes in higher education institutions.

To create the desired experience, virtual and augmented reality technologies require a proper blend of real-world information and computer-generated objects. However, participants can never have a perfect sense of VR/AR content without tools and gadgets [28]. The foundation of AR/VR tools is human perception, and they can appeal to various human senses. Tools can be visual, auditory, tactile, or olfactory devices and external devices, such as a positioning system that can be integrated into these tools [27].

Simultaneously, the described technology is frequently cited as an educational concept that positively influences the development of a variety of student abilities, such as practical skills, self-organisation, and discipline [32]. The optimal and effective provision of learning can support and develop students' spatial awareness, improve memory, and bring them closer to the environment of the practical application of the acquired skills. This has been identified as one of the most significant factors transforming the educational field [22].

Consequently, research on virtual reality technologies' effect on student learning effectiveness is a highly relevant and vital topic today. Indeed, trustworthy data and the scientific community's attention to incorporating cutting-edge technology in the educational process contribute to advancing practice-oriented higher education [19].

1.1 Literature Review

Several procedures and mechanisms in the educational environment have been reorganised due to the digitalisation of education [12]. Students and learners have started to discover novel approaches to identifying and enhancing information retrieval, peer communication, or academic task patterns. As a result, the applicant's future profession has been influenced by digital online tools. It is now possible for individuals to independently analyse the labour market in their region, compare the advantages and disadvantages of various universities, and determine their career orientation [30].

VR and AR are computer-based and device-based technological systems that allow users to be fully or partially immersed in a world of digitised images [16]. VR replaces the real world with a simulated one, and it requires the user to interact directly with the system [11]. As a result, the user is completely engrossed in a computer-generated, artificial, three-dimensional scenario and is unaware of their surroundings. AR does not replace reality but rather enhances it by allowing users to see and interact with virtual images superimposed on a real physical environment [5]. AR technology has become an innovative space available for ubiquitous and regular use in educational practice thanks to updates and low-cost applications on modern mobile phones [25].

Understanding the difference between the real and the virtual is necessary to precisely define these terms [4]. The two extremes of the spectrum are virtual and physical settings. Although the philosophical concept of reality is intricate, the real world is bound by the laws of physics, and it is where things can be experienced directly as they are. In contrast, the virtual world is a computer-simulated environment that may or may not obey physical laws such as time, gravity, or material properties [14]. In a broader sense, participants are completely immersed in the computer-generated virtual world. Participants, however, are physically present in the real world. The reality-virtuality (RV) continuum is a spectrum between real and virtual environments that can accommodate various types of AR or VR [4].

González-Zamar and Abad-Segura [11] examined global research on the use of virtual reality in higher education over the last thirty years (1989-2019). According to the researchers, VR technology has become an alternative to traditional learning in recent years, particularly in developed countries [11]. The three-dimensional visualisation, immersion, and interaction similar to the real world are the reasons for the demand for VR [11]. The process of socialisation through a practice-oriented concept cannot take place without the public's participation. Involving the public is essential for assessing societal needs and agreeing on a problem-solving strategy [9].

Students' cognitive tasks are carried out using VR/AR technology in a manner similar to real life; it is a practical activity with a true sense of perception. Students can experience the activity of aesthetic objects through VR/AR and sense the evolution of those objects through virtual perception [6].

Unlike VR/AR, the use of multimedia equipment in the classroom does not allow for detailed and thorough multidimensional observation. The VR/AR environment allows students to experience painting, sculpture, or architecture in person and create their own artwork [15]. In Hui et al. [15], for example, schoolchildren were invited to use VR to take the visual arts courses 'Mighty General' and 'Southern Song Dynasty Official Kiln'. Hui et al. [15] planned and designed the porcelain manufacturing process. The students completed all manufacturing steps (melting, drawing, printing, cutting, drying, glazing, and kiln firing) before printing the finished pieces on a 3D printer. The researchers identified enhancements in classroom effects, including new opportunities to acquire previously unavailable knowledge, heightened focus on the learning task, and increased creativity [31].

Cabero-Almenara et al. [5] investigated AR and VR technologies' learning effects on undergraduate art students. The project led by Cabero-Almenara et al. [5] involved the creation of a three-dimensional object inspired by the artwork in the Church of the Annunciation in Seville. The intervention aimed to determine how well AR and VR technologies were accepted and how well they worked technically and aesthetically. Cabero-Almenara et al. [5] found that learners accepted the technologies they used and intended to use them again.

The modern educational environment is distinguished by rising expectations for future professionals' intellectual abilities and practical skills, as well as their ability to perceive new changes in response to current challenges. In the real world, this demonstrates the pressing requirement for the specialised delivery of vocational education and training under a practice-oriented concept. The development of society, the requirement for quick specialist adaptation to contemporary requirements, and, consequently, quick socialisation are the driving forces behind the need for a practice-oriented concept [19].

1.2 Purpose and Objectives

Education digitalisation has become a critical factor in improving the learning effectiveness of 21st-century students. Each region strives to maximise the impact of learning technologies implemented following their respective technologies. Therefore, virtual/augmented reality technologies can serve as a rational means of bridging the gap between student learning and current professional practices. However, many academics remain sceptical of virtual reality technologies' potential because they can disrupt students' learning, reduce their concentration on the learning process, and require specific skills. The study's novelty is in implementing a virtual reality training programme at M.Utemisov West Kazakhstan University and Kyrgyz National University and in determining how it affects students' academic performance and information competence.

Thus, the purpose of this study was to determine the impact of virtual reality technologies as practice-oriented learning stimuli on the academic performance of future primary school teachers.

The following objectives were formulated during the study:

1) Analyse the performance of first-, second-, and third-year university students according to Content Module 1;
2) Introduce a Virtual and Augmented Reality Technologies section in the syllabus based on the experimental sample of respondents;
3) Assess the impact of the implemented module on the shift in student performance as measured by Content Module 2.

2 Methodology

2.1 Research Design

The research process consisted of a series of sequential steps. The method was borrowed from the Akman and Çakır [2] study.

The first step involved determining the topic's applicability and reviewing the body of knowledge regarding the variables influencing how effectively students learn using virtual reality technologies.

The second step involved developing the research framework for the article. A sample of respondents was chosen, and a training programme was created for an experimental group.

The third step involved describing a task to the two groups of respondents and holding a training session for the experimental group of students.

The fourth step synthesised the academic performance results from Content Module 2, which included different types of integration for the control and experimental groups.

2.2 Sample

The study was conducted at two universities in Kazakhstan and Kyrgyzstan. M. Utemisov West Kazakhstan University was the first university. A total of 118 fourth-year Pedagogy students (mean age 22.7, SD=18) from this university participated in the research. There were 112 (94%) female students and 6 (6%) male students. In terms of ethnicity, 80% of the students were Kazakhs, while 20% were Russians. The respondents were students enrolled in the Methods of Teaching Computer Science in Primary Schools module. The study also included 105 students (mean age 21.9, SD=12) from the fourth year of Pedagogy at Kyrgyz National University. There were 64 girls (61%) and 41 boys (39%). Kyrgyz comprised 70% of the population, Uzbeks 14.7%, Russians 7.3%, and Dungans 1.1%. The participants were split into two groups: the experimental and the control groups. The acceptable sampling error did not exceed $p = 4.74$ based on the total number of students enrolled at this university. Therefore, the sample can be considered sufficiently representative for the study.

2.3 Survey

The survey began in October 2021, at the end of Content Module 1. First, the students completed a questionnaire to assess their understanding and mastery of VR tools. The students then moved on to the Methods of Teaching Computer Science in Primary Schools module, which included a Virtual and Augmented Reality Technologies section.

The control group of respondents used the traditional training plan to implement the programme.

According to the schedule, the experimental group of respondents received training in VR/AR tools taught by computer science teachers in two weekly lectures and practical sessions. The training included using VR glasses, the EyeJack development environment, and the CoSpaces Edu software for creating virtual and augmented reality objects. A special programme with various 3D models of characters, locations, and so on had been created for the training. The first two sessions were spent getting acquainted with the software. Following that, students were asked to solve problems by solving cases using the graphic editor and broadcasting situations gathered from YouTube. In other words, each task simulated in the VR mode was designed as a real homework assignment for future primary school teachers (Figure 1).

Figure 1: Example of a VR Case as Part of the Methods of Teaching Computer Science in Primary Schools Module.

The section of the programme lasted four weeks. Following that, a traditional knowledge test was administered, the results were used to determine the correlation of indicators.

The data were processed using IBM SPSS Statistics and Microsoft Excel 2007.

2.4 Data Analysis

Finding the arithmetic mean of all the scores earned during each module served as the basis for analysing the performance of the study's participant students.

The survey employed multistage quota sampling. The sampling error was calculated using the following formula:

$$SamplingErrorFormula = Z \times \frac{\sigma}{\sqrt{n}},$$

where Z is the indicator according to the required confidence interval (95%); n is the sample size; σ is the standard deviation of the population.

Therefore, the sampling error was 0.885% or about 1%. As there were no unreported errors and the reported errors did not exceed the specified level, it was possible to conclude that the obtained data were of reliable quality.

Cronbach's alpha was used to test the reliability of the questionnaire designed to survey students. Cronbach's alpha values were interpreted as follows: ¿0.9 excellent; 0.8 good; 0.7 acceptable; 0.6 doubtful; and ¿0.5 unsatisfactory [10]. The questionnaire's cumulative Cronbach's alpha value was 0.896, indicating that it was valid and could be used in the survey.

2.5 Ethical Issues

The study's purpose and objectives were communicated to all participants. The students permitted the survey data to be processed and analysed. Although personal information (students' gender and background) and professional information (students' speciality) were collected for completeness, it was not disclosed in any way. The survey was delivered and coordinated with representatives from the participating universities' ethics committees.

Table 1: Checking the Effectiveness of the Developed Programme Using the Kolmogorov-Smirnov Criterion.

T_1	T_2	T_3
0.24	0.24	0.06
$T_1 T_1 T_{cr} T_{cr}$	$T_2 T_2 T_{cr} T_{cr}$	$T_3 T_3 T_{cr} T_{cr}$
The hypothesis is rejected; students who took the digital course to improve knowledge sharing and communication performed academically differently than students who received traditional distance learning	The hypothesis is rejected; students who took the digital course to improve knowledge sharing and communication did not achieve the same distributional values	The hypothesis is accepted; the experimental group's academic performance is no worse than that of the control group respondents

2.6 Limitations

The questionnaire items designed specifically for the study were as simple as possible; however, the work still has some limitations. They are primarily related to individual psychological characteristics of students that cannot be accounted for in this study, such as latent motivations for learning activities or respondents' consciousness. Similarly, students may not recognise certain behaviours or actions as influencing their decisions, instead viewing them as their own.

3 Results

The educational course was validated using the Kolmogorov-Smirnov criterion (Table 1).

According to the primary analysis of students' academic performance, most performed mediocrely. The chi-square analysis of the success factor of the current learning environment for students and female students of both groups was provided in Table 2. It was discovered that students in both groups gave mediocre ratings to the current online learning environment (p=0.353). Furthermore, there was some nonuniformity on several questions:

It was observed that the calculated chi-square value was $X2(1, N = 293) = 1.02$, $p = 0.37585$ (NonSig. $p < 0.5$), while the calculated chi-square value with Yates's correction was $X2(1, N = 293) = 0.94678$, $p = 0.37595$ (NonSig. $p < 0.5$).

Table 2: Chi-Square Analysis of Student Well-Being before the Course ($N = 293$).

Criterion groups	Marginal row totals
Control group	72.6 (71.9) [0.357]
Experimental group	70.35 (70.5) [0.368]

After completing the 4-week virtual reality programme, the survey results on the effectiveness of the academic sessions in Content Module 2 improved slightly. As shown in Table 3, the correlation between the experimental and control groups increased substantially. Tutors and teachers observed that when classes were taught using virtual reality platforms, students in the experimental group were more willing to participate in tasks and seminars. According to the results of Content Module 2, students in the experimental group performed significantly better than students in the control group in terms of overall academic performance ($p = 4.187$). Each group's results showed a high correlation.

It was observed that the calculated chi-square value was $X2(1, N = 293) = 1.99, p = 0.417584$ (NonSig. $p < 0.5$), while the calculated chi-square value with Yates's correction was $X2(1, N = 293) = 0.7384, p = 0.27459$ (NonSig. $p < 0.5$).

Table 3: Chi-Square Analysis of Academic Performance after the Course ($N = 293$).

Criterion groups	Marginal row totals
Control group	76.35 (76.9) [0.366]
Experimental group	92.4 (90.8) [0.448]

However, the corresponding correlation between the results of Spearman's surveys indicates different results for academic performance (Table 4).

Table 4: Result Correlation between Groups according to Spearman's Survey.

	1		
Control group	0.35684	1	
Experimental group	0.97643	0.83274	1

4 Discussion

The effects of virtual reality technologies on the development of students' information competence and academic performance were investigated in this study. Even though there was a slight internal difference between the groups before the discussed methods were used, this difference was found to be statistically significant. Furthermore, this difference was also found to exist between the test results and was maintained in the analyses.

Several studies have found that using VR/AR in educational settings yields positive results. Improved learning outcomes, personal motivation, interest in the subject, and engagement in the learning process are all advantages [1]. Researchers are particularly interested in improving learning outcomes [24, 26]. Some emphasise cognitive abilities, such as memory and comprehension, connected to visualisation, the illustration of abstract concepts, and the multimodality of VR and AR.

The socialisation of future specialists as a result of the practice-oriented concept entails the development of cognitive skills in all participants. This allows them to navigate the information space, apply their newly acquired knowledge in practice, and create activities independently. Targeted two-way socialisation of all participants is therefore implied by students participating in social projects [23].

Techniques for improving learning effectiveness through new technologies are also actively used in the arts. In recent years, the arts have begun to actively implement new methods for improving the quality of education in terms of quantity and complexity of learning. However, using technology alone is not enough to improve the quality of education [18]. When it comes to structuring in education, methods are different from computer-assisted learning.

Research has demonstrated that AR/VR technologies are of high quality, useful for education, and can assist students in more effectively developing their skills and knowledge. AR/VR systems can make learning content more appealing to students, increasing their motivation and interest. Students enjoy AR/VR learning and observe the learning process, and AR/VR systems help them acquire more accurate knowledge. A better comprehension of the educational challenges that have been addressed in the educational literature is indicated by the research on AR/VR systems [8]. Some students, for example, cannot perceive 3D models, while others cannot visualise invisible phenomena such as the rotation of the Earth. AR/VR enables students to view 3D models, virtually manipulate objects, deduce unobservable phenomena, and experience abstract concepts (for example, travelling to a wormhole). These virtual experiences can help students think more clearly and correct misconceptions.

Researchers have found that modern technology has many advantages, including the ability to save time and money and to be tailored to the needs of each user [13]. In the context of VR/AR, however, the savings can manifest themselves in the learner's ability to significantly reduce the required real-world practice by substituting it with virtual practice (such as preparing, restarting, and observing machines and mechanisms).

Technical issues with brightness, response time, resolution, and power consumption have been cited as disadvantages of VR/AR technology. Display quality suffers when the brightness is too low. A low-brightness screen will be affected by ambient light in high-brightness conditions [29]. Furthermore, when using VR, the user experiences dizziness due to the delay in changing the viewing angle [29]. Low-resolution pixels on the screen also cause dizziness and reduce the quality of the experience [29]. Technical issues, malfunctions, poor playback accuracy, and inconvenient headset use result in decreased interaction, impaired presence, and decreased motivation to use VR/AR technology [13].

5 Conclusion

The research programme includes creating educational methods and systems, including the application of modern technology to address issues in education. The research is novel in that it implements a virtual reality training programme at M. Utemisov West Kazakhstan University and Kyrgyz National University and analyses its effects on students' academic performance and information competence. Hence, the current study sought to ascertain the impact of virtual reality technologies as incentives for practice-oriented learning on future primary school teachers' academic performance. According to the preliminary analysis of students' academic performance, most had mediocre academic performance. However, teachers' observations revealed that when classes were taught using virtual reality platforms, students in the experimental group were more willing to participate in tasks and seminars. According to the results of Content Module 2, students in the experimental group performed significantly better than students in the control group in terms of overall academic performance ($p = 4.187$).

The article's practical significance is to investigate how virtual reality technologies might enhance Kazakhstan and Kyrgyzstan's educational system. AR/VR technologies benefit education and can assist students in acquiring skills and knowledge more efficiently.

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