

THEORETICAL AND PRACTICAL BASES OF THE USE OF DIGITAL PEDAGOGY AND ARTIFICIAL INTELLIGENCE TOOLS IN TECHNICAL SCHOOLS

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Abstract

This article covers the theoretical and practical foundations of improving the effectiveness of education in technical schools through digital pedagogy, artificial intelligence tools, LMS platforms, virtual laboratories, digital assessment, and cooperation with employers. The research was conducted based on world experience - UNESCO-UNEVOC, UNESCO–World Bank–ILO joint analyses, OECD, World Bank, and the practice of advanced countries. The article developed a digital competency model for a technical school teacher, stages of implementing an innovative lesson, a comparative analysis of international experience, and practical recommendations for Uzbekistan. As a result, an 8-component digital pedagogy ecosystem, a 5-block teacher competency model, and a 6-stage lesson design were proposed to improve the quality of education in technical schools. The results of the research are of scientific and practical importance in improving the skills of teachers in the vocational education system, modernizing lessons, and strengthening integration with labor market requirements.

Keywords: Technical school, TVET, digital pedagogy, artificial intelligence, LMS, virtual laboratory, teacher competence, dual education, digital assessment, pedagogical innovation.

Introduction

By the second quarter of the 21st century, the digital transformation of the vocational education system, the automation of production, the emergence of new professions in the labor market, and the expansion of solutions based on artificial intelligence have radically renewed the demand for teachers. Now the technical school teacher is not only a provider of theoretical knowledge, but also a mentor for the student, designer, facilitator, digital content creator, evaluation analyst, and practitioner who establishes cooperation with industry.

The UNESCO-UNEVOC initiative “Digital Transformation in TVET” emphasizes that digital transformation is being supported by integrating new digital skills into the TVET system, strengthening digital skills training for teachers and trainers, and developing diagnostic and



development toolkits for educational institutions. This source shows that digitalization has a simultaneous impact on the learning process, content, assessment and management [1].

According to a joint analysis by UNESCO, the World Bank and the ILO in 2023, TVET systems in many low- and middle-income countries are not fully responsive to labour market needs and are not sufficiently prepared to meet the increasing demand in the coming years [2]. This situation requires a review of course content, practical training, teacher qualifications and employer relations, especially in technical schools.

The OECD Digital Economy Outlook 2024 report found that in 2023, two-thirds of EU citizens, or 67 percent, said they would need additional education and training to improve their digital skills [3]. The World Bank has highlighted the significant potential of digital technologies in education, and in particular artificial intelligence, to address teacher shortages and quality issues in low- and middle-income countries [4]. This evidence underscores the need for a new methodological platform for technical school teachers.

The purpose of this article is to systematize the theoretical and practical foundations of the use of digital pedagogy and artificial intelligence tools for teachers of technical schools, analyze world experience, propose innovative lesson design mechanisms, and develop practical recommendations suitable for the conditions of Uzbekistan.

Research methodology

The study used a systematic approach, comparative analysis, content analysis, generalization and modeling methods. Open reports of UNESCO-UNEVOC, UNESCO, World Bank, OECD and ILO, as well as materials based on good practices in TVET, were studied. The approaches to digitalization of vocational education in Germany, Singapore and South Korea were compared.

The article also functionally analyzed components such as pedagogical design, digital content creation, assessment, reflection, data literacy, virtual laboratory, and collaboration with employers from the perspective of technical school teachers. Based on the analytical results, an 8-component “digital pedagogy ecosystem”, a 5-block “digital competency model”, and a 6-stage “innovative lesson implementation” model were developed.

Table 1. Global trends in the digitalization of the TVET system and their relevance for technical schools

Source	Main idea or indicator	Importance for technical schools
UNESCO-UNEVOC	Digital transformation requires a system of new digital skills, teacher training, and toolkits in TVET.	It is necessary to establish continuous and systematic teacher training.
UNESCO–World Bank–ILO (2023)	Many TVET systems are not sufficiently responsive to labor market needs.	The content of the course should be aligned with industry, services, and the local economy.
OECD (2024)	67% of the EU population said they needed additional training to develop their digital skills.	The lifelong learning model is equally important for teachers and students.
World Bank	AI powers personalized learning, automated assessments, and virtual tutoring.	Artificial intelligence tools help customize lessons and increase the speed of feedback.

Digital Pedagogy Ecosystem in a Vocational School

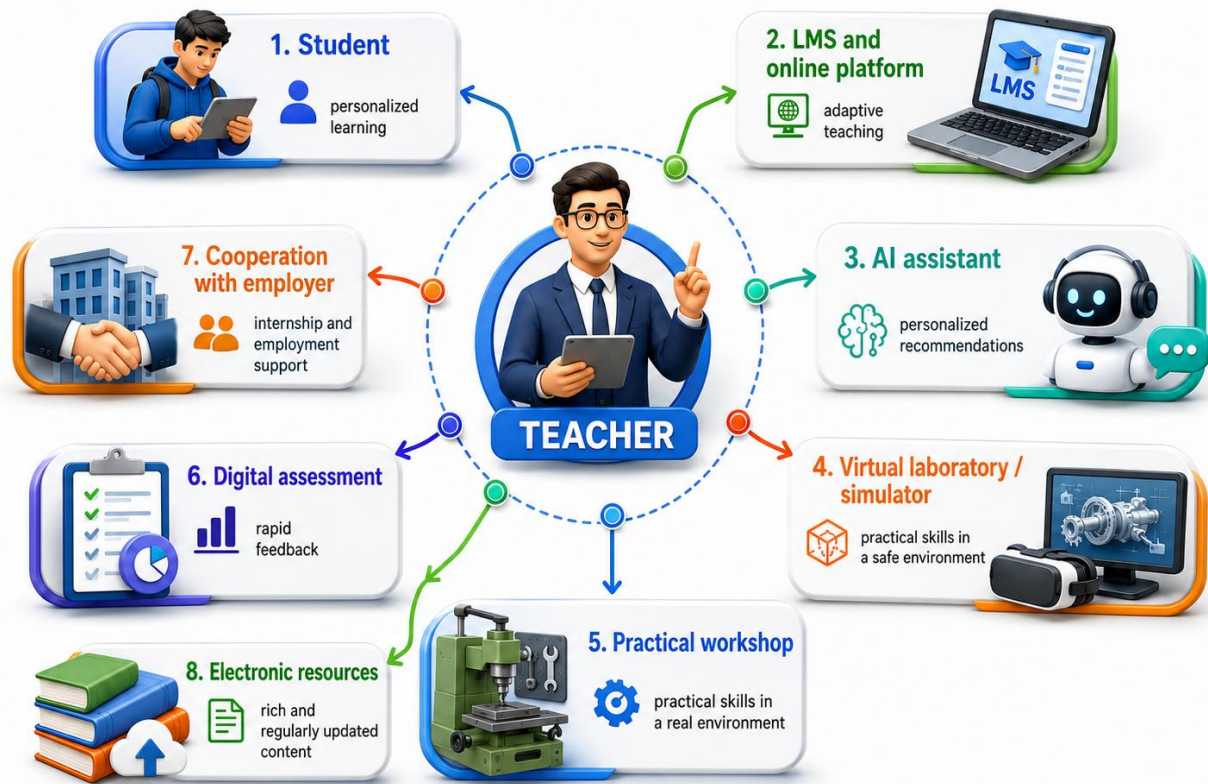


Figure 1. Digital pedagogy ecosystem in a vocational school (infographic in English)

Results and discussion

1. Digital pedagogical ecosystem in the technical school

The proposed digital pedagogical ecosystem interprets the technical school teacher as the central subject. Around him there are eight interconnected components: the learner, LMS and online platforms, artificial intelligence assistant, virtual laboratory or simulator, practical workshop, digital assessment, employer collaboration and electronic resources. This approach is consistent with the nature of vocational education and allows for the integration of theoretical, practical and production-related competencies in one system.

The first component is the learner. At the heart of digital pedagogy is the idea of personalized learning. Based on the learner's interests, level of preparation, and future professional direction, it is necessary to differentiate tasks, provide adaptive content, and form an individual learning path. Artificial intelligence and LMS platforms automatically record the learner's activity, errors, and learning dynamics, providing the teacher with instant analytics.

The second and third components — LMS and AI assistant — optimize the work of the teacher. LMS is necessary for posting materials, distributing assignments, monitoring student activity, and summing up grades. AI assistant serves as an effective tool for developing lesson plans, creating test questions, simplifying text, preparing individual recommendations, analyzing portfolios, and reflecting. In this, information ethics, preventing plagiarism, and ensuring data security are important requirements.

The fourth and fifth components — virtual laboratory/simulator and practical workshop — reinforce the practical nature of vocational education. It is not possible to organize any technical training in a real production environment. Therefore, virtual simulators create a safe, economical and repeatable learning environment. However, they cannot completely replace a real workshop; on the contrary, they are effective as a preparatory stage for them. Thus, practical competence is formed through the integration of “virtual experience + real workshop”. The sixth component — digital assessment — provides a great advantage in monitoring student progress. Electronic tests, rubrics, e-portfolios, checklists and competency maps increase the transparency of assessment. The seventh component — cooperation with the employer — ensures that the curriculum meets the requirements of the labor market. The eighth component — electronic resources — forms a bank of video lessons, 3D models, infographics, regulatory documents, interactive catalogs and industry information.

Digital Competency Model of a Vocational School Teacher

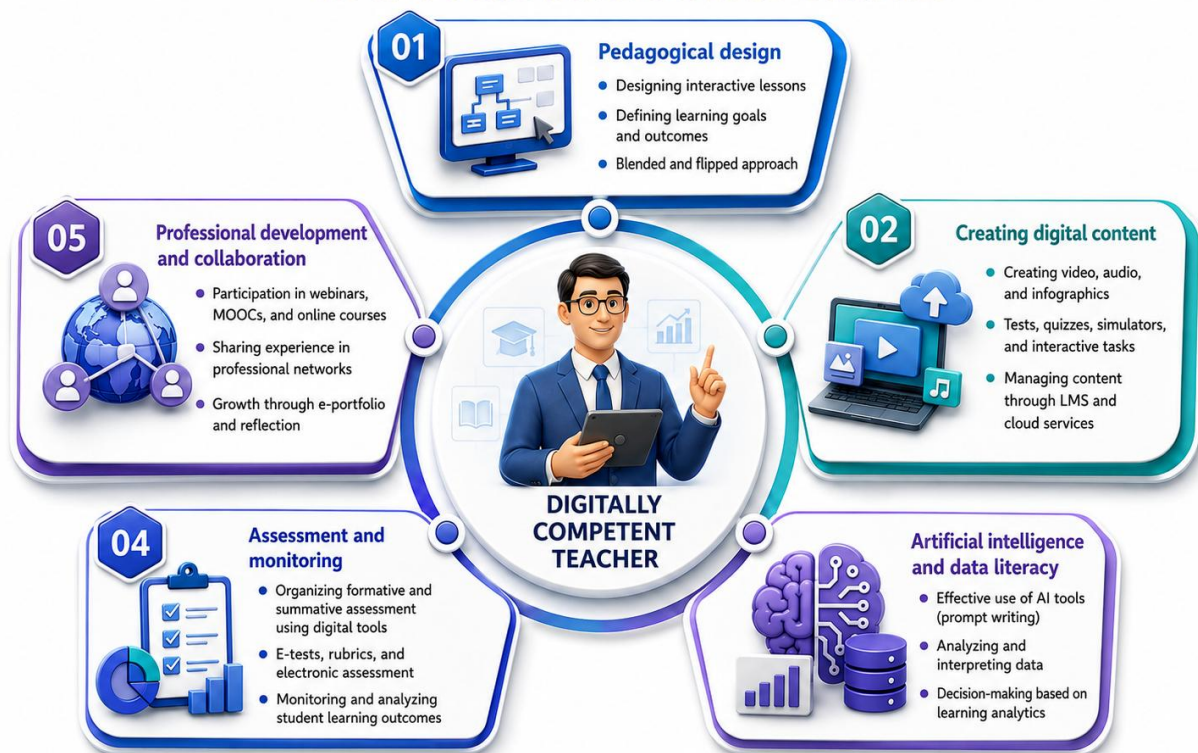


Figure 2. Digital competency model of a vocational school teacher (infographic in English)

2. Digital competency model of a technical school teacher

The proposed competency model consists of five main blocks: pedagogical design, digital content creation, artificial intelligence and data literacy, assessment and monitoring, professional development, and collaboration. These blocks complement each other and reflect the multifaceted role of the teacher in the modern educational process.

The pedagogical design block includes planning an interactive lesson in a goal-oriented manner, clearly defining learning outcomes, and using blended or flipped learning approaches.

This is especially important in vocational education, as the content of the lesson is directly linked to practical training, production tasks, and competency outcomes.

The digital content creation block covers the development of video, audio, infographics, e-manuals, tests, quizzes, simulators, and microcontent. The teacher should not be limited to using ready-made platforms, but should create content that is relevant to the professional nature of his subject. This will increase students' motivation and ability to solve practical problems.

The block of artificial intelligence and data literacy is the most relevant direction of digital transformation. A teacher should have competencies in writing prompts, critically evaluating the results of AI tools, analyzing data, making decisions based on educational analytics, and adhering to ethical standards. Today, the correct use of AI tools saves a teacher's time, but should not weaken academic control over unclear or erroneous results.

The Assessment and Monitoring block includes the organization of formative and summative assessment based on digital tools, e-tests, electronic rubrics, and analysis of digital traces of student activity. The Professional Development and Collaboration block includes webinars, MOOC platforms, teacher-student networks, pedagogical communities, e-portfolios, and reflection. It is this block that leads the teacher to a model of continuous professional growth, rather than a “one-time professional development”.

Table 2. Structural blocks and practical indicators of the digital competence model

Block	Content	Practical indicators
Pedagogical design	Interactive lesson design, goal and outcome setting, blended/flipped approach.	Lesson plan, module map, project assignment, practical task.
Digital content creation	Video, audio, infographics, test, simulator and LMS content preparation.	At least 10 digital resources, electronic task bank in 1 subject.
AI and data literacy	Prompt writing, results analysis, learning analytics, information ethics.	AI-powered course materials, analytical dashboards, and ethical guidelines.
Evaluation and monitoring	Electronic assessment, formative feedback, competency monitoring.	Rubric, e-portfolio, online test, mastery report.
Professional development and collaboration	MOOC, webinar, professional networking, industry outreach.	At least 2 training courses per year, 1 joint project with a partner enterprise.



Global Experience: Digitalization in Vocational Education

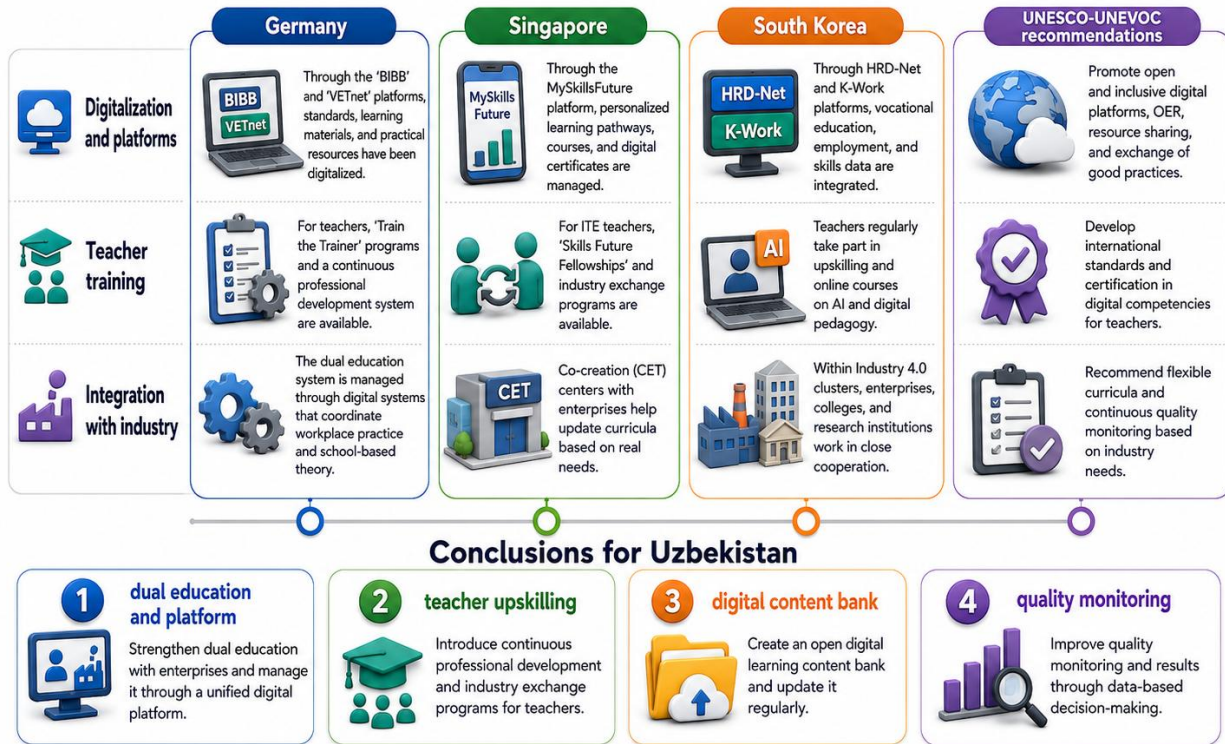


Figure 3. Global experience: digitalization in vocational education (comparative infographic in English)

3. World experience and conclusions drawn from it

Germany is famous for its dual model of vocational education, and digitalization serves to manage, standardize and monitor the practical part of this system. Educational materials, regulatory documents and training practices are systematized through institutional platforms such as BIBB and VETnet. The strength of this experience is the combination of practice in the enterprise and theory in school in a single management logic.

The Singapore experience is significant in that it has introduced skills planning, personalized learning paths, micro-skills certification, and industry partnerships through MySkillsFuture and the Institute of Technical Education (ITE). The Singapore model requires teachers to not only teach, but also manage the student's career trajectory.

In South Korea, platforms such as HRD-Net and K-Work integrate vocational education, employment, and skills markets. AI, online education, and Industry 4.0 clusters are linked to the activities of educational institutions. This model allows teachers to constantly monitor production trends through digital tools and update teaching content accordingly.

UNESCO-UNEVOC recommendations promote international standards for digital competencies for teachers, open educational resources, toolkits, comparative diagnostics and quality monitoring. These recommendations indicate four important areas for Uzbek technical schools: integrating dual education with platforms, implementing continuous teacher

upskilling, creating an open digital content bank, and organizing evidence-based quality monitoring.

Thus, world experience leads to one general conclusion: the success of the digitalization of vocational education depends not on the technical equipment itself, but on teacher competence, industry relevance, data-driven management, and flexible methodology.

Table 3. Comparative overview of the experience of selected countries

Criterion	Germany	Singapore	South Korea	Lesson for Uzbekistan
Platforms	Standard and resource system	Personal path based on MySkillsFuture	HRD-Net and employment integration	Creating a single professional digital platform
Teacher training	Train-the-Trainer model	SkillsFuture and industrial internships	AI and digital pedagogy courses	Continuous upskilling and internships
Industry integration	Dual education	Co-creation centers	Industry clusters 4.0	Joint module and internship with the enterprise
Evaluation	Focused on practical competence	Micro-qualifications and certification	Digital monitoring and analytics	Competency-based e-assessment system

Stages of Introducing an Innovative Lesson in a Vocational School



Figure 4

Figure 4. Stages of introducing an innovative lesson in a vocational school (infographic in English)

4. A step-by-step model for implementing an innovative lesson

The proposed 6-step model for improving the effectiveness of the lesson in the technical school covers a continuous cycle from identifying needs to improving. The first stage - identifying needs - begins with a diagnosis of the level of knowledge of students, the requirements and expectations of the enterprise. At this stage, the teacher should identify labor market signals, student difficulties and gaps in practical competencies.

The second stage is to set learning objectives. The objectives should be specific, measurable, linked to professional competencies, and focused on the results that will be demonstrated at the end of the lesson. The third stage is to select a digital tool. Here, the teacher selects a tool that is appropriate for the content of the lesson and the expected result - an LMS, a quiz platform, a simulator, an AI service, a video editing program, or an assessment system.

The fourth stage is designing a practical lesson. This is the most important stage in vocational education, and it includes the technological sequence of the task, safety rules, working with equipment, digital resources and assessment criteria. The fifth stage is assessing and analyzing the results of students in online and offline forms, drawing analytical conclusions from them and providing individual feedback. The sixth stage is improving and updating the content, tools and methods of the next lesson based on the analytics obtained.

The advantage of this model is that it helps the teacher see the lesson not as a “one-time event”, but as a continuous development process, enriched by information and reflection. The KPI indicators in the infographic — activity, competence, time savings and practical results — allow monitoring the effectiveness of this model.

Table 4. Recommended KPI indicators for assessing the effectiveness of an innovative lesson

Indicator	Content	Evaluation method	Recommended level
Activity	Class participation, assignment completion, activity in the LMS.	Attendance, platform logs, tracking.	80–85% and above
Competence	The level of independent completion of a practical task.	Rubric, checklist, workshop results.	75–80% and above
Time saving	Time saved in content distribution, evaluation, and reporting.	Questionnaire and time analysis.	20–30% time savings
Practical result	Product quality, project outcome, certification or production assignment.	Expert evaluation, portfolios.	85–90% and above

Practical recommendations

1) It is advisable to conduct an internal audit of digital competence for teachers in each technical school and determine individual development paths. Based on the results of the audit, teachers should be divided into basic, intermediate and advanced levels and step-by-step professional development programs should be developed.



2) It is necessary to create an open digital content bank across disciplines. This bank should include video lessons, 3D models, technological maps, regulatory documents, safety instructions, mini-tests, and practical assignments. The content can be regularly updated and made available to students via QR codes or LMS.

3) It is necessary to not limit cooperation with enterprises to only practice, but also to update the content of the lessons, involve experts, and transform them into a joint module for mini-projects and skills assessment. This will increase the number of cases in the lessons that are closer to real production tasks.

4) It is important to develop ethical guidelines when implementing AI tools. Teachers should be aware of prompt writing, data verification, copyright, privacy, and academic integrity. AI tools can enrich the lesson, but they cannot completely replace the teacher's pedagogical decisions.

5) For quality monitoring, it would be useful to develop a simple analytical dashboard that integrates data from the LMS, electronic journal, and assessment systems. This dashboard would track activity in lessons, assignment completion, practical skills results, and the dynamics of skill growth.

Conclusion

The article systematically covers the theoretical and practical foundations of the use of digital pedagogy and artificial intelligence tools in technical schools. The analysis shows that the main success factor of digitalization in the vocational education system is not the availability of technical tools, but the methodological and digital competence of the teacher, adaptability to the labor market, and data-based management.

The proposed 8-component digital pedagogical ecosystem, 5-block teacher competency model, and 6-stage innovative lesson design are important as methodological solutions that can be practically applied for technical schools. They allow for personalization of lessons, optimization of teacher work, strengthening of students' practical skills, and systematization of quality monitoring.

Based on world experience, one of the top priorities for Uzbek technical schools is to integrate dual education with digital platforms, create a system of continuous upskilling of teachers, form an open content bank, and introduce analytical monitoring systems. Systematic implementation of practical measures in these areas will significantly increase the quality and efficiency of vocational education.

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