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UNIVERSITY STUDENTS' PERCEPTION OF PERSONALIZED ADAPTIVE LEARNING IN THE PROCESS OF STUDYING COMPUTER SCIENCE

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Abstract. Personalized adaptive learning has become an important direction in contemporary computer science education because it enables instructional processes to be adjusted to students' individual learning needs, prior knowledge, and learning pace. This study investigates how university students perceive the implementation of personalized adaptive learning in computer science courses and examines its influence on learning engagement, problem-solving abilities, and academic experiences. Particular attention is given to the factors that facilitate or hinder students' acceptance of adaptive educational technologies.

The research employed a mixed-methods design. Quantitative data were collected from 384 university students using an author-developed questionnaire based on a five-point Likert scale, while qualitative insights were obtained through semi-structured interviews with 20 participants selected from the survey sample. Quantitative findings were processed using descriptive and inferential statistical techniques, whereas qualitative responses were examined through thematic analysis to identify recurring perceptions and experiences.

The findings indicate that students recognize the educational value of personalized adaptive learning, particularly for improving problem-solving skills, analytical thinking, and engagement in practical learning activities. Nevertheless, many participants expressed uncertainty regarding their readiness for self-regulated learning and their ability to assume greater responsibility for their own educational progress. The study also demonstrates that the educational benefits of adaptive learning remain constrained by the limited integration of adaptive technologies into instructional practices, course design, and assessment procedures.

The results suggest that the successful implementation of personalized adaptive learning in computer science education requires not only appropriate technological infrastructure but also pedagogically grounded instructional design, continuous teacher support, and assessment strategies that better reflect students' individual learning trajectories.

Keywords: personalized adaptive learning, computer science teaching, computer technology, adaptive learning, self-regulated learning, student perception, learning engagement, learning effectiveness

Introduction

Computer science education increasingly requires learning models that can respond to differences in students' prior knowledge, programming experience, and

pace of mastering new material. For this reason, personalized adaptive learning has become relevant as a way to adjust learning content, tasks, and feedback to individual educational needs. One of the key factors of these transformations is the active introduction of personalized and adaptive educational technologies aimed at taking into account the individual characteristics of students, their level of training, learning rate and cognitive characteristics. In the context of digitalization of education, these approaches are considered as an effective tool for improving the quality of education and student engagement, especially in computer science disciplines.

In personalized adaptive learning, instructional materials, learning activities, and feedback are continuously adjusted according to learners' individual progress and educational needs. Unlike traditional learning models that focus on a single pace and content for all students, adaptive technologies involve students' active participation in managing their own educational trajectory, developing self-regulation skills, and solving practice-oriented tasks. This approach is especially relevant for teaching computer science, where differences in the level of training and the style of thinking of students are most pronounced.

In international educational practice, personalized adaptive learning is being actively implemented in universities in developed countries, where digital infrastructure and pedagogical innovations make it possible to effectively use intelligent learning systems, learning analytics and elements of artificial intelligence. At the same time, in many educational systems that are in the process of transformation, traditional, teacher-centered approaches still prevail, characterized by the predominance of lecture forms, standardized assessment procedures and limited opportunities for individualization of learning. In such circumstances, the transition to personalized adaptive learning requires not only technological changes, but also a revision of pedagogical attitudes, educational design and assessment system.

The problem is particularly important in the context of computer science education in higher education. Modern requirements for graduates include not only subject knowledge, but also advanced skills in algorithmic thinking, problem solving, self-study, and digital competence. However, traditional teaching methods do not always ensure that these competencies are fully developed. Personalized adaptive learning based on individual educational trajectories, programming practice, and learning error analysis can contribute to deeper learning and the development of students' professional skills.

Despite the obvious potential of personalized adaptive learning, its practical implementation in university education faces a number of difficulties. The main problems include the limited willingness of students to self-regulated learning, the insufficient level of digital pedagogical training of teachers, as well as the fragmented introduction of adaptive technologies into the educational process. As a result, personalized solutions are often used sporadically, without system integration into the educational environment and teaching methods of computer science.

In this regard, it is of particular interest to study the perception of students as key participants in the educational process. Analyzing their attitudes towards personalized adaptive learning, assessing its impact on learning outcomes, and factors contributing to the adoption or resistance of these approaches allows for a deeper understanding of the real opportunities and limitations of implementing adaptive technologies in university practice.

The present study investigates personalized adaptive learning in the process of studying computer science in higher education through the prism of students' perception. The paper analyzes the general attitude of students to adaptive educational technologies, their impact on learning outcomes and involvement in solving educational and practical tasks, as well as the conditions that determine students' willingness to learn in a personalized digital environment. In particular, the research aims to find answers to the following questions:

1. What is the general perception of personalized adaptive learning by university students in the process of studying computer science?
2. How do students assess the impact of personalized adaptive learning on their learning outcomes and engagement?
3. What factors contribute to the acceptance or resistance of personalized adaptive learning by students?

Personalized adaptive learning is based on modern learning theories that focus on the individual characteristics of students, their cognitive styles, the level of training and the rate of assimilation of educational material [1]. Unlike traditional learning models, which assume a single content and pace for all students, personalized learning is focused on the formation of individual educational trajectories that take into account differences in knowledge, skills and learning needs of students [2].

Adaptive learning involves the use of digital technologies, learning analytics, and artificial intelligence elements to dynamically modify the learning content, complexity of tasks, and feedback forms [3]. Within the framework of this approach, students are not passive recipients of information, but actively interact with the educational environment, taking part in managing their own learning [4]. Personalization is achieved by analyzing learning data, including test scores, behavioral patterns, and typical student mistakes.

Findings reported in recent empirical studies indicate that adaptive instructional approaches may contribute to stronger learner engagement and sustained motivation, particularly in technology-supported learning environments [5]. Such approaches are especially effective in a digital educational environment, where learning can be flexible, modular, and focused on the practical application of knowledge [6].

In recent years, personalized adaptive learning has been actively implemented in higher education in order to improve the quality of training specialists with not only subject knowledge, but also skills in critical thinking, problem solving and independent learning [7]. Universities are increasingly using adaptive platforms, intelligent learning systems, and online courses to accommodate students' individual differences.

Personalized adaptive learning is of particular importance in the field of computer science and computer science education [8]. These disciplines are characterized by high variability in the level of initial training of students, differences in algorithmic thinking and the speed of mastering practical programming skills. Adaptive technologies allow students to master the material at their own pace, receive individual recommendations and timely feedback.

Personalized adaptive technologies may improve engagement, motivation, and academic performance [9], but their effectiveness depends on course design quality and students' readiness for autonomous learning.

Despite the significant potential of personalized adaptive learning, its practical implementation in universities faces a number of challenges. One of the key barriers is the preservation of traditional, teacher-centered learning models, in which students are accustomed to a clearly structured learning process and minimal independence.

Additional difficulties are associated with limited digital pedagogical training of teachers, insufficient integration of adaptive technologies into curricula and the lack of a systematic approach to the use of educational data. In the context of mass higher education, there are also problems associated with large study groups and limited resources.

Modern online platforms, automatic task verification systems, intelligent assistants and analytical tools can partially compensate for the lack of resources and provide individual support to students. The use of adaptive technologies in computer science teaching is particularly promising, where digital tools are an integral part of the learning process.

Studying students' perceptions is an important aspect of evaluating the effectiveness of personalized adaptive learning. Students' attitude to adaptive technologies, their subjective assessment of the usefulness, convenience and fairness of adaptation significantly affect the level of academic engagement and willingness to use these approaches in educational activities.

Research shows that students who positively perceive personalized learning are more likely to demonstrate a high level of motivation, activity, and satisfaction with the learning process [10]. At the same time, students accustomed to traditional forms of teaching may have difficulty transitioning to self-regulated and adaptive learning, especially if they are not provided with sufficient support and clear instructions [11].

In the context of computer science education, the perception of personalized adaptive learning is of particular importance, since successful mastery of the discipline requires regular practice, independent work and error analysis [12]. Understanding the factors contributing to the acceptance or resistance of adaptive technologies on the part of students makes it possible to develop more effective pedagogical strategies and create conditions for the sustainable implementation of personalized learning in university practice.

Materials and methods

A cross-sectional mixed-methods design was applied to examine students' perceptions at one point during the 2024–2025 academic year. The quantitative stage involved a questionnaire survey, while the qualitative stage used semi-structured interviews to clarify students' individual experiences. The combination of quantitative and qualitative methods allowed us to gain a comprehensive understanding of the students' learning experience, their attitude to adaptive technologies, as well as the difficulties and advantages of their application.

To ensure the diversity of the sample, a convenient sampling method was used, which made it possible to reach students from various faculties and educational programs related to computer science and computer science. The study involved 384 students who filled out a questionnaire aimed at assessing their attitudes towards personalized adaptive learning, perceptions of its effectiveness and emerging difficulties. The questionnaire included 45 statements on the Likert scale, which made it possible to quantify the subjective experience of students.

For an in-depth analysis of students' perceptions, a subsample of 20 participants was selected, with whom semi-structured interviews were conducted. The interviews provided a deeper understanding of the students' individual learning experiences, the specifics of interacting with an adaptive educational environment, and their suggestions for improving the implementation of personalized adaptive learning in computer science courses.

Statistical processing included descriptive measures for summarizing the dataset and inferential procedures for examining differences between participant groups. The SPSS v.27 software tools were used for data processing, whereas NVivo v.12.

The study participants were selected from among university students in the 2024–2025 academic year by distributing questionnaires to students studying computer science disciplines. The sample was formed using the convenient sampling method, which made it possible to quickly collect the required number of respondents.

The total sample size was 384 students, and there was a gender imbalance: 73.4% of the respondents were women and 26.6% were men. According to the courses of study, the largest proportion of the sample were students of 2–3 courses (38.0% and 38.3%, respectively), while students of 1 and 4 courses were represented to a lesser extent (15.1% and 8.6%).

By place of residence, the majority of participants represented rural areas (44.0%), followed by urban residents (33.1%) and students from remote or hard-to-reach regions (22.9%). This sample structure reflects a typical demographic picture of students studying in computer science-related fields.

The questionnaire was developed in stages to ensure its reliability and validity. At the initial stage, 60 statements were formulated on a five-point Likert scale aimed at assessing students' perception of personalized adaptive learning in the process of studying computer science. The statements were developed based on attitude criteria and grouped into the following five dimensions:

- Learning engagement and motivation (10 statements);
- development of problem solving and algorithmic thinking skills (10 statements);
- learning experience and individualization of learning (10 statements);
- The role of the teacher and the digital educational environment (10 statements);
- Assessment and feedback in adaptive learning (5 statements).

The respondents rated their degree of agreement on a five—point scale:

- 1 - completely disagree;
- 2 - disagree;
- 3 - I find it difficult to answer;
- 4 - I agree;
- 5 - I totally agree.

To verify the reliability of the questionnaire, a pilot study was conducted, based on the results of which statements with a Cronbach's alpha coefficient from 0.71 to 0.91 were selected, which indicates a high internal consistency of the scales.

For the qualitative stage of the research, a Semi-structured interview program was developed, which includes six thematic blocks: educational engagement, the experience of personalized learning, the development of independence, the role of adaptive technologies, the perception of assessment and motivation to learn computer science.

The research procedure was conducted in compliance with ethical and methodological requirements. At the initial stage, the permission of the university administration to conduct the research was obtained. The survey was conducted in face-to-face format, after which the data was carefully checked for completeness and correctness.

384 correctly filled out questionnaires were selected from the total array of questionnaires, the rest were excluded from the analysis. In parallel, Semi-structured interviews were conducted with 20 students who expressed their voluntary consent to participate and an audio recording of the conversation. The interviews were conducted individually, which allowed for detailed and meaningful answers.

The use of quantitative and qualitative data collection methods ensured the complementarity of the results and increased the reliability of the study's conclusions.

To analyze quantitative data, the capabilities of the IBM SPSS Statistics v.27 package were used. Descriptive statistical methods (frequencies, averages, standard deviations) were used, as well as scale intervals for interpreting averages:

- 1.00–1.80 — complete disagreement.
- 1.81–2.60 — disagreement.
- 2.61–3.40 — uncertainty.
- 3.41–4.20 — consent;
- 4.21–5.00 — full consent.

The student's t-test and univariate analysis of variance (ANOVA) were used to identify differences between the groups.

The qualitative data obtained during the interview was analyzed using thematic analysis in the NVivo v.12 environment, which made it possible to identify key topics reflecting students' perception of personalized adaptive learning.

Results and discussion

Table 1 presents the results of the analysis of students' perception of personalized adaptive learning in the process of studying computer science. The analysis is based on data collected from 384 students. The section on academic engagement and motivation presents assessments of the effectiveness of personalized adaptive technologies in terms of increasing students' interest and activity in the learning process.

Table – 1. Students' perception of personalized adaptive learning in the process of studying computer science

Component	N	Mean	SD	Interpretation
Academic engagement and motivation	384	2.92	0.80	Uncertainty
Critical thinking and problem solving	384	3.46	0.72	Approval
Learning experience	384	3.18	0.81	Uncertainty
The role of the teacher	384	2.61	0.78	Disagreement
Evaluation and feedback	384	2.58	0.76	Disagreement

The results show that students generally do not strongly agree that personalized adaptive learning automatically increases their engagement and interest in learning computer science. Thus, the statement "I feel more involved when learning adapts to my level of knowledge" has an average value of $M = 2.49$ ($SD = 0.850$), and the statement "Personalized adaptive learning increases my interest in the discipline being studied" has an average value of $M = 2.48$ ($SD = 0.620$). Low averages indicate that some students are skeptical about the ability of adaptive technologies to increase motivation on their own.

At the same time, students positively evaluate individual elements of personalized adaptive learning. For example, the statement "I like learning using adaptive tasks and collaboration" received an average value of $M = 3.53$ ($SD = 0.750$), and "Practice-oriented adaptive tasks are more interesting than traditional lectures" - $M = 3.52$ ($SD = 0.698$). This indicates that students recognize the value of the practical orientation and flexibility of adaptive methods.

However, a significant portion of the responses reflect uncertainty, especially regarding self-regulated learning. The statements "Adaptive learning motivates me to study topics independently" ($M = 2.95$; $SD = 0.841$) and "I feel more responsible for learning outcomes in an adaptive environment" ($M = 2.92$; $SD = 0.796$) show that students are not always ready to take an active role in managing their own educational trajectory. This result is consistent with research

indicating the difficulties of moving from traditional forms of learning to self-regulated digital models.

The analysis of the block related to the development of critical thinking and problem-solving skills demonstrates more positive assessments. Students generally agree that personalized adaptive learning promotes the development of analytical thinking and practical programming skills. The statement “I feel more confident when solving complex problems after learning in an adaptive environment” has a value of $M = 3.49$ ($SD = 0.710$), and “Adaptive learning helps connect theory with practical tasks” has a value of $M = 3.55$ ($SD = 0.698$).

High averages were also obtained for statements related to analytical thinking and reflection: “Adaptive learning encourages me to ask more questions” ($M = 3.51$; $SD = 0.711$) and “I analyze information critically more often when learning in an adaptive environment” ($M = 3.49$; $SD = 0.681$). This confirms the potential of personalized adaptive technologies in shaping the professional competencies of future computer science specialists.

At the same time, indicators related to group projects and the development of creativity remain in the zone of uncertainty. For example, “Adaptive group projects improve my problem-solving skills” ($M = 2.97$; $SD = 0.815$) and “Adaptive learning stimulates my creative thinking” ($M = 3.03$; $SD = 0.825$) reflect students’ ambiguous attitudes towards these aspects.

The results of the learning experience analysis show that students recognize that personalized adaptive learning makes the educational environment more dynamic ($M = 3.52$; $SD = 0.830$) and generally more attractive compared to traditional lectures ($M = 4.00$; $SD = 0.795$). At the same time, students do not always feel in control of their own learning ($M = 2.47$; $SD = 0.790$), which indicates the need for clearer pedagogical support.

Regarding the role of the teacher, most of the statements received ratings of disagreement. This indicates that students do not always perceive the teacher as an effective facilitator of adaptive learning. The exception is the statement “Teacher feedback in an adaptive environment is more useful than in traditional teaching” ($M = 3.52$; $SD = 0.580$), which emphasizes the importance of high-quality digital feedback.

The analysis of the assessment block shows that students are critical of existing forms of assessment in a personalized adaptive environment. Most of the statements received values below the consent threshold, which indicates a lack of transparency and consistency of assessment procedures with the principles of personalization and adaptability.

The results of the t-tests (Table 2) showed no statistically significant differences between men and women in all analyzed components ($p > 0.05$). This indicates that the perception of personalized adaptive learning does not depend on gender.

Table – 2. Comparison of perception of personalized adaptive learning by gender (t-test)

Indicator	t	Sig. (2-tailed)
Engagement and motivation	0.109	0.914
Critical thinking	-1.090	0.278
Learning experience	0.426	0.671
The role of the teacher	0.156	0.876
Evaluation	0.763	0.446

The univariate analysis of variance (Table 3) also did not reveal significant differences between students of different courses in most indicators. A slight approximation to the significance level is observed only in the “assessment and control” block, however, the differences do not reach a statistically significant level ($p > 0.05$).

Table – 3. Comparing the perception of Personalized Adaptive Learning by Course (ANOVA)

Indicator	F	Sig.
Engagement and motivation	0.575	0.631
Critical thinking	1.142	0.332
Learning experience	0.906	0.438
The role of the teacher	0.610	0.609
Evaluation	2.112	0.098

Conclusion

In this study, the perception of personalized adaptive learning by university students in the process of studying computer science was studied. The results showed that students generally positively assess the potential of personalized adaptive educational technologies, especially in the context of developing critical thinking, analysis, and practice-oriented problem-solving skills. At the same time, differences have been identified in the assessments of the effectiveness of these approaches in terms of increasing academic engagement and motivation. A significant part of the students expressed doubts about their willingness to fully take responsibility for the learning process, which indicates insufficiently developed skills of self-regulated learning, which are a key component of personalized adaptive models.

Despite this, students positively perceive individual elements of personalized adaptive learning, such as practice-oriented tasks, adaptive exercises, and interactive forms of work that contribute to a deeper understanding of computer science teaching materials. At the same time, the dominance of traditional forms of teaching, particularly the lecture format, continues to limit students' opportunities to actively participate in the learning process and make full use of the potential of adaptive technologies. This indicates that the introduction of personalized adaptive learning requires not only technological solutions, but also systemic changes in teaching practice.

An analysis of the teacher's role has shown that students do not always perceive teachers as effective facilitators of adaptive learning. This reflects the complexity of the transition from a teacher-centered model to student-centered and data-driven learning, in which the teacher acts as a mentor, an analyst of educational data and an organizer of individual educational trajectories. Insufficient pedagogical support and limited integration of adaptive tools reduce the effectiveness of learning personalization.

In addition, the results of the study revealed the critical attitude of students towards existing forms of assessment in a personalized adaptive environment. Students note that assessment procedures do not always reflect their individual progress, the learning process, and the development of practical programming skills. This indicates the need to revise the assessment system with an emphasis on formative feedback, analysis of educational data and tracking the individual dynamics of student achievements.

The findings obtained in this investigation suggest that adaptive instructional strategies can strengthen computer science education when they are supported by appropriate pedagogical practices and institutional readiness.

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ЖОҒАРҒЫ ОҚУ ОРЫНДАРЫ СТУДЕНТТЕРІНІҢ ИНФОРМАТИКАНЫ ОҚУ ПРОЦЕСІНДЕ ДЕРБЕСТЕНДІРІЛГЕН АДАПТИВТІ ОҚЫТУДЫ ҚАБЫЛДАУЫ

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Астана, Қазақстан

Аңдатпа. Дербестендірілген адаптивті оқыту қазіргі информатиканы оқытуды дамытудың маңызды бағыттарының бірі болып табылады, өйткені ол студенттердің жеке білім беру қажеттіліктерін, бастапқы дайындық деңгейін және оқу материалын меңгеру қарқынын ескеруге мүмкіндік

береді. Бұл мақалада университет студенттерінің информатика курстарында дербестендірілген адаптивті оқытуды қолдануды қалай қабылдайтыны, сондай-ақ оның оқу белсенділігіне, есептерді шешу дағдыларына және жалпы білім алу тәжірибесіне ықпалы қарастырылады. Сонымен қатар адаптивті білім беру технологияларын қабылдауға ықпал ететін немесе оларды қолдануда қиындық туғызатын факторларға ерекше назар аударылады.

Зерттеу аралас әдіснамалық тәсіл негізінде жүргізілді. Сандық деректер бес балдық Лайкерт шкаласына негізделген авторлық сауалнама арқылы 384 студенттен жиналды. Сапалық деректер жалпы іріктемеден таңдалған 20 қатысушымен өткізілген жартылай құрылымдалған сұхбаттар арқылы алынды. Сандық нәтижелер сипаттамалық және инференциалдық статистика әдістерімен өңделді, ал сұхбат жауаптары студенттердің қайталанатын пікірлері мен оқу тәжірибесін анықтау мақсатында тақырыптық талдау арқылы зерделенді.

Зерттеу нәтижелері студенттердің дербестендірілген адаптивті оқытудың білім беру құндылығын, әсіресе есептерді шешу дағдыларын, аналитикалық ойлауды және практикалық оқу әрекетіне қатысуды дамытудағы маңызын мойындайтынын көрсетті. Сонымен бірге қатысушылардың едәуір бөлігі өзін-өзі реттейтін оқуға дайындық деңгейіне және өз оқу траекториясы үшін жауапкершілікті өз бетінше қабылдау қабілетіне қатысты сенімсіздік білдірді. Сондай-ақ адаптивті оқытудың тиімділігі адаптивті технологиялардың оқыту тәжірибесіне, курс құрылымына және бағалау рәсімдеріне жеткіліксіз енгізілуімен шектелетіні анықталды.

Зерттеу нәтижелері информатиканы оқыту процесіне дербестендірілген адаптивті оқытуды табысты енгізу үшін тек технологиялық инфрақұрылым ғана емес, сонымен қатар педагогикалық тұрғыдан негізделген оқу дизайны, оқытушының тұрақты қолдауы және студенттердің жеке оқу жетістіктерінің динамикасын көрсететін бағалау жүйесі қажет екенін көрсетеді.

Тірек сөздер: дербестендірілген адаптивті оқыту, информатика бойынша оқыту, компьютерлік технологиялар, адаптивті оқыту, өзін-өзі реттейтін оқыту, студенттерді қабылдау, оқуға қатысу, оқытудың тиімділігі

ВОСПРИЯТИЕ СТУДЕНТАМИ УНИВЕРСИТЕТА ПЕРСОНАЛИЗИРОВАННОГО АДАПТИВНОГО ОБУЧЕНИЯ В ПРОЦЕССЕ ИЗУЧЕНИЯ ИНФОРМАТИКИ

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Аннотация. Персонализированное адаптивное обучение становится одним из значимых направлений развития современного обучения информатике, поскольку позволяет учитывать индивидуальные

образовательные потребности студентов, их исходный уровень подготовки и темп освоения материала. В данной статье рассматривается, как студенты университета воспринимают применение персонализированного адаптивного обучения в курсах информатики, а также как они оценивают его влияние на учебную вовлечённость, развитие навыков решения задач и общий образовательный опыт. Особое внимание уделяется факторам, которые способствуют принятию адаптивных образовательных технологий или, напротив, вызывают затруднения при их использовании.

Исследование было проведено с применением смешанного методологического подхода. Количественные данные были получены на основе анкетирования 384 студентов с использованием авторской анкеты, построенной на пятибалльной шкале Лайкерта. Качественные данные были собраны посредством полуструктурированных интервью с 20 участниками, отобранными из общей выборки. Количественные результаты были обработаны с применением описательной и инференциальной статистики, а ответы интервью проанализированы методом тематического анализа для выявления повторяющихся мнений и учебного опыта студентов.

Полученные результаты показывают, что студенты признают образовательную ценность персонализированного адаптивного обучения, особенно в развитии навыков решения задач, аналитического мышления и вовлечённости в практико-ориентированную учебную деятельность. Вместе с тем значительная часть участников выражает неопределённость относительно готовности к саморегулируемому обучению и способности самостоятельно отвечать за собственную образовательную траекторию. Также установлено, что эффективность адаптивного обучения ограничивается недостаточной интеграцией адаптивных технологий в преподавательскую практику, структуру курса и процедуры оценивания.

Результаты исследования позволяют заключить, что успешное внедрение персонализированного адаптивного обучения в процесс изучения информатики требует не только развитой технологической инфраструктуры, но и педагогически обоснованного учебного дизайна, постоянной поддержки преподавателя и системы оценивания, отражающей индивидуальную динамику учебных достижений студентов.

Ключевые слова: персонализированное адаптивное обучение, обучение информатике, компьютерные технологии, адаптивное обучение, саморегулируемое обучение, восприятие студентов, учебная вовлечённость, эффективность обучения

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