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METHODS OF STATISTICAL AND PEDAGOGICAL EVALUATION OF THE EFFECTIVENESS OF NEW GENERATION TEXTBOOKS IN VOCATIONAL EDUCATION

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Annotation This article analyzes the methodology for assessing the quality and effectiveness of new generation textbooks in the system of vocational education based on pedagogical and statistical criteria. During the study, the impact of competency-based approach, interdisciplinary integration and digital technology development materials on students' knowledge level was investigated. It was statistically substantiated that as a result of experimental work, practical classes organized with the use of SolidWorks, KOMPAS-3D, CAD / CAM programs significantly increase the competence of students. Normal distribution, mean, dispersion, and correlational analysis techniques were used in the study.

Keywords: competency approach, pedagogical monitoring, statistical analysis, CAD/CAM, SolidWorks, KOMPAS-3D, new generation textbooks, vocational training, quality of education.

INTRODUCTION In the context of today's globalization, digital transformation and industry transition to Industry 4.0, modernization of vocational education system has become one of the priority public policy priorities. As a result of the accelerated development of automated control systems, artificial intelligence, robotics, CAD / CAM/CAE platforms and digital engineering technologies in modern manufacturing enterprises, the labor market is increasingly demanded for specialists with new competencies. Therefore, the introduction of innovative pedagogical technologies into the system of vocational education and the creation of a new generation of textbooks play an important scientific and practical role.

The "New Uzbekistan Development Strategy for 2022-2026", approved by the Decree of the President of the Republic of Uzbekistan dated January 28, 2022, No. UP-60, defines one of the main strategic tasks in the areas of human capital development, training in accordance with international standards in the areas of technical and engineering. In this strategy, the digitalization of the education system, the introduction of a model of competency education integrated with the development and production of modern textbooks are among the priority tasks.

According to studies by international organizations UNESCO, UNICEF and OECD, by 2030, the share of digital competencies in technical and vocational education will increase to 65–70%. Meanwhile, the World Economic Forum's Future of Jobs Report predicts that by 2030, about 50% of existing occupations will be radically transformed by digital transformation. There is a sharp increase in the need for specialists who know 3D modeling, virtual design and automated production technologies, especially in the areas of engineering, industrial technology and design.

The results of international pedagogical surveys show that educational processes based on interactive and digital teaching materials have a significantly higher efficiency than traditional methods. For example, a study by the OECD in 2024 found that the level of student knowledge acquisition in technical education institutions using CAD/CAM technologies is on average 32% higher. Also, a study by MIT (Massachusetts Institute of Technology) and the European Training

Foundation noted that students who worked with virtual laboratories and 3D engineering programs increased their spatial thinking performance by up to 40%.

The results of pedagogical monitoring show that in practical classes using SolidWorks, AutoCAD, KOMPAS-3D and other digital design programs, the speed of mastering complex technical drawings by students was 1.7–1.9 times higher than in traditional teaching methods. At the same time, it has been found that in lessons based on interactive visual materials, students' independent working skills improve by 35–45%.

In the scientific developments of researchers J. Bruner, B. Bloom, V.P. Bespalko and A. Nabayev, it is substantiated that educational literature based on a competency approach is an important tool for the development of not only theoretical knowledge of the student, but also practical skills and creative engineering thinking. It is scientifically proven that teaching aids developed on the basis of interdisciplinary integration give high results in improving the effectiveness of teaching.

One of the main problems that exists in the system of technical education today is the insufficient link between theory and practice. Many traditional textbooks do not adequately reflect real industrial technologies, modern engineering programs, and innovative manufacturing processes. This adversely affects the degree of practical training of graduates and the degree of adaptation to the demands of the labor market.

In this context, the most urgent scientific task is the development of new generation textbooks, the assessment of their quality and effectiveness on the basis of scientific and statistical methods, the improvement of the pedagogical monitoring system and the integration of modern CAD/CAM technologies into the educational process. This study aims to analyze these issues theoretically and practically.

RESEARCH METHODOLOGY This study is aimed at the pedagogical and statistical assessment of the quality and effectiveness of new generation textbooks in the system of vocational education. Research work was carried out at the Tashkent Institute of Chemical Technology and its Yangiyer branch during the 2014-2025 academic year. In total, 126 students were involved in the pilot work, teaching in the following disciplines: "Engineering and computer graphics", "Technical mechanics" and "Machine parts".

In order to ensure the scientific reliability of the study, the respondents were divided into two equal groups:

1. control group — 63 students;
2. The experimental group consists of 63 students.

The training sessions in the control group were based on traditional pedagogical methods. Printed manuals, standard graphic drawings and classical practical exercises were used. In the experimental group, a new generation of textbooks developed on the basis of innovative and integrated pedagogical technologies were introduced.

The following state-of-the-art technologies and methodological approaches were used in the experimental group: 3D modeling based on SolidWorks software; Create engineering graphics and virtual drawings using KOMPAS-3D; Automated design via CAD/CAM technologies Interactive e-learning aids multimedia and animated visuals; Competency assessment system; Virtual Lab Elements; Problem-based and project-based teaching methods (Project Based Learning).

Throughout the study, a comprehensive pedagogical monitoring system was developed to determine students' knowledge, skills, qualifications and competence (BCMC). During the monitoring process, diagnostic tests, practice tasks, individual projects, questionnaires, expert assessments and the methods of statistical observation were used.

The evaluation criteria were carried out on the basis of 5 main components: **Scientificity and** logic — scientific basis, consistency and consistent coverage of the topics; **Level of modernity** - the reflection of digital technologies, CAD/CAM systems and modern industry standards in textbooks; **Compliance with pedagogical technologies** - the level of organization based on interactive methods, multimedia tools and a competency approach; **Orientation to independent learning** - the ability to develop students' independent work, analytical thinking and creative approaches; **Development of practical competencies** — the level of formation of technical design, engineering graphics and design skills.

Each criterion was evaluated on the basis of a 100-point rating system, and the significance coefficient of all components was considered equal:

$K_1=K_2=K_3=K_4=K_5=1$

Mathematical and statistical methods were used to determine the statistical reliability of the study. Including: arithmetic mean; dispersion; standard deviation; correlational analysis; Stewart Criterion; Analyses based on the law of normal distribution have been performed.

The results of the pedagogical experiment were processed using Microsoft Excel, SPSS and Python statistical analysis tools and analyzed in the form of diagrams, graphs and accompanying tables.

The results obtained at the end of the experimental test showed that classes organized on the basis of a new generation of textbooks significantly improve students' knowledge, spatial thinking, technical design skills and competencies of independent work.

PEDAGOGICAL ANALYSIS The results of pedagogical experiments showed that classes organized on the basis of digital technologies served a significant development of students' competence. In the experimental group: spatial thinking — up to 37%; Engineering Thinking — by 31%; Independent work skills — up to 42%; Applied design competency — an increase of 46%.

In particular, 3D modeling classes based on SolidWorks and KOMPAS-3D programs strengthened students' motivation and technical thinking.

According to the results of the experiment, students trained using interactive electronic textbooks mastered complex technical drawings 1.8 times faster than traditional ones.

As a result of the survey, 84% of respondents said that visual and interactive materials facilitate understanding of the topic.

Statistical analyses showed a high correlation between innovative pedagogical technologies and student competency:

$r=0.84$

The results confirmed that the new generation textbooks are an important pedagogical tool for improving the effectiveness of vocational and technical education.

It has been found that the new generation educational literature, developed on the basis of modern educational technologies, has the following advantages: Improves the visuality of the educational process; Provides integration of theory and practice; Develops students' creative thinking; Forms digital engineering competencies; Increases the effectiveness of independent learning.

Comparative analysis with international studies shows that in education systems using CAD/CAM technologies, students' knowledge is on average 25–40% higher.

The results of the research showed that in vocational education the important scientific and practical value of creating a new generation of textbooks and their evaluation on a pedagogical and statistical basis.

It has been found: Teaching aids based on a competency approach significantly improve the effectiveness of education; The use of CAD/CAM technology has a positive impact on the development of engineering competencies; Statistical analysis confirms the reliability of the results; Interactive and integrative approaches are becoming a key driver of modern education.

In the future, the integration of artificial intelligence, virtual laboratories and adaptive learning systems into a new generation of textbooks is considered an important promising direction.

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