PEDAGOGICAL OPPORTUNITIES OF DIAGNOSING STUDENTS' LEARNING OUTCOMES IN A DIGITAL LEARNING ENVIRONMENT

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Abstract. The article analyzes the pedagogical opportunities of diagnosing higher education students' learning outcomes in a digital learning environment. It reveals the didactic value that rapid formative assessment, adaptive testing, learning analytics, electronic portfolios, rubrics, and artificial intelligence tools add to the diagnostic process. At the same time, the limitations of digital diagnostics (validity, academic integrity, the digital divide, data privacy) are identified, and the pedagogical conditions for their sound use are substantiated. The article is based on a theoretical analysis of international and national scholarly sources.

Keywords: digital learning environment, diagnostics, learning outcomes, formative assessment, adaptive testing, learning analytics, electronic portfolio, feedback, diagnostic competence.

Introduction. The digitalization of higher education has changed the content and forms of the educational process and has also had a significant impact on the practice of identifying and assessing learning outcomes. In Uzbekistan, the Concept for the Development of the Higher Education System until 2030 [1] and the "Digital Uzbekistan – 2030" Strategy [2] envisage improving the educational process on the basis of digital technologies and electronic monitoring of the educational process and its results. The transition to the credit-module system and the competence-based approach, in turn, requires that learning outcomes be monitored continuously throughout the course of study rather than through a single examination.

Traditional diagnostic tools (oral questioning, paper-based written work, final examinations) cannot fully meet this requirement: they deliver results late, do not take individual differences into account, and demand a great deal of the instructor's time. The digital environment makes it possible to resolve these problems in part, but technology in itself does not guarantee the quality of diagnostics. Technology serves the result only when it is subordinated to a pedagogical purpose. For this reason, studying precisely the pedagogical opportunities of digital diagnostics and the conditions for realizing them is a relevant scientific and practical task.

Main Body. Diagnostics (pedagogical diagnostics) is a systematic activity aimed at determining, measuring, and analyzing the course and results of the educational process and, on that basis, introducing changes into it. Unlike control, it does not merely record the current state: it identifies the causes of that state and determines the direction of development.

A digital learning environment is understood as an integrated system consisting of learning management systems (LMS, e.g., Moodle), online platforms, electronic resources, video conferencing, electronic testing and portfolio systems, learning analytics tools, and artificial intelligence services. An important feature of this environment for diagnostics is that every action of the student (task completion time, number of attempts, use of resources, participation in forums) is stored as a digital trace. As a result, the instructor can observe not only the final result but also the learning process itself.

International research shows that the effect of diagnostics on learning is strongest in its formative orientation. Analyzing more than 250 studies, P. Black and D. Wiliam reported that strengthening formative assessment significantly improves attainment, with effect sizes in the range of approximately 0.4–0.7 [3]. D. Wiliam interprets assessment as "assessment for learning" and argues that its main function is to gather evidence for adjusting teaching and learning [4]. R. Bennett, in turn, notes

that claims about the effectiveness of formative assessment are sometimes overly optimistic and that its quality depends on the criteria, the tools, and the instructor's preparation, and he calls for a critical approach to the topic [3]. The digital environment provides precisely the technical basis for carrying out this formative diagnostics on a large scale and rapidly.

Discussion and Results.

The main pedagogical opportunities of digital diagnostics

1. Rapid and continuous formative diagnostics and feedback

N. Gikandi and colleagues, who reviewed the literature on online formative assessment, identified validity, reliability, authenticity, and high-quality feedback as the main conditions of its effectiveness [4]. LMS tests and assignments can check results automatically and give the student an immediate response. This capability fully corresponds to the feedback model of J. Hattie and H. Timperley: effective feedback must answer three questions — where am I going, where am I now, and what is the next step [3]. In the authors' analysis, although the mean effect size of feedback is high (around 0.8), its effect varies considerably depending on the type of feedback [1]. V. Shute likewise showed that formative feedback supports learning only when it is specific, timely, and descriptive enough for the student to act on [2]. Thus, the pedagogical value of a digital tool lies not merely in a "correct/incorrect" mark but in providing an explanation that shows the student the next step.

Practical examples include: a Moodle test with an explanation attached to each answer option, a multiple-attempt mode for assignments, intermediate mini-tests, and a short diagnostic test completed by students before a lecture (entry diagnostics).

2. Individualization and adaptive testing

In a traditional test, all students complete the same set of questions. In computerized adaptive testing (CAT), the next question is selected on the basis of previous answers, so the questions adapt to the student's level of preparation [3], [1].

This approach, first, increases measurement precision by avoiding questions that are too easy or too difficult and, second, sustains the student's motivation. On the basis of diagnostic results, an LMS can propose an individual learning pathway to the student (additional materials, revision tasks). This is consistent with L.S. Vygotsky's idea of the zone of proximal development: the task lies slightly above the level the student can complete independently and thereby promotes development. It should be borne in mind that creating adaptive tests requires a large item bank and psychometric calibration; for this reason they are used mostly in large-scale systems, whereas within an individual course the LMS's conditional-routing features may be sufficient.

3. Learning analytics: monitoring the process and early identification

Learning analytics refers to the measurement, collection, analysis, and reporting of data collected during students' learning for the purposes of understanding and optimizing learning. G. Siemens substantiated the emergence of this field as an independent scientific discipline [1]; G. Siemens and P. Long emphasized that analytics tools can be a source of new evidence for decision-making in education [2]. R. Ferguson systematized the drivers and challenges in the development of learning analytics [3].

4. Authentic and competence-based diagnostic tools

In the modern paradigm, a learning outcome is understood as competence, and it cannot be verified by tests alone. The digital environment makes it easier to use authentic assessment tools: the electronic portfolio (students' work, reflection, and evidence of growth are stored in aggregate form); project and case assignments (collaborative work with documents, presentations); simulations and virtual laboratories; and stealth assessment based on game elements, in which students' knowledge and skills are observed during the activity and no separate test is administered [2]. Embedding rubrics in the LMS makes the assessment criteria transparent to students in advance and increases inter-rater agreement among

instructors. These opportunities serve the implementation of J. Biggs's idea of constructive alignment, that is, the mutual alignment of learning outcomes, teaching, and assessment [1].

5. Strengthening the student's agency

D. Nicol and D. Macfarlane-Dick regard formative assessment as a tool that supports students' self-regulated learning and proposed seven principles, including clear criteria, self-assessment, high-quality feedback, and dialogue with the instructor and peers [1]. Digital tools (the peer assessment module in an LMS, online forums, collaboratively edited documents, electronic learning journals) make these principles easier to implement. Students can monitor their own results, set goals, and take responsibility for their own learning. This is one of the most important developmental opportunities of digital diagnostics.

6. Opportunities offered by artificial intelligence tools

The systematic review by O. Zawacki-Richter and colleagues showed that assessment and diagnostics are among the main areas of artificial intelligence application in higher education, while critically noting that these studies lack sufficient pedagogical theory and involvement of educators [2]. W. Holmes and colleagues described the potential of AI-based intelligent tutoring systems, automatic analysis of essays and answers, and preliminary feedback on written work [3]. The UNESCO guidance document likewise places human oversight, transparency, and equity first in the use of artificial intelligence in education [1]. Thus, artificial intelligence should be an auxiliary tool in diagnostics, and the final pedagogical decision should remain with the instructor.

Comparative analysis of opportunities and limitations

Tool	Pedagogical opportunity	Main limitation
LMS tests and assignments	Immediate feedback, time saved on marking, multiple attempts	Mostly assess lower cognitive levels (recall, comprehension); depend on item quality
Adaptive testing	Individual difficulty level, measurement precision	Requires a large item bank and calibration; costly to develop

Learning analytics	Early identification, group and individual dynamics	Context-dependent prediction; privacy and ethical risks
Electronic portfolio	Evidence of development, reflection, authentic assessment	Time-consuming; becomes subjective without criteria
Rubrics (in the LMS)	Transparent criteria, inter-rater agreement	Applied formally if not carefully designed
Projects, cases, simulations	Observing competences in practice	Difficult to separate individual contribution; assessment is complex
Artificial intelligence tools	Preliminary feedback, personalization	Errors, lack of transparency, risk to academic integrity

Limitations and risks of digital diagnostics.

The validity problem. Questions that can be checked automatically are easy to write, but they often cannot measure complex competences (critical thinking, problem solving, communication). As a result, the risk arises that "what is easy to measure is what gets measured." As J. Biggs noted, the form of assessment determines how students learn [1]; therefore, diagnostics based on tests alone may encourage surface learning.

Academic integrity. In online examinations and assignments, the risk of copying, impersonation, and inappropriate use of artificial intelligence increases. Against this, changing the type of task is more effective than control (proctoring) tools alone: authentic tasks based on personal experience, local material, and process, supplemented by oral defense.

The digital divide. Students differ in internet speed, devices, and digital literacy. This can affect diagnostic results so that they measure technical access rather than knowledge. For this reason, alternative arrangements (an offline option, extended time, on-campus conditions) should be provided for high-stakes diagnostic tasks.

Data privacy and ethics. Learning analytics collects a large amount of personal data about students. S. Slade and P. Prinsloo identified ethical issues such as consent,

transparency, the purpose of data use, and students' control over their own data as the main problems in this regard [2]. Students should know what data are being collected and why, and should understand that these data are used to support them, not to punish them.

Workload and instructor competence. High-quality digital diagnostics requires instructors to spend more time preparing questions, rubrics, and tasks and interpreting results, and requires specialized training. The European Framework for the Digital Competence of Educators (DigCompEdu) singles out assessment and feedback as a separate area among educators' competences, which shows the need to develop instructors' diagnostic competence [2].

Conclusion. The digital learning environment creates broad pedagogical opportunities for diagnosing students' learning outcomes: rapid and continuous formative assessment, individualization, analytical monitoring of the process, authentic competence-based assessment, and stronger active student participation. These opportunities turn diagnostics from control into a developmental, predictive, and corrective activity.

At the same time, digital diagnostics is not in itself a guarantee of quality. Its effectiveness depends on the transparency of criteria, the reliability and validity of the tools, the instructor’s diagnostic competence, and compliance with equal opportunity and data ethics. The most appropriate path is to combine the speed and scale of digital tools with the instructor's pedagogical judgment and authentic assessment tools.

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