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AUTOMATED TESTING SYSTEMS IN THE PRACTICE OF TECHNICAL UNIVERSITIES STUDENTS' KNOWLEDGE ASSESSMENT

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Abstract

The paper presents a comprehensive analysis of automated testing systems (ATS) employed in technical higher education institutions across the Russian Federation, addressing the growing imperative for digital transformation in academic assessment. The study examines the proliferation of digital assessment tools as an integral component of the contemporary educational landscape, driven by the converging imperatives of large-scale digitalisation, the accelerated shift towards remote and hybrid learning modalities, and the pressing institutional need for objective, scalable, and pedagogically sound knowledge evaluation mechanisms that can complement or replace traditional examination formats. The research systematically identifies and characterises the principal ATS platforms currently operational in Russian technical universities, focusing on six prominent systems: INDIGO, Moodle (with customised testing modules), T-BMSTU, NSUts, ATS-Test, and STATUS (TM). Through a rigorous systematic comparative analysis, the paper evaluates these systems across multiple critical dimensions, including their primary pedagogical purpose, deployment architecture (cloud-based versus on-premises), supported test question types and multimedia integration, adaptive testing capabilities, data security and authentication protocols, and the depth and usability of their reporting and analytics functionalities. The empirical findings reveal that while no single ATS universally satisfies all institutional requirements and disciplinary nuances, the strategic selection, customisation, and integrative deployment of these systems—often in tandem—substantially enhance the objectivity, efficiency, scalability, and overall pedagogical effectiveness of student assessment. The paper concludes with actionable recommendations for future research directions, including longitudinal impact studies, and offers evidence-based strategies for institutional implementation and faculty training to maximise the educational benefits of automated assessment technologies.

Keywords: ATS (automated testing systems); higher technical education; knowledge assessment; computer-based testing.

1. Introduction

The digital transformation of higher education has fundamentally reshaped the paradigms of student assessment, with automated testing systems emerging as indispensable instruments for evaluating educational progress. In the Russian Federation, technical universities have been at the forefront of adopting these technologies, driven by the dual imperatives of enhancing assessment objectivity and accommodating the growing scale of student cohorts. The integration of automated testing systems into the educational process of technical higher education institutions represents not merely a technological upgrade but a pedagogical reorientation towards more efficient, transparent, and data-driven evaluation methodologies [1], [2], [3], [4], [5], [6], [7], [8].

The problem addressed by this research is the fragmented landscape of automated testing systems in Russian technical universities, characterised by diverse platforms [9], [10], [11], [12] with varying capabilities, deployment models, and pedagogical affordances [13], [14], [15], [16]. Despite the widespread adoption of such systems, there exists a notable gap in systematic comparative analyses that would enable institutions to make informed decisions regarding platform selection and implementation [17], [18], [19]. This study seeks to fill this gap by providing a comprehensive overview of the automated testing ecosystems currently operational in Russian technical higher education institutions.

A critical review of the existing literature reveals that while substantial research has been conducted on individual testing systems, comparative studies encompassing the full spectrum of platforms used in Russian technical universities remain limited [6], [2], [3], [4]. Saramakha and Ovsyannikova (2026) have demonstrated the effectiveness of the INDIGO automated testing system as a tool for assessing student knowledge, particularly within the foreign language module, highlighting its capacity to streamline testing processes and enhance assessment objectivity [7]. Ipatov et al. (2022) have explored new teaching approaches in the context of globalisation and digitalisation of higher engineering education, emphasising the critical role of technology-mediated assessment in preparing graduates for the demands of the modern engineering profession [1]. These works, however, tend to focus on individual systems or specific pedagogical contexts, leaving a gap in holistic, cross-platform comparative research.

The present study addresses these gaps by investigating the following research questions: what automated testing systems are currently employed in Russian technical universities, what are the distinctive features, advantages, and limitations of each system, how do these systems compare across key functional and operational dimensions, what recommendations can be offered for institutional selection and implementation.

The methodological approach of this research encompasses a multi-stage investigation. First, a comprehensive survey of automated testing systems was conducted through analysis of institutional publications, technical documentation, and scholarly literature. Second, the identified systems were categorised and described according to their core functionalities and architectural characteristics. Third, a comparative analysis framework was developed, evaluating each system across fifteen distinct criteria, including primary purpose, license model, deployment architecture, question types supported, multimedia integration, adaptive testing capabilities, security features, and reporting functionality. Finally, statistical data on system adoption across Russian technical universities were compiled to provide an empirical basis for the analysis [8].

The novelty of this research lies in its systematic, multi-dimensional comparative approach to automated testing systems in the context of Russian technical higher education. By providing a comprehensive inventory and comparative analysis of the principal ATS platforms, this study offers both theoretical contributions to the field of educational technology and practical guidance for institutional decision-makers.

2. Automated Testing Systems in Russian Technical Universities: An Overview

The analysis of educational institutions' official websites, news regarding the digitalization of education from 2025–2026, and tender documentation makes it possible to form a general picture of the solutions being used. Russian technical universities predominantly use domestic learning management systems (LMS) integrated with federal services.

The paper addresses a comparative analysis of automated systems based on empirical implementation experience at:

National and research universities:

- Bauman Moscow State Technical University
- Moscow Institute of Physics and Technology
- National Research Nuclear University MEPhI
- National Research University of Electronic Technology (MIET)
- MISIS University of Science and Technology

Polytechnic universities (multidisciplinary):

- Peter the Great Saint-Petersburg Polytechnic University
- Tomsk Polytechnic University
- Perm National Research Polytechnic University
- Sevastopol State University
- Vyatka State University

Technological universities:

- MIREA — Russian Technological University
- Saint-Petersburg State Institute of Technology

Working Paper of 37th DAAAM Symposium

- Moscow Polytechnic University
- D. Mendeleev University of Chemical Technology of Russia
- Kazan National Research Technological University
- ITMO University
- Saint-Petersburg Electrotechnical University "LETI"
- Samara National Research University named after Academician S.P. Korolev
- Don State Technical University
- Novosibirsk State Technical University
- Ufa University of Science and Technology
- Irkutsk National Research Technical University

As precise statistics for each individual university are unavailable, the table below presents the market share distribution among the studied group of 25 universities, based on the frequency of mentions of their solutions in the public domain:

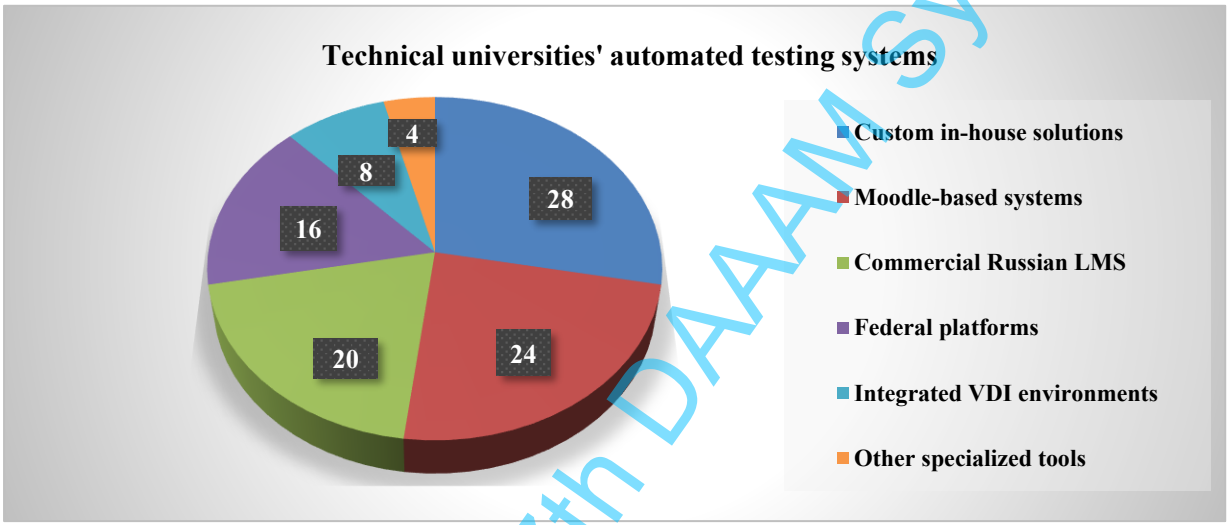

Fig. 1. Automated Testing Systems used in technical universities (in percentage)

Custom in-house solutions are used in dominant in top-tier research universities (MIPT, MEPhI, Bauman University, MISIS, Samara University) due to specific needs for testing code and complex calculations. Moodle-based systems are the most common solution in regional polytechnic institutes (Vyatka State, Perm Polytech, Irkutsk National Research, Novosibirsk Technical). Commercial Russian LMS are widely used in large industrial and technological universities (Don State Technical, Ufa University of Science and Technology, Moscow Polytechnic). Federal platforms are mandatory for unified digital skills assessment across all university types. Integrated VDI environments are sed specifically for practical IT and engineering lab tests where a full OS environment is required (ITMO, TPU, SPbSPU). Other specialized tools are the supplemental tools for formative assessment and online exam monitoring rather than main grading systems.

2.1. INDIGO Testing System

The INDIGO automated testing system, developed by Indigo Software Technologies, represents one of the most widely deployed professional testing platforms in Russian educational institutions [9]. INDIGO is a comprehensive software complex comprising server and application components, including a database management system, web server, data caching mechanisms, and load balancing tools. The system is designed to automate the processes of test creation, administration, and results processing across a broad spectrum of assessment scenarios.

INDIGO's primary strengths lie in its multifunctionality and the extensive customisation options it offers for test configuration [7], [13]. For each test, administrators can define various parameters, including test type, navigation settings, and question presentation modes. The system supports the generation of random test variants, with capabilities extending beyond simple question and answer shuffling to more sophisticated randomisation strategies. The user interface is noted for its modernity and usability, contributing to an efficient testing experience.

However, the system presents certain limitations. The licensing model involves significant costs. The absence of a distinct role-based access differentiation between "administrator" and "instructor" has been identified as a limitation in some implementations. Additionally, the system has relatively high hardware requirements [14], [15]. Despite these drawbacks, INDIGO has been successfully implemented in numerous technical universities, including the Ural State Law University and Saint-Petersburg State Institute of Technology where it is used alongside Moodle for independent student

Working Paper of 37th DAAAM Symposium

knowledge assessment [2], [3], [4] and in various faculties of technological universities for current control and intermediate assessment.

2.2. Moodle Learning Management System

Moodle (Modular Object-Oriented Dynamic Learning Environment) is an open-source learning management system that has achieved near-ubiquitous adoption in Russian higher education, including technical universities. While primarily a comprehensive LMS, Moodle's testing and quiz modules provide robust automated assessment capabilities that many institutions leverage as their primary testing platform [12].

Moodle's testing functionality supports a wide variety of question types, including multiple choice, true/false, short answer, numerical, matching, and essay questions. The platform enables the creation of question banks, randomisation of questions and answers, and the configuration of adaptive tests that adjust difficulty based on student performance. Moodle's open-source nature and extensive plugin ecosystem provide institutions with exceptional flexibility in customising the testing environment to meet specific pedagogical requirements [5], [6].

The principal advantages of Moodle for technical universities include its zero-licensing cost, extensive community support, scalability, and integration capabilities with other institutional systems. However, the platform's flexibility comes with certain costs: effective implementation requires significant technical expertise for configuration and maintenance-. The user learning curve for both instructors and students can be substantial, particularly when utilising advanced testing features [16], [13].

Moodle is deployed across a wide range of Russian technical universities, including Peter the Great Saint-Petersburg Polytechnic University, Tomsk Polytechnic University, Saratov State Technical University, and Novosibirsk State Technical University. The platform's integration with institutional electronic information and educational environments (EIEE) makes it a natural choice for many universities seeking a comprehensive digital learning ecosystem.

2.3. T-BMSTU Automated Testing System

T-BMSTU is a specialised automated testing system developed at Bauman Moscow State Technical University (BMSTU) for the verification of student programmes in practical programming classes. The system represents a distributed software-hardware complex comprising three components: a web server, one or more testing servers, and a server for detecting incorrect borrowings (plagiarism) [11].

The architecture of T-BMSTU reflects its specialised purpose: the system is designed to accept student programme submissions, compile and execute them against predefined test cases, and provide automated feedback on correctness and efficiency. The plagiarism detection component adds a layer of academic integrity assurance that is particularly valuable in programming courses [3], [5].

The primary advantage of T-BMSTU is its deep specialisation for programming education, providing automated assessment that would be extremely labour-intensive if conducted manually. However, this specialisation also constitutes a limitation: the system is not designed for general-purpose testing across diverse disciplines. T-BMSTU has been successfully integrated into the BMSTU curriculum since 2011 [11] and serves as a model for discipline-specific automated testing systems in technical education.

2.4. NSUts Testing System

NSUts (Novosibirsk State University Testing System) is an automated testing system developed at Novosibirsk State University, primarily designed for programming Olympiads and the educational process in programming courses. The system is distributable and can be used both for conducting Olympiads at various levels and for independent student training [15].

NSUts provides comprehensive functionality for programming contest administration, including problem submission, automated judging, and results management. The system's architecture and feature set are optimised for the specific requirements of programming competitions, with support for multiple programming languages and efficient test execution [18].

The system's strengths include its specialised feature set for programming assessment, its distributable nature enabling deployment across multiple institutions, and its proven track record in Olympiad settings [5]. Limitations include its narrow focus on programming assessment, which limits applicability to other disciplines, and the requirement for technical expertise in deployment and maintenance.

2.5. ACT-Test System

ACT-Test (Automated Testing System) is a comprehensive computer-based testing platform developed by ACT-Centre, widely used in Russian educational institutions for knowledge assessment. The system has been recognised as a de facto standard for computer-based testing in the Russian educational context [20].

ACT-Test supports a wide range of question types and testing scenarios, with a substantial bank of test materials covering disciplines across higher and secondary professional education. The system's test materials are developed in

Working Paper of 37th DAAAM Symposium

accordance with Russian State Standards (GOST) and international IMS standards. ACT-Test provides both server and client components, supporting centralised administration and distributed testing.

The system's advantages include its comprehensive question bank, compliance with Russian educational standards, and established reputation in the Russian educational community. Limitations include its proprietary nature and associated licensing costs, as well as potential challenges in integration with existing institutional systems. ACT-Test has been implemented in various technical universities, including agricultural and technological institutions, for both current assessment and accreditation testing [20].

2.6. STATUS (TM) System

STATUS (TM) is a specialised system for training and automated testing in theoretical mechanics, developed and implemented at Bauman Moscow State Technical University. The system was introduced in May 2020 and is used in both face-to-face and distance learning modes [11].

STATUS (TM) exemplifies the trend toward discipline-specific automated testing systems that address the particular challenges of assessing student performance in complex technical subjects. The system's focus on theoretical mechanics allows for the development of question types and assessment strategies specifically tailored to the cognitive demands of the discipline [17].

The primary advantage of STATUS (TM) is its pedagogical specialisation, enabling assessment that is closely aligned with course learning objectives. However, like other specialised systems, its applicability is limited to the specific discipline for which it was designed.

2.7. Comparative Analysis

The following table presents a comparative analysis of the automated testing systems examined in this study, evaluated across fifteen functional and operational dimensions.

Criterion	INDIGO	Moodle	T-BMSTU	NSUts	ACT-Test	STATUS (TM)
Primary Purpose	General-purpose testing	Comprehensive LMS with testing	Programming education	Programming Olympiads	General-purpose testing	Theoretical mechanics
License Model	Proprietary (commercial)	Open-source (GPL)	Proprietary (institutional)	Open-source (distributable)	Proprietary (commercial)	Proprietary (institutional)
Deployment	Server-client	Web-based	Distributed web	Web-based	Server-client	Desktop/Web
Test Question Types	Multiple types	Extensive (12+ types)	Programming tasks	Programming tasks	Multiple types	Discipline-specific
Multimedia Integration	Yes	Yes	Limited	Limited	Yes	Limited
Question Banking	Yes	Yes	Limited	Limited	Yes	Limited
Test Randomisation	Extensive	Extensive	Limited	Limited	Yes	Limited
Adaptive Testing	Yes	Yes (with plugins)	No	No	Yes	No
Test Administration	Centralised	Centralised	Centralised	Centralised	Centralised	Centralised
Access Control	Role-based	Granular	Role-based	Role-based	Role-based	Role-based
Proctoring	Limited	Limited (integrations)	No	No	Limited	No
Reporting & Analytics	Comprehensive	Comprehensive	Basic	Basic	Comprehensive	Basic
Data Export	Yes	Yes	Yes	Yes	Yes	Yes
Integration	Limited	Extensive	Limited	Limited	Limited	Limited
Ease of Learning	Moderate	Moderate-High	Moderate	Moderate	Moderate	Moderate
Security Measures	High	High	Moderate	Moderate	High	Moderate
Regulatory Compliance	Russian standards	International	Institutional	Institutional	GOST, IMS	Institutional
User Learning Curve	Moderate	Moderate-High	Moderate	Moderate	Moderate	Moderate
Scalability	High	High	Moderate	Moderate	High	Low
Community Support	Commercial	Extensive	Institutional	Academic	Commercial	Institutional
Differentiation of Access Rights	Limited	Extensive	Basic	Basic	Moderate	Basic
Results Statistics	Comprehensive	Comprehensive	Basic	Moderate	Comprehensive	Basic

Working Paper of 37th DAAAM Symposium

Automatic Certificate Generation	Yes	Yes (with plugins)	No	No	Yes	No
Difficulty Level Division	Yes	Yes	No	No	Yes	No

Table 1. Comparative Analysis of Automated Testing Systems in Russian Technical Universities

The comparative analysis reveals several significant patterns. First, the systems exhibit a clear distinction between general-purpose platforms (INDIGO, Moodle, ACT-Test) and specialised systems (T-BMSTU, NSUts, STATUS TM). General-purpose systems offer broader applicability but may lack the deep pedagogical specialisation of discipline-specific platforms. Second, the open-source model of Moodle and NSUts provides cost advantages and flexibility but may require greater technical expertise for effective implementation. Third, the commercial systems (INDIGO, ACT-Test) offer comprehensive feature sets and established support structures but at significant licensing costs.

Regarding adoption patterns across Russian technical universities, the available data suggest that Moodle enjoys the widest deployment, serving as the foundational learning management system for numerous institutions, including Tomsk Polytechnic University, Saratov State Technical University, and Novosibirsk State Technical University. INDIGO has achieved substantial penetration, particularly in institutions requiring professional-grade testing capabilities, with implementations at the Ural State Law University, various technological university faculties, and through commercial licensing. T-BMSTU and STATUS (TM) represent institutional innovations at Bauman Moscow State Technical University, while NSUts has gained recognition in the programming Olympiad community and educational settings. ACT-Test maintains a significant presence through its established position in Russian educational testing infrastructure.

3. Conclusion

The analysis presented in this paper demonstrates that automated testing systems have become integral to the educational assessment landscape of Russian technical universities. The proliferation of these systems reflects the broader digitalisation of higher education and the recognition of automated assessment as a means of enhancing objectivity, efficiency, and pedagogical effectiveness.

The comparative analysis reveals several key conclusions. First, the landscape of automated testing systems in Russian technical universities is characterised by diversity, with institutions employing a range of platforms from general-purpose systems like Moodle and INDIGO to specialised systems like T-BMSTU and STATUS (TM). This diversity reflects the heterogeneous needs of technical education, where both broad-based assessment and discipline-specific evaluation are required.

Second, the selection of an automated testing system involves a complex trade-off between functionality, cost, technical requirements, and pedagogical alignment. Open-source systems offer flexibility and cost advantages but demand technical expertise for effective implementation. Commercial systems provide comprehensive feature sets and support structures but at significant cost. Specialized systems offer deep pedagogical alignment within their domains but limited applicability beyond.

Third, the effective implementation of automated testing systems requires more than technological deployment; it demands pedagogical integration, faculty development, and institutional commitment to quality assurance in assessment. The systems examined in this study are tools whose effectiveness depends on the educational context in which they are employed and the pedagogical strategies they support.

Fourth, the research literature, including the works of above-mentioned authors confirm that automated testing systems, when appropriately implemented, contribute significantly to the quality of educational assessment in technical higher education-. These systems enable more frequent, consistent, and objective assessment while providing valuable data for educational quality monitoring and improvement.

The development of this research should be directed toward creating hybrid environments that combine AI-based adaptive item generation with next-generation proctoring systems to ensure a seamless and secure assessment process. The issue of long-term tracking of learning outcomes requires particular attention, as addressing it will make it possible not only to confirm the validity of current measurements but also to identify hidden patterns in the dynamics of skill acquisition. The integration of these directions will create a synergistic effect in which proctoring data and longitudinal metrics are used to train AI question-generation models themselves, making them increasingly accurate. Such an interdisciplinary approach will require revisiting traditional psychometric methods and developing new ethical standards that account for the role of automated systems. Consequently, further work in these areas is not merely a supplement but a necessary condition for the transition to fully personalized and evidence-based education.

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Working Paper of 37th DAAAM Symposium

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