

Training of Future Educators for the Introduction of Mobile Applications, AR and VR Technologies into the Educational Process*

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Abstract. This work deals with the relevance of innovative technologies in the educational process, focusing on mobile learning, augmented reality (AR), and virtual reality (VR) technologies. The advantages and challenges of the implementation of augmented reality and virtual reality technologies into the educational process and their role as a means of achieving new educational results are considered. Further, the teachers» training as an essential element for the realization of mobile learning and the introduction of AR and VR applications into the educational process is determined. The authors have developed a program, content, and distance educational and methodological support of the course. The presented course has been implemented into the training of students of pedagogical directions using distance educational technologies. The course is purposed to develop a set of professional competencies in students in the field of mobile educational applications with the use of augmented reality and virtual reality technologies, aiming to intensify students» cognitive activity, increase their motivation to study, and consequently, to enhance the learning activity.

Keywords: mobile learning, distant learning technology, mobile applications, augmented reality and virtual reality technology, interactive technology.

1 Introduction

Presently, evolving technologies and devices are instrumental in many spheres of human activity. In this view, modern education is inconceivable without the introduction of new approaches and innovative tools. Together with distance learning, mobile learning is one of the main educational priorities today. The application of augmented reality (AR) and virtual reality (VR) technologies in mobile learning seems to be an effective

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tool for the development of informational and communicative competence, as well as the enhancement of the educational process.

Up to date, there are existing researches devoted to the prospects of mobile learning and the introduction of AR and VR technologies into the educational process. These researches comprise the issues of the organization of mobile training [6], determine the main principles of mobile learning or training, emphasizing the time and location-independent access [4], analyzing the functionalities of mobile portals; access from cell phones, SMS-mailings, -questioning, -testing [1], multi-tasking application of mobile devices for various professional fields [2, 5].

2 Problem Statement

Thus, having analyzed theoretical elaborations and practical projects in the realization of mobile training and the introduction of AR and VR technologies into the educational process, it is possible to determine their main advantages:

- Accessibility of learning; the scope of the educational process is extended beyond the walls of the educational institution and realized by the means of technologies accessible to the majority of the targeted audience, such as tablets or smartphones.
- Individualization of learning; gives the possibility to approach individual specifics of students and is personal-oriented.
- Interactivity; by providing information in multimedia format, promotes better learning and memorizing of the material, increasing interest in the educational process. AR and VR create a multidimensional space for study; enable students to explore the world interactively through visualization and full immersion into the subject. The interactive, «playable» learning motivates students, increases their interest in classes, and involves them in active cognitive activity [7].
- Cooperation; the realization of learning activities of the students and the development of students' ability to learn are carried out, among other things, through participation in joint groups and communities. The expansive opportunities of AR technology for conducting interactive classes encourage students' cooperation and develop teamwork skills [2].
- Facilitate access to education for people with special needs.
- Renounce paper materials, or eventually replace existing visual training tools. In this case, it will facilitate the reduction of material costs, i.e. cost-efficient. It is also an environmental concern.
- Promote the distribution of educational materials among users owing to up-to-date wireless technologies (WAP, GPRS, EDGE, Bluetooth, Wi-Fi).

The use of mobile devices in the educational process will facilitate a solution to the following issues.

Organize «teacher-student» interaction within the classroom setting. Larger classrooms or lecture halls demand more effort from students to ask questions and get an immediate response. In this view, mobile systems equipped with special educational

applications designed to function in the short-answer question mode in real-time will considerably enhance feedback in the educational process [5].

Visualization of lecture material. To date, there are classrooms which instrumentation still incomplete with modern tools for demonstration of educational material, such as computerized projectors, monitors, interactive boards. In this connection, mobile devices can display lecture material by transmitting data directly to students' phones, a projector, or a TV screen. In this case, the teacher will not have to carry a laptop or ask the school administration to provide a computer tool.

Learning opportunities that will be available at any suitable place or time. Such implementation will also significantly increase the effectiveness of distant learning.

Make it possible to carry out works using software tools in classrooms that are not computerized. The use of mobile devices in this direction will reduce the dependence of the place and time of classes on the location of computer classes and their utilized capacity.

Negative aspects of mobile learning:

- technical facilities provided with the required functions may not be available for some students.
- lack of skilled teachers to introduce mobile devices into the educational process.
- lack of training mobile resources and programs for students in various learning activities.
- mobile devices provoke students and schoolchildren to entertaining activities (games, communication, videos, and audio resources) distracting them from the educational process.
- small size and low screen resolution.

To date, only the last two items seem to be challenging. Below listed are the main activities directed to achieve the objectives of mobile learning.

Organization of distance lecturing. The use of remote communication applications provides learnings that demand no classroom. Given such an opportunity, students from other regions, students with limitations in health, staying at medical institutions, or those, due to circumstances, being unable to attend classes at the university, will be engaged in interactive communication [3].

Use of mobile devices for visualization of lecture material. The development and use of special applications for mobile devices will transfer data from the teacher's device directly to the students' phones. Such a method of material visualization will make it possible to use demonstration materials electronically even in the classrooms lacking computer tools. In this case, the pre-set application will be accessible through the connection of mobile devices, such as a tablet or smartphone, with any compatible projection equipment for data output. This way of using mobile devices does not necessitate the availability, shifting, and setting of a PC or laptop.

Organization of computer-sensitive laboratory works. Modern tablets and smartphones are capable of running the same or similar applications as regular computers, so it is crucial when presumably there is a shortage of computer tools in the lab. In such situations, students will be able to perform tasks using their mobile devices. Also,

tablets and smartphones are less dependent on the power source and can function in case of power failure or blackout in the network.

Organization of testing. Testing is widely applied by teachers as a method of student knowledge check. Educational institutions have applied computerized testing for over two decades. Mobile devices can significantly enhance the existing capabilities of testing. For example, it is possible to have test cases deployed on a web server and access them from anywhere, within the range of GPRS, Wi-Fi, or similar communications.

Organization of surveys and questionnaires. Currently, software tools designed for conducting surveys and questionnaires are being developed and implemented employing modern communications. These programs will facilitate to saving of time and printing on paper carriers. Moreover, it will enable to conduct such surveys and questionnaire outside classrooms

3 Development of Distance Learning Course

To get the students of pedagogical directions prepared for the use of technological innovations in future professional activity, a program and educational and methodological support of the course «The use of mobile applications, augmented and virtual reality technologies in the educational process have been developed.

The purpose of the course is to develop a set of professional competencies in students in the field of use of the functionality of mobile applications, technologies of augmented and virtual reality to intensify the cognitive activity of students, increase their motivation to study.

The main objectives of the course are:

- educational introduction of mobile applications augmented and virtual reality technologies;
- familiarization with the application specifics of augmented and virtual reality technologies to increase the level of visibility and interactivity in training;
- development of professional competencies of the students in the field of application of mobile applications, technologies of augmented and virtual reality in the educational process.

The course structure and contents are defined by the requirements to the baccalaureate degree course on the direction 44.03.01 «Pedagogical Education», the «Informatics and Information Technology in Education» profile.

The basic concepts of the course are the following:

- mobile technologies and tools in education;
- possibilities and peculiarities of application of augmented reality technology in the educational process;
- technologies and solutions for virtual reality
- systems of virtual reality;
- firmware to create augmented and virtual reality elements.

The total labor intensity of the course is 72 academic hours, of which 36 hours are audience classes.

Below are the course subjects and their annotations:

Subject 1. Use of mobile technology in modern education.

«Mobile training» concept, capabilities, and goals of the mobile training implementation. Characteristics, principles, and features of mobile learning. Mobile applications in the work of a modern teacher. The main issues and limitations of mobile learning technology. Analysis of mobile applications used in the educational process.

Practical work 1. Development of surveys and quizzes employing mobile applications.

Practical work 2. Create interactive learning games with mobile applications.

Practical work 3. Development of QR code and its use in the educational process.

Subject 2. Virtual (VR) and augmented (AR) reality technologies in the educational process.

The essence of virtual and augmented reality technologies, methods of their implementation, and fields of application. Operating principles and functionality of AR and VR applications. Classification and comparison of virtual and augmented reality systems. Analysis of the practical experience of using virtual and augmented reality systems in the educational process.

Subject 3. The technology of development of educational VR and AR applications.

Approaches to application development using virtual and augmented reality technologies. Overview and comparison of some existing software development kits (SDK) for

AR-applications. Comparative description of VR and AR content development tools in browsers.

Practical work 1. Develop augmented reality (AR) elements and use them in learning.

Practical work 2. Design educational VR content for use in the educational process.

Realization of the developed course «Application of mobile applications, technologies of augmented and virtual reality in the educational process» envisages the use of distance education technologies, which not only allow the application of innovative methods in training but also enable different categories of students to get equal access to educational materials and resources of the course.

Federal Law No. 273-ФЗ «On Education in the Russian Federation» defines the basic legal conditions that facilitate the implementation of educational programs using distance education technologies and e-learning [9]. This process concerns the solution to the current problem of modern education - the creation of unified information and educational space in the country.

To this end, various ICT tools are available to enable the educational organization to lay the groundwork for the creation of an e-learning environment, including various e-learning materials and tools, distance learning courses, etc. Among these tools are educational integration platforms with sufficiently powerful functionality to implement e-learning [8].

The correct selection of software for developing the distance training course is critical for the realization of all didactic capabilities and advantages of distance educational

technologies [10]. There are many software environments, shells, or platforms for creating a distance course. For example, such agents as ATutor, Claroline, Dokeos, LAMS, OLAT, OpenACS, Sakai, Moodle, etc.

When selecting the above development tools for e-learning, it is necessary to consider the following criteria:

- a set of functional capabilities providing independent interaction between the user and educational content;
- possibility of pedagogical and operational support, access to training results;
- modern online tools for control and assessment of learning;
- variety of the means of communication between the student and the teacher;
- software tools for the creation and management of educational resources;
- application of various types of educational content, etc.

Besides, the educational integration platform for e-learning should provide for timely changes and support new educational technologies, standards, and tools.

The analysis of the information formation of educational platforms has revealed the dynamics of their development: from the Learning Content Management System (LCMS) and the Learning Management System (LMS) to the personal learning environments (PLE) and virtual learning environments (VLE), which will not confine the student within the strict boundaries of the educational environment, but enable the individualization of the learning process by adapting the environment to a specific student [10].

By comparing LMS and LCMS systems, it can be seen that some allow the automation of administrative aspects of learning (LMS), and others focus on educational content development (LCMS). Besides, although the functionality of these systems is much the same, methods of solving some problems can be realized in various ways that are not always optimal.

After analyzing the various open-source LMS platforms, we conclude that in the Russian education system it is advisable to use the Modular Object-Oriented Dynamic Learning Environment (Moodle), as it features the modification following the GNU (General Public License) terms, thus facilitates the reduction of financial costs.

Moodle's dynamic learning environment, on the one hand, is an effective and affordable means of creating distance learning courses of various types, on the other hand, it enables an interactive interaction between the participants of the educational process.

Distance training courses developed using Moodle virtual learning environment enable you to authorize users, distribute powers, create an environment for hosting e-learning materials that support specific types of content, communicate environment users, analyze and store training results, interact with mobile users, etc.

However, note that, on the one hand, technically and methodologically, not all of the tools can be integrated into the distance learning course developed in LMS Moodle, and on the other hand, the tools can be supplemented with various means and services. For example, for e-learning, as an online service, that can be integrated into LMS Moodle with advanced functionality, there are available Google services, video services, webinars, online presentations, social networks, map intelligence, interactive online boards, etc.

The structure of the course «Application of mobile applications, technologies of augmented and virtual reality in the educational process» in the Moodle environment fully corresponds to the course program and includes theoretical material supplied by multimedia content, practical tasks allowing to master the technologies considered, self-facilitated tasks, loading of which is provided in the system for training control, example questions for self-control of knowledge and preparation for intermediate certification (see **Ошибка! Источник ссылки не найден.**).

Fig. 1. Homepage of the course

The end-of-course assessment involves the credit test and the final test assignment, directed to assess the degree of absorption of the learning material.

4 Diagnostic Procedure

The analysis of the results makes it possible to conclude the quality of learning of the studied material and the level of academic achievements of each student and group in general. The calculation of the average value of the group mastery of learning concerning the tasks of different complexity during intermediate control will allow the teacher to estimate the degree of the educational absorption of a particular learning section of the studied course, and to identify the sections that would reveal most challenging. This will substantially facilitate a timely correction of the educational process.

The difference between a particular value and an average one of the educational absorption rate, shown by students, is expressed through the dispersion, calculated by the following formula:

$$\bar{S}^2 = \frac{1}{n} \sum_{k=1}^n (x_k - \bar{x})^2 \quad (1)$$

Where x_k is a particular value, \bar{x} is an average value; n is the number of the students tested in the sample.

Table 1 shows average values of the absorption and the dispersion of three current samples and the reference ones that were taken during the course using distance-learning technology.

Table 1. Dynamics of the average values of the absorption and the dispersion

Intermediate test						Final test	
Sample 1		Sample 2		Sample 3		Absorption, k	Dispersion
Absorption, k	Dispersion	Absorption, k	Dispersion	Absorption, k	Dispersion		
0,74	0,19	0,85	1,90	0,98	0,60	0,98	0,15

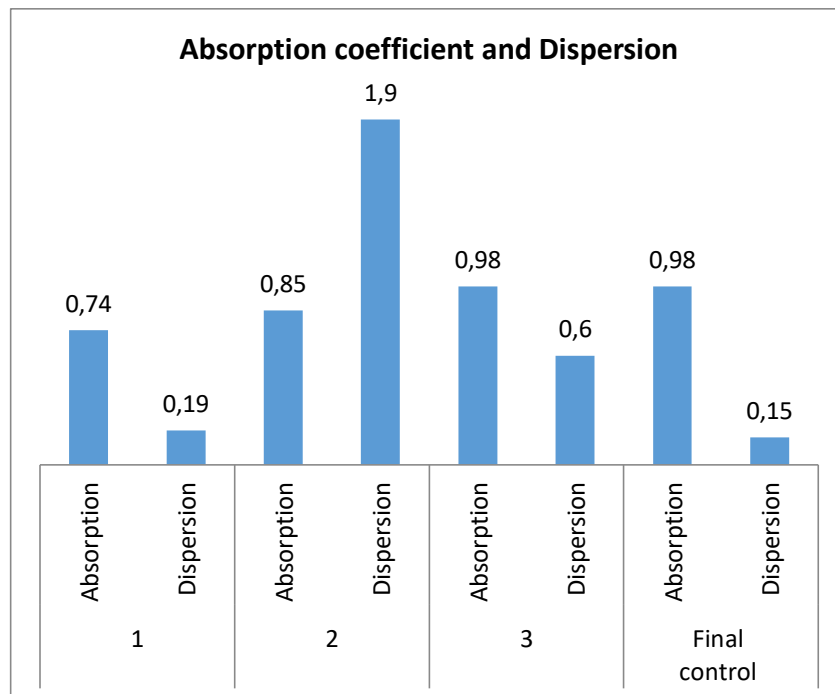


Fig. 2. Dynamics of average values of the absorption and the dispersion.

From the above data, it can be seen that the given course has resulted in positive dynamics of the educational absorption. The absorption reached its maximum value in the final test, whereas the dispersion initially grew, then decreased, and reached its minimum in the final test. The increase in the average absorption has indicated an improved learning activity of the students tested. However, this is a partial improvement, for an increase in dispersion indicates that not all of the students have been involved in the intense activity. Therefore, the teacher is to adjust the organization of methodological work, paying special attention to the students who showed a lowered involvement in their cognitive activity.

The increased average value of the absorption coefficient along with the decrease of dispersion on the final sample proves the effectiveness of the learning technology proposed.

5 Conclusions

The use of innovative technologies, such as mobile applications, AR and VR technologies in the educational activities, is stimulating to the individual activity of the students; it contributes to the development of students' interest in the learning material, develops the ability and needs for self-knowledge, thus resulting in a higher level of student independence and self-assessment.

The presented course «Application of mobile applications, technologies of augmented and virtual reality in the educational process» will make it possible to solve several basic problems, connected with the development of educational content, caused by a considerable increase in the volume of teaching material; it is updating, difficulties of the preparation of educational resources and expansion of the digital educational environment.

The new technological level of teachers' training presented, provides a new quality of education and simultaneously facilitates the personification and a significant intensification of the educational process, increasing students' motivation, and contributing to a more objective personal fulfillment of the students. Moreover, the above approach can significantly improve the quality of educational services provided, as well as contribute to the enhancement of professional competencies of future teachers.

The results obtained in the process of the training course have shown the improved absorption of the material learned and thus the effectiveness of the learning technology proposed.

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