The use of virtual reality technology in training transport industry specialists

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Abstract. The issue is relevant under consideration i due to the rapid development of virtual and augmented reality technologies (VR, AR), their active use in education and all engineering and technology areas which requires the development of competencies additional to those already existing in federal standards, which expand knowledge, skills and abilities of students by immersing them in the virtual reality mode. The results of the analysis of information on the use of virtual and augmented reality technologies in the educational process can be used in the development of VR / AR simulators for training transport industry specialists. The study developed a lesson based on the VR technology for logistics and transport management students and a lesson flow chart and modelled a scenario for VR space using 3D models and visualization. The study showed that it is necessary to use VR-technologies in training transport industry specialists to improve knowledge and skills in mastering disciplines related to the transport industry.

1 Introduction

Digitalization of science and education is an objective process characteristic of the world globalization process. Efficiency of implementation of digital technologies into the educational process determines the competitiveness of staff in the national and foreign markets, acquisition of new knowledge and skills, including in virtual reality. Advanced information technologies and innovations in the form of virtual reality (VR) are a new education paradigm.

Researchers claim that VR is a new ontology which immerses the individual in the information environment, which provides the possibility of performing actions with virtual objects [1]. It is important for students to have computer skills and for the educational system to use advanced technologies in the educational process. The issue of training highly qualified personnel considering global digitalization is acute. Each state strategic planning document involves the digital development of all sectors, and the education industry is no exception. "The Strategy for the Digital Transformation of Science and Higher Education Industry" was developed by the Ministry of Science and Higher Education as part of the Decree of the President of the Russian Federation dated July 21, 2020 No. 474 "On the national development goals for the period up to 2030". Digital maturity is the transformation of the industry, the achievement of a level of digitalization sufficient to integrate business processes. Within this document, various projects aimed at the digital transformation of the industry have been developed: development of digital services, modernization of educational programs, data management, and effective management of human resources [2]. The strategy clearly shows the intensive digitalization of the educational process with the integration of science into business. This is due to the projects listed in the digital transformation strategy for the science and higher education industry shown in Fig. 1.

These projects are aimed at improving the quality of data and systematizing work with it for its use in making managerial decisions. They contribute to the comprehensive approach to digital transformation in the industry, methodological and information support for science and higher education institutions in the implementation of the digital transformation strategy, the development of digital services in science and higher education, covering all types of business processes of educational institutions aimed at meeting the needs of all participants. The development of a single ecosystem of services for research and development is being implemented to improve their quality and availability, as well as to reduce the fixed and variable costs by creating the required infrastructure [3].

The use of digital technologies in the educational process is popular. One of their key applications in the educational process is augmented and virtual realities.

Augmented Reality (AR) is an incomplete immersion of in the virtual world, when additional information in the form of virtual objects is superimposed on the real picture of the world. Augmented reality can become a good assistant, both in everyday life and in professional activities.

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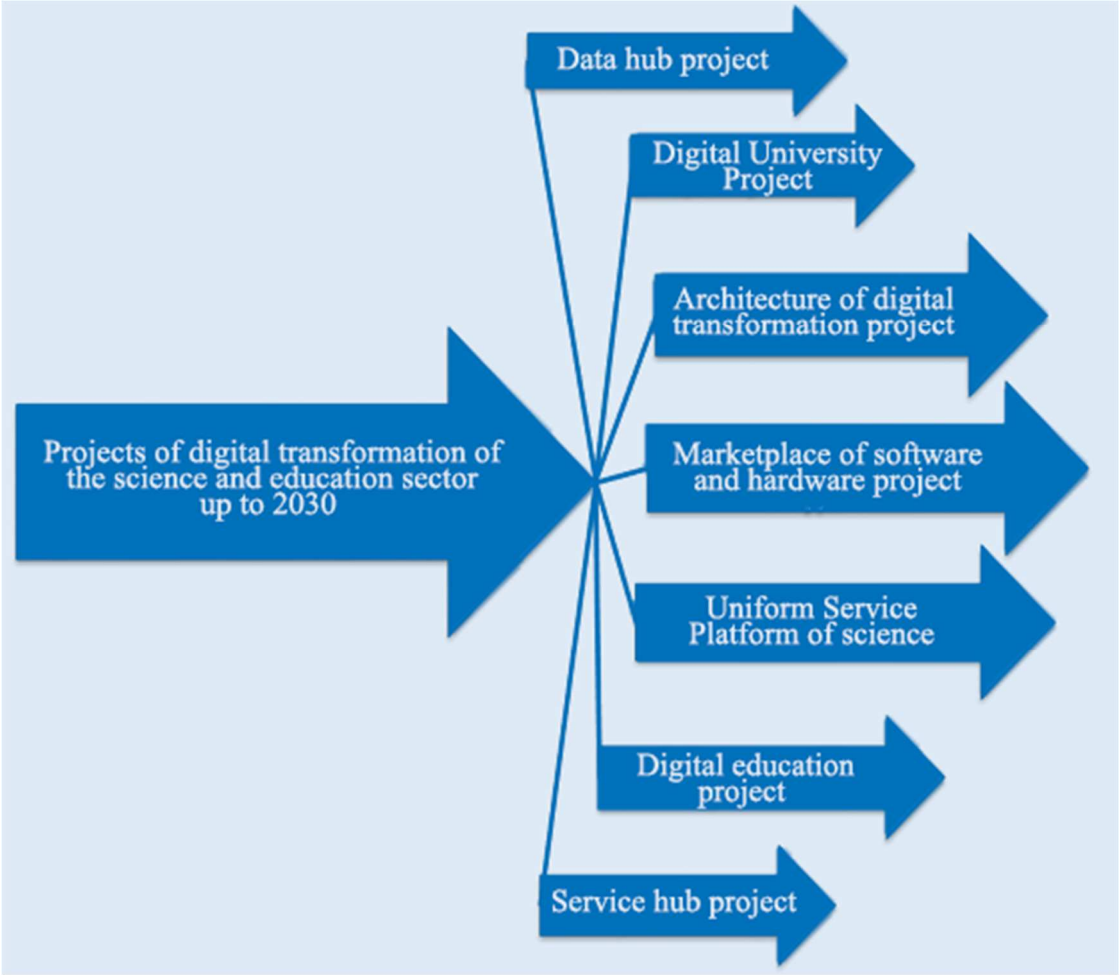

Fig. 1. Projects of digital transformation of the strategy (compiled by the author).

Virtual reality (VR) is an artificial world created by technical means interacting with humans through the senses. The use of virtual reality covers a whole range of tasks when creating realistic simulators for training specialists in areas where training on real objects is associated with unreasonably high risks or requires significant financial costs. Virtual reality technologies are indispensable in training rescuers, pilots, engineers, architects and other highly specialized specialists [4].

The immersion technology has been developed for a long time; foreign experience in using this technology by enterprises has revealed some obstacles, such as technological integration, data readiness, inability to define use cases, skills and general awareness of specialists.

Capgemini Research Institute, which is one of the largest in the world of consulting companies in the field of management and information technology, conducted a survey. More than 700 enterprises with knowledge of virtual and augmented reality technologies took part in the survey. 73% of organizations reported more than $1 billion in revenue in the fiscal year, with 600 organizations in the pilot phase of adopting these technologies. The survey makes virtual reality technologies even more relevant in educational activities, since it is virtual reality technologies that are a breakthrough step in the development of the economy, allowing for a more stable digital maturity of enterprises.

Educational VR is a separate field of application of digital technologies helping expand the amount of knowledge, based on reliable information, close to reality, potentially associated with other teaching methods, focused on teachers and students.

Teaching methods using educational VR differ from the traditional ones as they allow for modeling a complex visual-spatial-auditory environment, with many stimuli and make it possible to perform actions with virtual objects and objects that contribute to gaining complex experience. This means that the development of VR as an immersive interactive technology that is considered attractive by the student community can play an important supporting role in the learning process. The main advantages of using augmented (AR) and virtual reality (VR) are to immerse the student in the approximate reality of their professions, gaining access to situational, experiential learning, which is not possible in traditional classroom settings. For example, a non-profit company in the United Kingdom that provides network and IT services and digital resources to support institutions of additional and higher education and research in the public sector “Jisc” conducted a survey on the benefits of VR technologies in the educational process. The results of the survey are shown in Fig. 2.

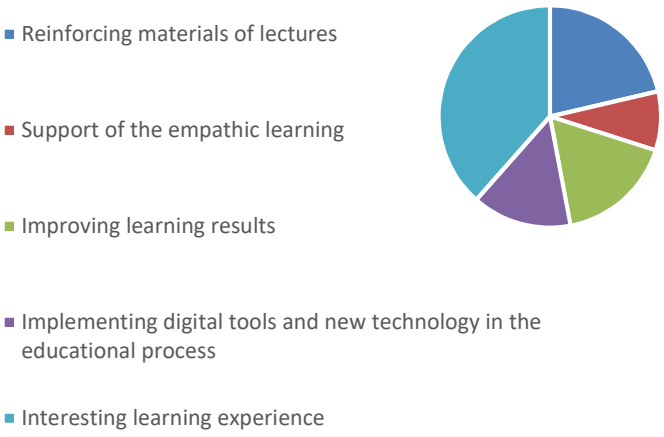

Fig. 2. Results of the survey "The benefits of VR technologies in the educational process" (compiled by the author).

Fig. 2 clearly shows the advantages of introducing virtual reality into the educational process. It is certainly an exciting learning experience, allowing for the consolidation of the material received in lectures, and the ability to immerse students in the digital environment of their future profession. VR technology in education can be presented in different specializations. Table 1 shows the areas of application.

Table 1. Applications of virtual reality in the educational process (compiled by the author).

Applications		
Labor protection and industrial safety	Actions in emergencies	Maintenance
SIZ, SKZ simulators, Virtual instructions	Training of PLA/PMLA	Virtual simulators of technological processes
Height work simulators	Training of PLA/PMLA	Virtual simulators of vehicle operations
Simulators for identifying dangerous factors	First aid	Virtual simulators of TOR

Figure 3 shows that virtual reality technology will improve the process of training specialists in the transport industry, both at the beginning of mastering a specialty and as an advanced training. This technique will allow students to work out practical skills by immersing themselves in an approximate reality, without a threat to life and health. For example, a digital twin of objects is taken in the format of a 3D model, loaded into the VR concept and a scenario for immersing the student in approximate reality is created; a case is created in the form of actions or searching for errors (e.g., the scenario "Rescue a drowning man"). It is possible to determine whether the future specialist will act correctly, what actions he will perform and to model possible causes of the sinking of the ship. VR technologies serve as an effective assistant in training specialists in shipbuilding, maintenance and repair of ships. The main task in training shipbuilding and ship repair specialists is to reduce the cost of project approval. The solution that VR technology provides is determined by discussing the model, demonstrating the ship and shipyard to customers, visualizing existing or developed 3D models, agreeing and checking the interior and exterior of the ship, identifying errors or inaccuracies at the design stage. The technology can reduce travel costs, the number of errors and their cost, time for project approval, and improve the quality of decision-making. VR technologies are also used in mechanical engineering.

2 Materials and Methods

The object of the study is the process of training specialists in the field of transport based on VR technologies. The subject is the use of VR technologies for the purpose of a more in-depth mastering of professional competencies in training of transport industry specialists. The author used the following research methods: analysis of the methodological foundations of professional activities of an educational organization, regulatory documents, scientific literature and other sources on the issues of implementation of virtual reality technologies. The general methodology included involved the use of theoretical research methods (analysis, synthesis, comparison). Scientific and technical information on the use of virtual technologies in the educational process was collected and analyzed. General information about VR/AR technologies was analyzed (history of creation, applications, elements and devices used to implement these technologies). The directions and methods of using virtual and augmented realities in the educational process were considered, examples of educational software and hardware systems used abroad, simulators and platforms for various areas of education were provided, and studies of the effectiveness of the use of these technologies in education were analyzed. Virtual technologies used to train specialists in the transport industry were explored.

3 Results and Discussion

VR technologies in mechanical engineering have the following advantages: quick coordination of tactical and technical characteristics, reduction of time for designing new locomotives, scaling of technologies to other divisions of the enterprise.

Based on the above examples of the used of VR technologies, a number of tasks can be set:

- Large expenditures of time and resources for the coordination of projects;
- High cost of mistakes made at the design stage;
- High cost of creating layouts and inability to see various configurations;
- Complex assessment of the ergonomics and ease of maintenance of a project that has not yet been implemented;
- Due to the lack of practical experience, specialists get injured and damage expensive equipment.

To implement VR lessons, you need a script that is created from ready-made or created 3D models such as TinkerCAD, 3Dtin, 3DSlash, 123DCatch, Sculptris, SketchUp, Blender 3D, FreeCAD, OpenSCAD. The 3D model is a digital twin of an object that is planned to be studied or due to which a virtual reality simulator is created for the purpose of training employees or students.

It is the digital twins of parts or structures that serve as a tool for creating virtual reality, including BIM modeling, which is being implemented in the construction of transport infrastructure facilities together with AR and VR technologies. It is an excellent solution to many problems at all stages of the life cycle.

The introduction of AR and VR technologies is a new step in improving production, deepening knowledge, saving on costs in design, construction, operation and reconstruction. In this regard, the use of virtual and augmented reality technologies in the educational process is becoming even more relevant.

Metrics of the effectiveness of these technologies:

- VR can increase test results by 28.5%, the number of positive emotions, the level of involvement in VR-learning (Source: “Learning in virtual rality: Effects on performance, emotion and and engagement”);
- 72% of students prefer learning in VR (Source: Declarative knowledge acquisition in immersive virtual learning environments article);
- 80% of students using VR confirm that they like this format, and it has significantly improved their knowledge. (Source: Loughborough University);
- Student retention (i.e., a person is ready to return to this learning on their own initiative) - 75% (Source: MASIEReport 2017).

The article will describe authorial experience in developing a VR lesson for students of secondary vocational and higher education (this technology can also be applied in advanced training courses for transport industry workers). The Digitalization of Education program at the VR Concept Academy provided the author with a unique opportunity to gain a positive experience in creating a lesson for logistics students and to develop a technological map of the lesson which contains the following elements: goals and objectives of the lesson, a scenario for VR space.

A description of the VR space was presented (3D models), technical equipment of the lesson was proposed, and an expected effect from the use of VR technologies in the educational program was determined. The VR project is a practical exercise that involves the development of professional competencies by immersing the student in virtual reality. For this purpose, the author created a lesson scenario in virtual reality, presented a 3D model of a working sea berth (area), a cargo ship, containers and other types of cargo, as well as models of cargo grips. This scenario allows you to visually immerse the student in the activities related to loading operations.

A distinctive feature of this practical lesson in VR space is the mistakes intentionally made by the author on cargo and cargo grips, which should be detected by students while in virtual reality, which will demonstrate their professional competencies.

The technical equipment of the lesson is computers and helmets for immersion in the VR space.

4 Conclusion

According to the current legislation, graduates of secondary vocational education should be certified during the demonstration exam (Federal Law of December 29, 2012 N 273-FZ “On Education in the Russian Federation”; Federal State Educational Standards of

Secondary Education; Order of the Ministry of Education and Science of Russia of June 14, 2013 N 464 (as amended by 08/28/2020) "On approval of the Procedure for organizing and implementing educational activities in educational programs of secondary vocational education", the regulation of the Agency for the Development of Professional Communities and Workforce "Young Professionals"). The cost of certification of one workplace under the program of specialties of SPO for conducting a demonstration exam is more than 3 million rubles. The VR-project can serve as an excellent tool for the certification in the form of a demonstration exam.

The article described the expected positive effect from the use of VR technologies in educational activities:

- exciting and engaging learning experience – 100%;
- improvement of learning outcomes – 80%;
- involvement in educational activities –100%;
- safety – 80%;
- attention – 90%;
- interest in learning the profession – 100%;
- development of thinking – 100%;
- development of spatial imagination – 100%;
- reinforcing lecture materials in practical VR lessons – 100%;
- development of analyzing qualities – 100%;
- increasing the level of residual knowledge – 100%;
- increasing the coefficient of knowledge quality – 90%.

The economic feasibility of the project is:

- saving space on equipping the class (by means of visual aids and teaching supplies, replacing space with computer equipment);
- savings on licensing the platform for the demonstration exam;
- attractiveness of the educational institution: the use of innovative VR technologies in the educational process will positively affect the subsequent recruitment of applicants;
- the ability to use this technology in advanced training courses for specialists in the transport industry;
- the ability to use this technology to create drawings in shipbuilding;
- expansion of scientific and technical potential;
- optimal integration of VR technologies in the educational process and advanced training of teachers;
- creation of an innovative model of education;
- involvement of all participants in the learning process (improvement of labor productivity);
- when using AR instead of VR technologies, the effectiveness of the learning process decreases due to the specifics of AR helmets;
- improvement of the methodology of educational processes;
- reduced complexity of the process of mastering the educational course related to the visual representation of information received;
- improvement of indicators of educational activities due to the expanded functionality.

Thus, the use of virtual reality in educational activities is a big step into the digital future.

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