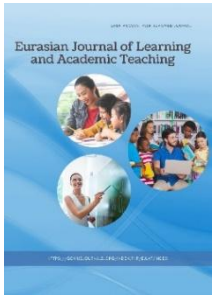

The Impact Of Digital Educational Resources On The Training Of Future Specialists In The Transport Sector Of Uzbekistan

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ABSTRACT

This paper presents the author's concept of the systematic integration of digital educational resources into the training process of specialists in the transport sector of the Republic of Uzbekistan. Digitalization is considered not as an auxiliary tool, but as a key factor in the formation of a holistic digital professional environment that transforms the structure of competency-based training. A multi-level model has been developed, including institutional, methodological, technological, and evaluative-reflective components.

An experimental study using statistical methods confirmed a significant increase in the level of professional competencies and the formation of a stable digital professional identity among students.

Keywords: Digital educational environment, transport education, digital integration, professional competencies, digital maturity.

Introduction

The current stage of economic development is characterized by the active implementation of digital technologies, which affect all sectors, including the transport industry. Under these conditions, there is an increasing need to modernize the system of professional education, focusing on training specialists capable of effectively operating in a digital environment.

Training personnel for the transport sector involves the formation not only of theoretical knowledge but also of practical skills in working with digital control systems, logistics platforms, analytical tools, and monitoring systems.

Digital educational resources are a key element of the modern educational environment. Their use ensures flexibility in learning, expands access to information, and enables the simulation of real professional situations.

Digital resources include electronic learning materials, online platforms, virtual laboratories, simulators, learning management systems, and specialized software complexes. Their application is based on the principles of interactivity, adaptability, accessibility, practical orientation, and integration with professional activities.

The transport sector of Uzbekistan is developing under conditions of digital transformation, which requires the advanced training of specialists with modern competencies. The transport industry places increased demands on the professional competence of workers. Future specialists must possess:

- skills in managing transport systems;
- knowledge of the regulatory and legal framework;
- abilities to analyze transport flows;
- competencies in digital monitoring and logistics systems.

The use of digital resources makes it possible to bring the educational process closer to real professional conditions.

The impact of digital educational resources on the formation of professional competencies:

1. Development of practical skills. Simulation technologies and virtual simulators make it possible to model emergency situations, logistics schemes, and transport flow management without risks to safety.
2. Increasing student motivation. Interactive forms of learning promote active student engagement in the educational process, as well as the development of independence and critical thinking.
3. Individualization of learning. Digital platforms allow for consideration of each student's level of preparation and the creation of personalized learning trajectories.

An analysis of existing approaches shows that the implementation of digital technologies is often superficial and limited to replacing traditional materials with electronic equivalents. Such an approach does not ensure qualitative changes in the structure of specialist training. In this regard, there is a need to develop a systematic model of digital integration aimed at transforming the educational process.

Within the framework of this study, the concept of a digital professional ecosystem is proposed, representing an integrated educational environment that combines digital resources, modeling technologies, analytical tools, and management mechanisms.

The ecosystem includes:

1. Institutional level — regulatory and strategic support for digitalization.
2. Methodological level — digital design of academic disciplines.
3. Technological level — simulators, digital twins, analytical platforms.
4. Reflective level — digital monitoring and personalized feedback.

International Comparative Analysis. The study is based on an analysis of practices implemented by universities included in the QS and THE Top-1000 international rankings. At the Massachusetts Institute of Technology (USA), the concept of integrating digital transport simulators into the structure of engineering programs is implemented. At Delft University of Technology (Netherlands), a model of digital twins of infrastructure is applied. At the Technical University of Munich (Germany), digital logistics laboratories using real data sets are employed. At the National University of Singapore, analytical platforms for forecasting transport flows have been introduced.

The analysis shows that successful practices are characterized by a systematic approach to digital integration and a focus on modeling a real professional environment.

Materials And Methods Of The Study

This study is comprehensive in nature and includes:

1. a theoretical and literature review of international and national scientific sources;
2. a comparative analysis of educational practices of foreign universities;
3. a pedagogical experiment;
4. quantitative and statistical processing of empirical data.

The selection of sources was carried out according to the following criteria:

- publications in journals indexed in Scopus and Web of Science;
- proceedings of international conferences on transport and engineering education;
- studies conducted by universities included in the QS and THE Top-1000 rankings;
- regulatory documents of the Republic of Uzbekistan.

As part of the review stage, the following educational practices were examined:

- engineering programs with digital laboratories;
- courses on intelligent transport systems;
- programs using digital twins of infrastructure;
- educational platforms applying big data analytics.

The analysis made it possible to identify four устойчивых (stable) directions of digital transformation:

1. integration of simulators into the structure of academic disciplines;

2. use of digital twins of transport facilities;
3. implementation of analytical data processing platforms;
4. digital monitoring of competencies.

The obtained results formed the basis for the development of the author's model of a digital professional ecosystem. The study was conducted in the format of an experiment with control and experimental groups.

Research Methods. The following methods were used:

- pedagogical experiment;
- testing;
- case analysis;
- surveys;
- quantitative and statistical data processing.

Digital Maturity Index (DMI). The study applied a Digital Maturity Index of the educational program developed by the author:

$$IDZ = \frac{I + M + T + R}{4}$$

где:
I — institutional component;
M — methodological component;
T — technological component;
R — reflective component.

Statistical Methods of Data Processing. The following methods were used for data analysis: calculation of the mean value, standard deviation, Student's *t*-test, and Pearson's correlation coefficient.

1. Calculation of the Arithmetic Mean. The arithmetic mean was calculated using the formula:

$$\mathrm{M} = \frac{\sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{x_i}}{\mathrm{n}}$$

where:
M — mean value of the indicator;
x_i — individual values;
n — sample size.

2. Calculation of the Standard Deviation

$$SD = \sqrt{\frac{\sum(x_i - M)^2}{n-1}}$$

where:
SD — standard deviation;
M — mean value;
n — number of observations.

3. Student's *t*-test for Independent Samples. To assess the statistical significance of differences between the experimental and control groups, the following formula was used:

$$t = \frac{M_1 + M_2}{\sqrt{\frac{SD_1^2}{n_1} + \frac{SD_2^2}{n_2}}}$$

where:
M_1, M_2 — mean values of the compared groups;
SD_1, SD_2 — standard deviations;
n_1, n_2 — sample sizes of the groups.

4. Pearson's Correlation Coefficient. To determine the relationship between the level of digital integration and the indicators of competency formation, the following formula was used:

$$r = \frac{\sum(x - \bar{x}) \cdot (y - \bar{y})}{\sqrt{\sum(x - \bar{x})^2 \cdot \sum(y - \bar{y})^2}}$$

where:
r — correlation coefficient;
x — indicator of the level of digital integration;
y — indicator of competency formation.

Interpretation of the coefficient:

- 0–0.3 — weak correlation
- 0.3–0.7 — moderate correlation
- 0.7–1.0 — strong correlation

The study obtained a value of r = 0.62, which indicates a moderate positive correlation.

Calculation of the Integral Competency Indicator. The integral indicator of professional competence (ICI) was defined as the arithmetic mean of four components:

$$IPK = \frac{K_{cog} + K_{oper} + K_{anal} + K_{ref}}{4}$$

where:
K_{cog} — cognitive component;
K_{oper} — operational component;
K_{anal} — analytical component;
K_{ref} — reflective component.

Internal consistency of the diagnostic methods was assessed using Cronbach's α coefficient:

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum S_i^2}{S_t^2}\right)$$

where:
k — number of scales;
S_i^2 — variance of each scale;
S_t^2 — total variance of the test.

The obtained value α = 0.81 indicates a high reliability of the instrument.

Results And Discussion

The initial diagnostics showed no statistically significant differences between the experimental and control groups across all components of professional competence ($p > 0.05$).

The integral indicator of professional competence (ICI) was:

- Experimental group — 68.4 ± 5.2 points
- Control group — 67.9 ± 5.6 points

The comparability of the groups ensured the validity of the subsequent analysis of the effectiveness of the implemented model. After the implementation of the systematic digital integration model in the experimental group, the following changes were recorded:

Component	Before the Experiment	After the Experiment	Increase
Cognitive	69.1	76.7	+11%
Operational	66.4	78.3	+18%
Analytical	67.8	77.3	+14%
Reflective	70.2	81.4	+16%
Integral Indicator	68.4	80.1	+17%

Results And Discussion

International studies demonstrate that digitalization has the greatest effect when:
– simulation platforms are used;
– digital twins are implemented;
– digital monitoring of competencies is applied.
The results of this study confirm these findings and demonstrate the possibility of adapting international models to the conditions of Uzbekistan.

The analysis of the dynamics of indicators allows us to conclude that digital integration:

1. enhances the operational component of training through the simulation of professional situations;
2. activates analytical thinking through working with digital data;
3. forms reflective mechanisms of self-control;
4. reduces the gap between the educational and professional environments.

Thus, the digital educational environment performs the function of a structure-forming element in training. The obtained data confirm the proposed concept of a digital professional ecosystem.

Digital integration has a systemic impact, affecting:

- the content of education;
- teaching methods;
- forms of assessment;
- professional socialization of students.

Limitations and Prospects. Despite the positive results obtained, the following should be taken into account:

- the limited duration of the experiment;
- the need to scale the study;
- the lack of long-term monitoring of graduates' professional adaptation.

Prospects for further research are associated with the development of a national digital platform for transport education and the expansion of the sample to the interuniversity level.

Conclusions

The conducted theoretical and methodological study makes it possible to formulate the following scientifically grounded conclusions:

1. Digitalization of transport education requires a systemic approach. It has been established that the fragmented implementation of digital educational resources does not ensure a qualitative transformation of professional training. Effectiveness is achieved only through the systematic integration of digital technologies into the structure of educational programs, covering content, teaching methods, assessment forms, and mechanisms of professional socialization.
2. The concept of a digital professional ecosystem has been developed and scientifically substantiated. For the first time, in the context of transport education in the Republic of Uzbekistan, a concept of a digital professional ecosystem has been proposed, including institutional, methodological, technological, and reflective levels.

3. Digital integration enhances the practice-oriented nature of training. The introduction of simulation technologies, digital cases, and elements of digital twins of transport processes contributes to:
   - reducing the gap between the educational and professional environments;
   - developing decision-making skills under conditions of uncertainty;
   - fostering analytical and algorithmic thinking.
4. International experience confirms the universality of the systemic model. A comparative analysis of practices in universities included in the Top-1000 international rankings has shown that a sustainable effect of digitalization is achieved through the integration of digital laboratories, simulation platforms, and analytical tools into the structure of educational programs. The proposed model demonstrates adaptability to the national conditions of Uzbekistan.
5. Scientific significance of the study. The research expands theoretical understanding of the mechanisms of digital transformation in sectoral education and contributes to the development of:
   - structural and functional analysis of professional training;
   - the theory of digital professional identity;
   - methodology for assessing the digital maturity of educational systems.
6. Practical significance. The obtained results can be used:
   - in the development of educational standards in the transport field;
   - in the creation of a national digital platform for transport education;
   - in professional development systems for teaching staff;
   - in shaping strategies for the digital modernization of universities in the Republic of Uzbekistan.

Systematic integration of digital educational resources serves as a strategic mechanism for modernizing the training of transport sector specialists in Uzbekistan. The formation of a digital professional ecosystem ensures a qualitative transformation of the competence structure, increases graduates' adaptability to the conditions of the digital economy, and creates prerequisites for the sustainable development of the transport industry.

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