

4.5. ARTIFICIAL INTELLIGENCE TECHNOLOGIES IN ENSURING THE QUALITY OF PROFESSIONAL TRAINING FOR SPECIALISTS IN THE MOTOR TRANSPORT INDUSTRY

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The digital transformation of industry and transport infrastructure is reshaping the requirements for training specialists in the automotive sector. Ensuring the quality of vocational education in this field requires innovative tools that support adaptive learning, monitor skill acquisition, and improve training efficiency. Artificial intelligence technologies enhance quality assurance by enabling data-informed decision-making, personalized learning pathways, and continuous performance assessment. This study explores the potential of AI-driven solutions to improve the professional training of automotive transport specialists. Particular attention is given to intelligent learning systems, predictive analytics, automated assessment tools, and digital simulators that support the development of technical competencies and operational safety skills. AI-based monitoring allows educators to identify learning gaps, track progress in real time, and provide timely feedback, thereby increasing training effectiveness and reducing the risk of professional errors. The paper also highlights organizational and pedagogical conditions necessary for successful AI integration, including teacher digital competence, infrastructure readiness, and ethical considerations related to data protection and algorithmic transparency. The findings indicate that AI technologies contribute to improved training quality, better alignment with labor market demands, and strengthened safety-oriented professional behavior.

Keywords: artificial intelligence (AI), vocational education, automotive transport training, quality assurance, adaptive learning, predictive analytics

The digitalization of motor transport infrastructure and service processes drives a shift from fragmented quality control of workforce training to integrated solutions in which educational data, practical performance results, and production indicators are combined into a single monitoring framework. In this context, ensuring the quality of professional training for specialists in the motor transport sector becomes particularly important under martial law, when requirements for logistics reliability, transport safety, and the speed of restoring transport capacity increase, while the educational environment often operates in blended formats and under pressure from resource constraints.

The implementation of a data-informed management approach in the training of specialists for the motor transport sector involves the systematic use of learning analytics and algorithmic data processing to enable timely tracking of learners' progress,

identification of risks of lagging in competency development, and support for managerial decision-making based on evidential indicators (Ifenthaler & Yau, 2020, pp. 1964–1968, 1974–1976). The practical impact of this approach lies in the transition from formalized reporting to quality management as a continuous process, in which learning outcomes serve as the basis for refining program content, configuring practical training, and adjusting professional development trajectories.

Contemporary scholarly discourse in the field of educational technologies demonstrates a shift in emphasis toward the intellectualization of learning and the development of intelligent learning systems as tools for personalizing and adapting educational scenarios to individual learning dynamics (Roll & Wylie, 2016, pp. 584–588, 592–594). This is particularly relevant for the motor transport sector, as the technological complexity of modern vehicles and service equipment increases the importance of practice-oriented learning models, simulators, and guided skills training, where errors in real-world environments carry a high risk threshold.

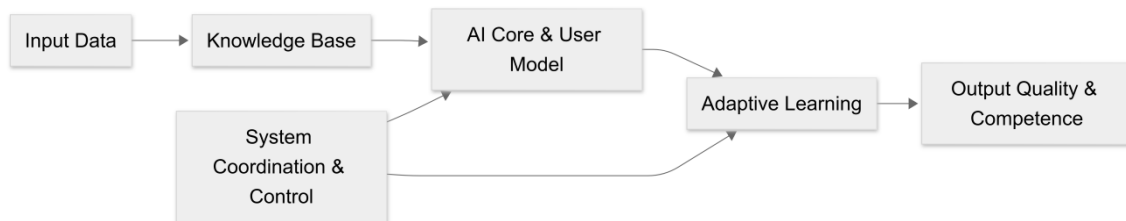
A significant analytical tool for supporting such decisions is learning analytics, understood as the systematic collection, processing, and interpretation of educational data aimed at improving learning effectiveness and enhancing pedagogical interventions. Studies focusing on the state and evidence base of learning analytics applications highlight the potential of analytical dashboards and predictive models for the early identification of problem areas in learning and for informed managerial decision-making at the institutional level (Viberg et al., 2018, pp. 100–104). In the context of training motor transport specialists, this approach can support quality control of diagnostic operations, the sequencing of technological procedures, and the stability of acquired safety-related skills, reinforced by timely and meaningful feedback as a key factor in learning progress (Hattie & Timperley, 2007, pp. 81–86, 90–93).

A distinct strand of contemporary research is associated with the use of artificial intelligence to transform mechanisms for ensuring educational quality, within which attention is focused on the shift from predominantly expert-driven and subjective assessment procedures to the systematic use of educational data and evidence-based foundations in managerial decision-making (Luckin et al., 2016, pp. 14–18). This approach involves the integration of analytical tools, adaptive educational technologies, and mechanisms for supporting pedagogical activity into a unified logic of operation of the digital learning environment.

Based on contemporary approaches to the application of artificial intelligence in education (Luckin et al., 2016, pp. 26–28), the interaction of analytical, adaptive, and managerial components of an AI-supported learning environment is synthesized and presented in Figure 4.1. The proposed model illustrates the interrelationships among sources of educational data, mechanisms for their algorithmic processing, and adaptive

learning tools, which together form a continuous loop for monitoring and improving the quality of professional training of motor transport specialists.

Figure 4.1. Conceptual model of AI-supported quality assurance in automotive vocational training



The presented model reflects the interrelationship between sources of educational data, artificial intelligence–driven analytical mechanisms, and adaptive learning tools that ensure continuous monitoring of the quality of specialist training. At the same time, systematic reviews emphasize that technological solutions must be pedagogically “embedded” in practice rather than exist as external, add-on instruments (Zawacki-Richter et al., 2019, pp. 8–11). For the motor transport sector, this means that AI tools should reinforce authentic pedagogical tasks, including the development of technological discipline, the cultivation of diagnostic culture, increased accuracy in the performance of operations, the standardization of assessment criteria, and support for learning in blended environments, including distance components. In the broader context, the design of digital learning spaces oriented toward adaptability and digital integration is viewed as a foundation for the development of new pedagogical models that align technology, content, and practical training (Gros et al., 2016, pp. 3–7, 21–24).

In this context, the current stage of development of educational technologies is characterized by the active penetration of artificial intelligence tools into various areas of professional training. Whereas in the early stages of digitalization learning management systems and electronic resources predominated, a transition is now taking place toward intelligent learning environments capable of analyzing educational data, adapting learning content, and supporting individualized professional development trajectories. These changes are driven by the need to increase learning effectiveness, ensure flexibility, and align education with the requirements of high-technology production.

Within scholarly discourse, artificial intelligence is viewed as a tool for supporting pedagogical and managerial decision-making based on the analysis of educational data and the prediction of learning outcomes. Machine learning algorithms make it possible to identify patterns in learners’ educational activities, to detect difficulties in mastering content in a timely manner, and to generate personalized recommendations for further learning. In this context, learning analytics emerges as an effective means of enhancing

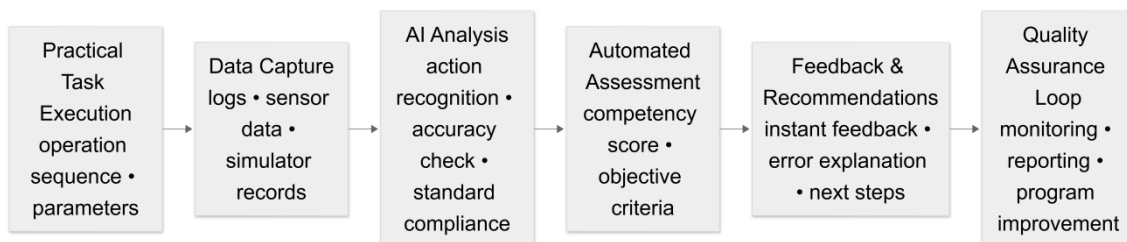
the effectiveness of the educational process and providing a rationale for pedagogical interventions.

One of the promising areas of artificial intelligence application is the development of adaptive learning systems capable of adjusting the complexity and sequence of learning materials in accordance with the learner's level of preparation. Such systems replicate the functions of individualized mentor support, provide immediate feedback, and contribute to the formation of sustainable professional skills. In vocational education, this is of particular importance, as it makes it possible to account for varying levels of learners' preparedness and differences in the pace of mastering technological operations.

Intelligent training systems and simulation environments play an important role by modeling production processes and providing opportunities to practice practical skills in safe conditions. The use of digital simulators enables the replication of complex production scenarios that are impossible or unsafe to model in real environments and fosters the development of algorithmic thinking, accuracy of actions, and professional responsibility. Research indicates that the application of simulation technologies enhances the acquisition of practical skills and reduces the adaptation period for specialists entering professional practice.

Artificial intelligence is also applied in the automated assessment of learning outcomes, ensuring objectivity and timeliness in evaluating competency development. Algorithmic systems can analyze the performance of practical tasks, record the sequence of operations, assess the accuracy of actions and compliance with technological standards, thereby contributing to the creation of a transparent evaluation system and increasing trust in the results of the educational process. A generalized structure of AI-supported automated assessment is presented in Figure 4.2.

Figure 4.2. AI-based automated assessment of learning outcomes



The structure presented in Figure 4.2 illustrates the sequence of data collection on the performance of practical operations, their algorithmic analysis, and the generation of objective assessment indicators. Recording task performance parameters, logging the sequence of technological actions, and verifying their compliance with established standards enable a comprehensive evaluation of professional competencies in real time.

The algorithmic processing of such data ensures not only the accuracy and impartiality of assessment but also the timely provision of feedback, which facilitates the correction of errors and the improvement of practical skills. As a result, a transparent system for monitoring the quality of learning is established, trust in the outcomes of the educational process is increased, and the foundation is laid for the continuous refinement of professional training programs in accordance with industry technological standards.

At the same time, the effectiveness of artificial intelligence technologies in vocational education is determined not only by the technical capabilities of the systems but, above all, by the pedagogical appropriateness of their integration. AI does not replace the instructor; rather, it expands their professional capabilities by providing tools for analyzing learning progress, individualizing instruction, and supporting learners in the development of professional competencies. It is precisely the combination of technological innovation and pedagogical expertise that creates the conditions for improving the quality of professional training in the context of the digital transformation of education.

The professional training of specialists in the motor transport sector is characterized by a high level of technological complexity and the multi-component nature of production processes. Modern vehicles are integrated technical systems that combine mechanical, electronic, computerized, and sensor subsystems, as well as digital control and monitoring systems (Bosch, 2022). This necessitates the development in future specialists of systemic technical thinking, the ability to work with digital diagnostic complexes, and an understanding of the principles of electronic control system operation.

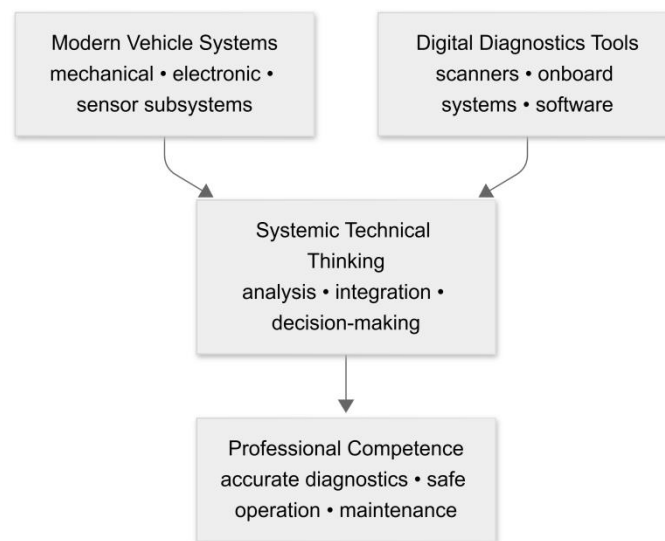
The increasing technological complexity of modern vehicles and the widespread use of digital diagnostic systems are changing the requirements for professional training of specialists in the motor transport sector. Effective performance of diagnostic, service, and operational tasks requires not only knowledge of individual technical components but also the ability to integrate information from mechanical, electronic, and sensor subsystems into a unified system of technical analysis. Under such conditions, the development of systemic technical thinking becomes particularly important, enabling analytical understanding of technical processes, the making of informed decisions, and adherence to safe professional practice procedures.

The use of digital diagnostic tools – such as electronic scanners, onboard computer systems, and specialized software – facilitates a shift from intuitive fault detection to evidence-based diagnostics grounded in data analysis. This, in turn, improves the

accuracy of technical decisions, the efficiency of maintenance, and the safety of vehicle operation.

The generalized interrelationship between the technological complexity of transport systems, the use of digital diagnostic tools, and the development of professional competence in motor transport specialists is presented in Figure 4.3.

Figure 4.3. Development of systemic technical thinking and professional competence in automotive specialists in the context of digital diagnostics.



A significant aspect of professional training is the safety component, as work in the motor transport sector is directly associated with risks to human life and health. Developing safety-oriented professional behavior involves mastering vehicle operation standards, maintenance procedures, action algorithms in critical situations, and compliance with occupational health and safety requirements. In this context, the accuracy of performing technological operations and accountability for outcomes becomes crucial, as errors in technical maintenance can lead to serious operational risks (International Labour Organization, 2020).

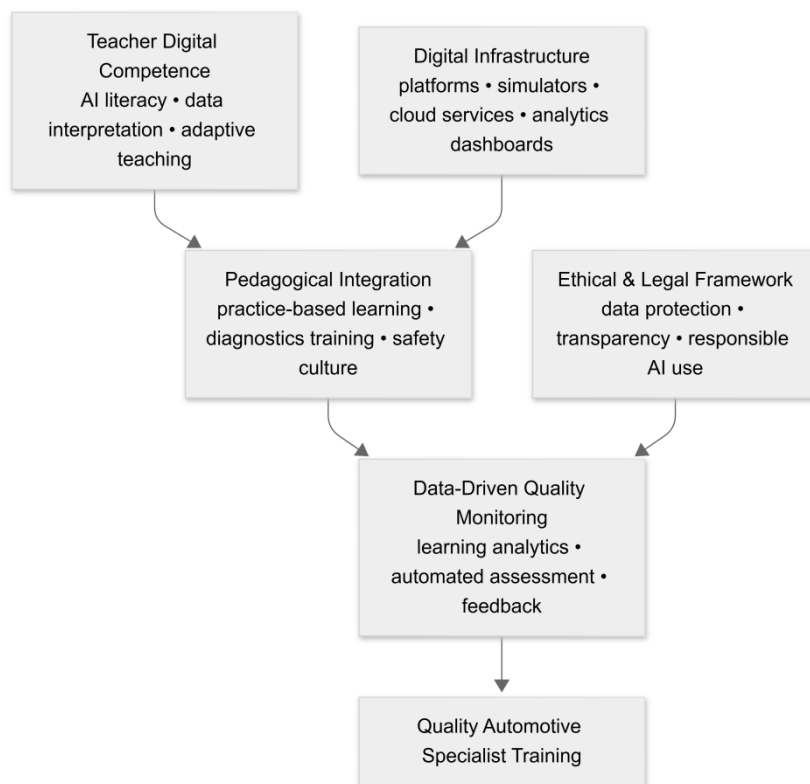
Equally important is diagnostic activity, which involves the use of electronic scanners, onboard computer systems, sensor modules, and specialized software for fault detection. Modern technical diagnostic technologies require specialists to be able to interpret digital data, analyze the operating parameters of components, and make informed decisions regarding maintenance and repair, in line with the development trends of intelligent transportation systems and digital diagnostics (Sussman, 2014).

The service component of professional activity is also undergoing significant transformation under the influence of the digitalization of transport infrastructure. High standards of service, the integration of information systems for managing service processes, and the use of electronic technical information databases require specialists to possess communication competence, client-oriented skills, and the ability to operate effectively in a digital service environment.

Thus, the nature of professional activity in the motor transport sector necessitates the integration of technical training, safety culture, diagnostic competence, and service orientation. This multidimensionality of professional requirements underscores the need to implement innovative educational approaches capable of ensuring high-quality training of specialists in accordance with contemporary technological and production standards.

To present the organizational and pedagogical conditions for implementing artificial intelligence technologies in a clear and concise manner, it is advisable to summarize them in the form of a structural model that illustrates the interaction of pedagogical, technological, and managerial components of the learning environment (Figure 4.4).

Figure 4.4. Organizational and pedagogical conditions for implementing AI technologies in quality assurance of automotive vocational training.



The presented model illustrates the interrelationship between instructors' professional readiness, digital infrastructure, and the pedagogical integration of intelligent technologies into the learning process. The use of learning analytics and automated assessment ensures continuous monitoring of learning outcomes, while ethical and legal principles guarantee the responsible use of data. The alignment of these conditions provides a foundation for improving the quality of specialist training and enables the adaptation of the educational process to the requirements of a digitalized motor transport sector.

Despite the significant potential of artificial intelligence technologies in ensuring the quality of professional training for specialists in the motor transport sector, their implementation is accompanied by a range of challenges and limitations of a technological, pedagogical, organizational, and ethical nature.

The integration of intelligent systems into vocational education occurs amid uneven digital readiness of educational institutions, limited funding, and the need to update material and technical resources. At the same time, the use of algorithmic solutions in assessment and monitoring of learning outcomes requires ensuring transparency, protecting personal data, and preventing algorithmic bias.

A significant challenge remains the level of digital readiness among teaching staff. Insufficient experience in using educational data analytics and AI tools may limit their pedagogical potential and lead to the formal application of technologies without integration into didactic practice. Moreover, there is a risk of excessive technologization of learning, where digital solutions replace pedagogical interaction, potentially reducing learner motivation and weakening the development of professional responsibility.

An important aspect is the technical limitations related to data quality, software system compatibility, and the stability of digital infrastructure. Incomplete or incorrect data can affect the accuracy of analytical conclusions, necessitating the combination of algorithmic solutions with expert pedagogical evaluation. In the context of professional training for the motor transport sector, this is particularly significant, as errors in assessing the development of practical skills may have safety implications.

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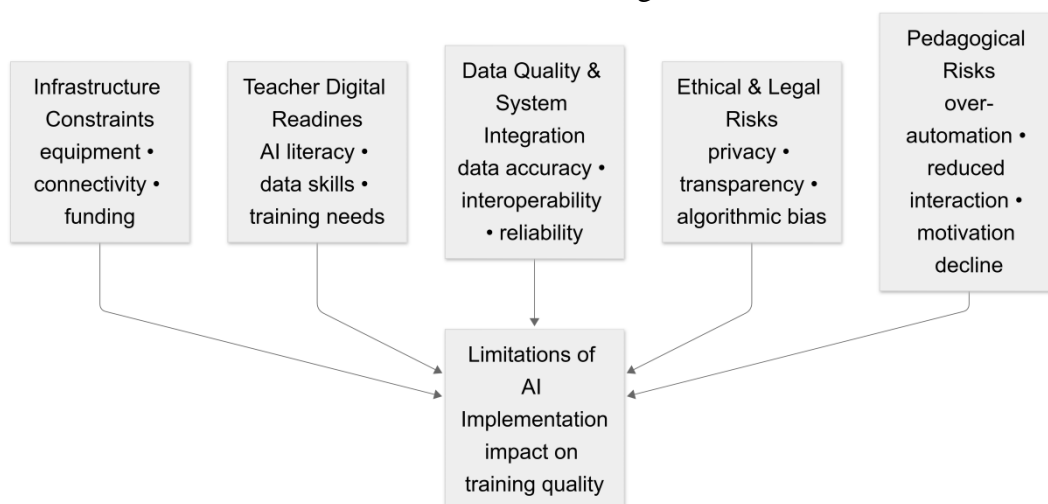
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Figure 4.5. Challenges and limitations of implementing AI technologies in automotive vocational training



The presented diagram summarizes the main factors that may limit the effective use of artificial intelligence technologies in vocational education. Infrastructure constraints, the digital readiness of instructors, data quality, and system compatibility affect the efficiency of analytical processes and adaptive learning. At the same time, ethical risks and pedagogical challenges require a responsible and balanced approach to

the implementation of AI tools. Considering these factors helps minimize risks and ensures the appropriate use of intelligent technologies to enhance the quality of professional training.

The synthesis of research findings indicates that the digital transformation of the motor transport sector is significantly changing the requirements for the quality of professional training of specialists. The technological complexity of modern vehicles, the widespread use of digital diagnostics, and heightened demands for safety and service interaction create a need for the development of systemic technical thinking, diagnostic culture, and responsible professional behavior.

The application of artificial intelligence technologies creates new opportunities for ensuring the quality of training. Intelligent trainers and simulators support the development of practical skills in a safe environment, learning analytics enables the timely identification of learning difficulties, automated assessment enhances the objectivity of competency evaluation, and adaptive systems support individualized professional development trajectories for learners.

The effectiveness of using AI technologies depends on the organizational and pedagogical conditions of their implementation, primarily: the digital readiness of instructors, the availability of modern infrastructure, the pedagogically balanced integration of intelligent tools into the curriculum, and adherence to ethical principles in handling data. At the same time, the implementation of artificial intelligence is accompanied by challenges related to uneven digital capacity of educational institutions, the need to enhance instructors' qualifications, and the assurance of the reliability of educational data.

Thus, the use of artificial intelligence technologies facilitates a shift toward evidence-based management of professional training quality, the enhancement of safety culture, and the alignment of acquired competencies with the current requirements of the motor transport sector. Future research prospects are associated with the development of adaptive learning environments and the improvement of methods for integrating AI solutions into the practical training of specialists.