Assessing Student Needs for AI-based Adaptive Learning in Higher Education

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***Abstract*—This study examines undergraduate Information and Communications Technology (ICT) students' needs, expectations, and concerns regarding Artificial Intelligence (AI)-supported adaptive learning for programming education in Kazakhstan. Using a mixed-methods descriptive design, data were collected from 134 students at two universities via a multilingual online questionnaire that combined Likert-scale items with open-ended questions. Quantitative results indicate high awareness of AI and strong readiness to use AI-supported learning tools, with the highest-rated needs focusing on adaptive content, automated practice/task generation, progress tracking, and mobile access. At the same time, students reported moderate concerns about the accuracy of AI-generated materials and the privacy of learning data, and they preferred models where teachers remain actively involved in interpreting and guiding AI feedback. Qualitative findings reinforced these patterns, identifying technical reliability, language/localization, transparency, and integration with existing Learning Management System (LMS) as key barriers, while emphasizing stability, explainable feedback, multilingual support, and teacher-in-the-loop functionality as priorities for improvement. This study should be interpreted as a pre-implementation needs assessment based on students' responses to a hypothetical AI-supported learning scenario and does not provide evidence of actual adoption or instructional effectiveness. The study contributes user-derived design requirements that can guide the development of trustworthy and context-appropriate AI-supported learning platforms for undergraduate ICT students in programming-related courses at the two participating universities; broader generalization to other higher education fields requires further research.**

***Keywords*—mixed-methods study, user experience, programming instruction, educational innovation, data privacy, adaptive education, personalized education**

I. Introduction

Artificial intelligence has in recent years assumed the character of a structuring, rather than merely auxiliary, technology in higher education. Its contemporary manifestations—large language models, Intelligent Tutoring Systems (ITS), adaptive learning platforms, learning-analytics dashboards, and affect-aware dialogic agents—are capable of performing a wide spectrum of pedagogical functions that were previously fragmented across different systems: diagnosis of learner states, generation of tasks, explanation of errors, sequencing of content, and visualization of progress [1]. What distinguishes the current wave from earlier computer-assisted instruction is not only the higher degree of automation, but the potential for pedagogical plasticity: Artificial Intelligence (AI) can be parameterized to respond to cognitive level, language preference, emotional state, and course objectives. In principle, such systems could approximate the individualized guidance associated with one-to-one tutoring and thus address structural problems typical for mass higher education—large groups, limited teaching time, and heterogeneous student preparedness.

Yet the recent literature is remarkably consistent in showing that this potential is realized only when AI is made subservient to pedagogical, cultural, and ethical rationales. Several strands of research point to the same tension. On the one hand, empirical and meta-analytic studies document a stable, medium-sized positive effect of AI-supported "smart learning" on achievement, engagement, and pacing, particularly when feedback is immediate and the learning context is informal or under-resourced [2]. Discipline-specific studies in programming, mathematics, and medical education likewise show that AI can lower cognitive load, make abstract procedures tangible (e.g. algorithm visualization, code explanation), and increase learner satisfaction [3–5]. On the other hand, philosophically and design-oriented works caution that unreflective adoption easily drifts into what Weidlich [6] calls a "technological effect in search of an educational cause": institutions deploy powerful systems without a sufficiently articulated view of what kinds of thinking, autonomy, or scholarly identity they intend to cultivate. Watanabe [7] goes further and, drawing on a Kantian conception of enlightenment, notes that overly directive AI tutors can diminish students' courage to use their own understanding, producing dependency and superficial task completion.

Despite these advances, the state of the art still leaves important practical questions under-specified: what do students themselves expect from AI-supported learning systems, what barriers could discourage use, and which design priorities should guide implementation in real institutional settings. Accordingly, the objective of the present study is to explore students' expectations, perceived barriers, and improvement suggestions for AI-supported learning environments in programming education in Kazakhstan. This study is framed as an exploratory, pre-implementation needs assessment focused on undergraduate Information and Communications Technology (ICT) students in programming-related courses at two Kazakhstani universities.

This is why user-centered and, more precisely, learner-centered design has emerged as a necessary precondition rather than an optional enhancement. Studies grounded in the Technology Acceptance Model, human–computer interaction, and human-centered AI in education all converge on the finding that perceived

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usefulness, ease of use, transparency of AI reasoning, and linguistic accessibility are decisive predictors of actual uptake [8, 9]. Students are more willing to engage with AI when they can see how an answer was generated, when the interface is available in their working languages, when the system is responsive on mobile devices, and—crucially—when teachers remain visibly present in the instructional loop. In other words, the technical affordance "AI can generate a quiz" is insufficient; what matters is whether the form of that quiz, the language of its explanations, the place where it appears (Learning Management System (LMS) or external app), and the possibility of teacher commentary align with learners' practices. This alignment cannot be reliably inferred from system logs or policy documents; it must be elicited from students themselves.

The Kazakhstani context makes this point particularly salient. National strategies such as Digital Kazakhstan and recent sectoral analyses demonstrate that the country has already achieved high levels of digital penetration and has begun integrating AI into university management, LMS platforms, and even discipline-specific instruction [10, 11]. Experiments with AI-based visualization tools for algorithms and data structures in Kazakhstani programming courses have shown superior outcomes and much higher student satisfaction than traditional methods [3, 12, 13]. At the same time, multiple national and regional studies note a persistent disjunction between macro-level digitalization and micro-level educational experience: students report English-only or poorly localized interfaces, unstable access outside major cities, insufficient guidance on responsible AI use, and a lack of integration with platforms they already use, such as Moodle [14–16]. Moreover, adoption has often been top-down; AI tools have been introduced to students, not co-designed with them [9]. This produces exactly the scenario described in international reviews: AI is present, even measurable at the level of KPIs, but its educational value is uneven because learners' expectations and barriers were not systematically collected at the outset [17, 18].

Research gap and contribution. Although AI-in-education research has expanded rapidly, several gaps remain that motivate the present study:

- Empirical needs-based studies in AI-supported higher education remain limited in Central Asia, including Kazakhstan, despite rapid national digitalization initiatives.
- Many studies evaluate AI tools after deployment, while fewer systematically elicit student requirements before any platform is designed or implemented.
- Mixed-method evidence exists, but the integration of quantitative priorities with qualitative barriers—especially those related to multilingual/localized use and teacher–AI roles—is often under-specified.

This study contributes by (i) providing mixed-method evidence from undergraduate ICT students in Kazakhstan, (ii) identifying prioritized functions and major adoption barriers for AI-supported programming learning, and (iii) translating student input into actionable design priorities for reliable, multilingual, teacher-integrated AI systems in this exploratory pre-implementation context.

Programming and algorithmization courses—such as "Algorithms, Data Structures and Programming" which are foundational in ICT programs—are an ideal locus for addressing this gap. These courses require stepwise reasoning, error diagnosis, and repeated practice, and they are also contexts in which students commonly use AI tools (e.g., code explainers, task generators, debugging assistants). This makes them a suitable context for examining student priorities and barriers related to AI-supported learning design. These are not accidental irritations; they map directly onto the trust, transparency, and accessibility dimensions the international literature identifies as central to human-centered AI in education [8, 19].

The inquiry is guided by the following research questions:

- What functions and features do students most want in an AI-supported learning platform for programming and algorithmization?
- What barriers—technical, linguistic, pedagogical, or ethical—could discourage their use of such a platform?
- What improvements do students themselves propose to render AI-supported learning effective, trustworthy, and compatible with existing teaching practices?

Answering these questions will make it possible to specify design priorities that are technologically feasible and educationally legitimate, thereby informing more user-centered AI integration in Kazakhstani ICT programs within the scope of this exploratory needs assessment.

II. Methodology

A mixed-methods descriptive design was used for examining students' expectations, perceived barriers, and suggestions for improvement on hypothetical AI-supported learning environments for programming education. This study was conducted before any prototyping of the platform occurred to ensure that student input would guide its design subsequently. Participants responded to a hypothetical AI-supported learning platform scenario; therefore, the study measures students' needs, expectations, and concerns rather than actual platform use, adoption, or learning outcomes. Quantitative (Likert-scale) and qualitative (open-ended) data were collected within the same online questionnaire during the same survey window, analyzed separately, and then integrated during interpretation by comparing the most highly rated quantitative priorities with the dominant qualitative themes (triangulation).

The sample consisted of 134 undergraduate students, all currently enrolled in the same course "Algorithms, Data Structures and Programming" at two universities in Kazakhstan. Of these, 75 were students at Buketov Karaganda National Research University (Information Systems, Software Engineering, and Management of Information Systems programs) and 59 students from Abylkas Saginov Karaganda Technical University (Information Systems program). First- and second-year students, all being aged 18–21, were recruited. Participants' experiences in familiarization with artificial intelligence varied; approximately two-thirds had engaged with tools such as ChatGPT, Grammarly, or Quizlet, as examples. Participation was voluntary; however, researchers were compliant with institutional ethics consent by providing participants the choice to opt out or participate anonymously.

Data were collected through an online questionnaire utilizing Google Forms. The questionnaire consisted of 6 themed sections that explored demographic characteristics, previous experience with AI, understanding and attitudes towards AI, desired functionality of platforms, areas of support for learning, potential concern, and open-ended inquiry into desired features and barriers perceived. Responses stemmed from five-point Likert scale selections and included comment boxes for further elaboration. The instrument was provided in Kazakh, Russian, and English to address any language concerns and considerations regarding amount of information. The multilingual versions were prepared by bilingual researchers and reviewed for clarity and equivalence across languages. The structure of the instrument is presented in Table 1, along with example question items from the thematic sections.

Table 1. Structure of the student survey and example items

Section	Question	Response Options / Scale Type
Section 1. Background Information	University / faculty	Open field
	Year of study	□ 1st □ 2nd □ 3rd □ 4th
	Field of study	Open field
	Have you ever used AI tools for learning (e.g., ChatGPT, Grammarly, Khanmigo, Quizlet)?	□ Yes regularly □ Sometimes □ Heard of them □ Never
Section 2. Awareness and Attitudes Toward AI in Learning	I am familiar with the concept of artificial intelligence in education.	5-point Likert (1 → 5)
	AI can make learning more effective and personalized.	5-point Likert (1 → 5)
	I trust AI-generated feedback if it is accurate and transparent.	5-point Likert (1 → 5)
	I am concerned that using AI might reduce my independent thinking.	5-point Likert (1 → 5)
	I am ready to use AI-based tools regularly in my studies.	5-point Likert (1 → 5)
Section 3. Desired Functions and Features	Adaptive content that changes difficulty based on my progress.	5-point Likert (1 → 5
	Personalized recommendations for what to study next.	5-point Likert (1 → 5)
	Automatic generation of practice tasks and quizzes.	5-point Likert (1 → 5)
	Feedback on my answers explaining errors and solutions.	5-point Likert (1 → 5)
	Tracking and visualizing my learning progress by topic.	5-point Likert (1 → 5)
	The ability for teachers to monitor my progress and give comments.	5-point Likert (1 → 5)
	Access to AI-generated lecture summaries or study notes.	5-point Likert (1 → 5)
	Mobile version or app access.	5-point Likert (1 → 5)
	Multilingual interface (Kazakh / Russian / English).	5-point Likert (1 → 5)
	Integration with existing LMS (e.g., Moodle, Canvas).	5-point Likert (1 → 5)
Section 4. Preferences for Learning Support	I prefer learning environments where	□ The AI provides hints and scaffolding □ The AI directly gives correct answers □ The teacher explains after AI feedback.
	I would use such a platform mainly for:	□ Exam preparation □ Daily coursework □ Independent study □ Skill improvement.
Section 5. Potential Concerns	I worry about errors in AI-generated materials.	5-point Likert (1 → 5)
	I worry about data privacy and how my progress data will be used.	5-point Likert (1 → 5)
	I am afraid AI systems might replace teachers.	5-point Likert (1 → 5)
	I think universities should train students how to use AI responsibly.	5-point Likert (1 → 5)
Section 6. Open-Ended Questions	Which three functions would you most like to have in an intelligent learning platform?	Open-ended (text response)
	What would make you not want to use such a platform?	Open-ended (text response)
	Any additional suggestions for improving learning through AI?	Open-ended (text response)

During the spring semester, prior to development of the platform, the survey was conducted online (April–May 2025). Instructors presented the purpose of the research during class time and forwarded the participation link via the university's learning-management systems. Each student completed the survey individually in a range of 15–20 minutes. Each participant read an introductory statement that explained the objectives, the voluntary nature and data protection of the study, and indicated consent electronically before proceeding. All data were housed in encrypted institutional accounts, and identifying information was not collected.

Quantitative data were initially analyzed using descriptive statistics (means, standard deviations and frequency distributions) to summarize general tendencies related to awareness, perceived usefulness and functional priorities. This helped identify which platform features were most valued by students and the most common concerns. In addition, simple exploratory subgroup comparisons (e.g., by year of study) were conducted using inferential tests to examine whether selected quantitative responses differed across student subgroups. Open-ended responses were then analyzed through inductive thematic coding following the approach of Braun and Clarke. Each researcher independently identified recurring terms such as "mobile optimization", "AI is giving wrong answers", and "needs support from local language," which later were grouped into higher-order themes such as functionality, usability, transparency, accessibility and pedagogical integration. Coding disagreements were discussed and resolved until consensus was reached. Percentage of agreement between raters was kappa statistics (κ) = 0.87, indicating a high level of reliability. The κ value was computed on a subset of responses independently coded by both researchers prior to consensus coding.

Internal consistency reliability of the Likert-scale item groups was assessed using Cronbach's alpha (α) for Awareness and Attitudes Toward AI in Learning (Section 2), Desired Functions and Features (Section 3), and Potential Concerns (Section 5). The α values were interpreted using commonly applied thresholds, where $\alpha \geq 0.70$ indicates acceptable internal consistency, $\alpha \geq 0.80$ indicates good internal consistency, and $\alpha \geq 0.90$ indicates excellent internal consistency.

Quantitative and qualitative strands were then integrated to develop decisions about meaningful design implications. Patterns in the data indicated the students' priority areas; and qualitative responses revealed their thought processes about these intentions and contextual constraints limiting adoption. Integration was achieved by comparing the highest-rated quantitative priorities with the most frequent qualitative themes and illustrative responses, so that qualitative themes could explain, contextualize, and expand the quantitative trends by identifying convergences and complementary insights. This combination provided an empirically based rationale for designing pedagogy-supportive, linguistically-appropriate AI-enriched learning environments to meet the learning and engagement needs of programming students in Kazakhstan's higher educational system.

III. Results

A. Overview of Participants and AI Tool Usage

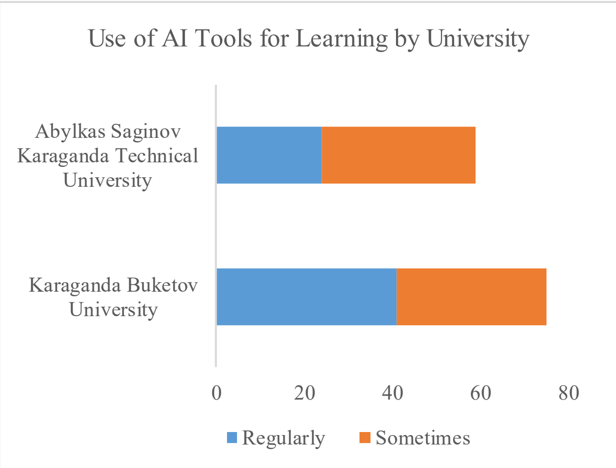

Fig. 1. Frequency distribution of students' AI tool use for learning by university.

A total of 134 undergraduate students took part in the research, with all students being registered in Algorithmization and Programming subjects across two universities in Kazakhstan. Some 75 students were from Buketov Karaganda National Research University (Information Systems, Software Engineering and Management of Information Systems programs) while the remaining fifty-nine students were from Abylkas Saginov Karaganda Technical University (Information Systems program). Most participants were first- and second-year students aged 18 to 21 years with varying degrees of experience with artificial intelligence reflective of their varied past experience with AI based educational technologies. As indicated in Fig. 1, students at each university demonstrated a level of activity usage of AI tools for learning with minor differences in frequency of use. For example, approximately forty of respondents from the Buketov Karaganda National Research University reported using an AI tool regularly while thirty-five claimed occasional usage. A similar but slightly lower trend emerged in students from Abylkas Saginov Karaganda Technical University, with approximately twenty-five respondents reporting regular use of AI and thirty-four reported occasional use of AI tools. The results indicate that a significant majority of students at both institutions are already using AI-based tools (e.g., ChatGPT, Grammarly, Quizlet) as part of their learning experiences. This suggests that Kazakhstani ICT students are not new to AI-supported learning. Nevertheless, differences in frequency of use suggest differences in access, motivation, and confidence that we will visit in later sections where we focus on considerations of student perceptions, functional priorities demands and barriers.

B. Students' Perceptions and Readiness toward AI in Learning

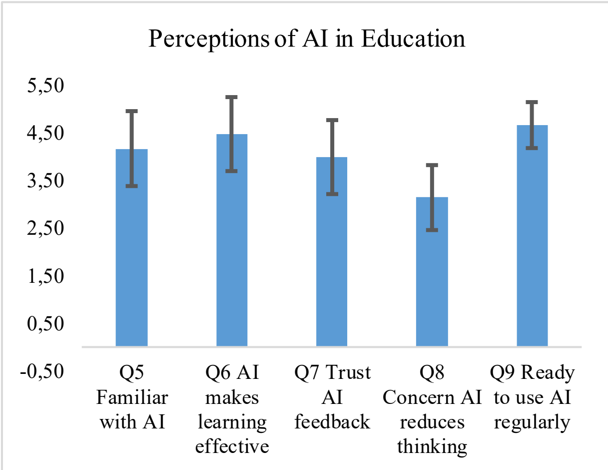

Fig. 2. Mean scores (± SD) for students' awareness, attitudes, and readiness toward AI in learning.

Overall, student attitudes toward artificial intelligence in education were positive, reflecting an increasing level of interaction and willingness to use AI-based tools during academic work. As noted in Fig. 2, mean scores for the five perception questions (Q5–Q9) suggest that most students see AI as a useful and effective supplement to their education. On a five-point Likert scale, students reported a high degree of familiarity with AI ($M = 4.16$, SD = 0.78) that indicates many students, especially those students studying ICT, are aware and knowledgeable of tools that utilize AI, consistent with their knowledge of various tools like ChatGPT and Grammarly discussed in the previous section. Students most strongly agreed with the statement, "AI supports effective and personalized learning," ($M = 4.47$, SD = 0.78), indicating that students therefore recognize the potential of AI to enhance engagement, personalize learning content, and provide personalized feedback on their work. In the same way, students displayed high levels of readiness to consider using AI regularly ($M = 4.66$, SD = 0.49) confirming that students have not only a willingness to consider the integration of AI tools, for example, into their learning environments, but a disposition to also engage with AI-based tools. In contrast, students' responses regarding trust in AI generated feedback were selected with moderate mean scores ($M = 3.99$, SD = 0.79) and indicated cautious optimism that students value assistance of AI for learning but do not necessarily trust the reliability or transparency of AI-based outputs. The lowest mean score was noted for a concern that AI could potentially impede independent thinking (M = 3.13, SD = 0.69). While the mean score does not reflect significant anxiety, it does suggest there are still a group of learners that are resistant to delegating too much authority with respect to an AI that might weaken critical thinking skills. Overall, these findings suggest student attitudes toward AI are positive, but conditional. The students recognize that AI could be an effective and accessible form of learning, but there remains some importance placed on autonomy and teacher presence, which fits with the human-centered AI frameworks described earlier.

C. Desired Functions and Features for AI-supported Learning

Students provided clear and consistent preferences about the functions and features they would like to see in future AI-supported learning settings. As shown in Fig. 3, the quantitative ratings (Q10–Q19) indicate that almost all the proposed features were considered important, with mean ratings above 4.0 based on a five-point scale—indicating notable shared agreement among the cohort. The highest rated features were mobile app availability (M = 4.39, SD = 0.75) and automatic practice or quiz generation (M = 4.31, SD = 0.74). These findings reinforce that students highly value flexibility and tools to learn on-demand to match their digital habits, which allow them to practice anywhere, anytime. Personalized recommendations about what to study next (M = 4.21, SD = 0.81) and adaptive content that modifies based on learner progress (M = 4.15, SD = 0.78) were similarly among the top preferences, indicating students' interest in routes and trajectories of learning that are individualized.

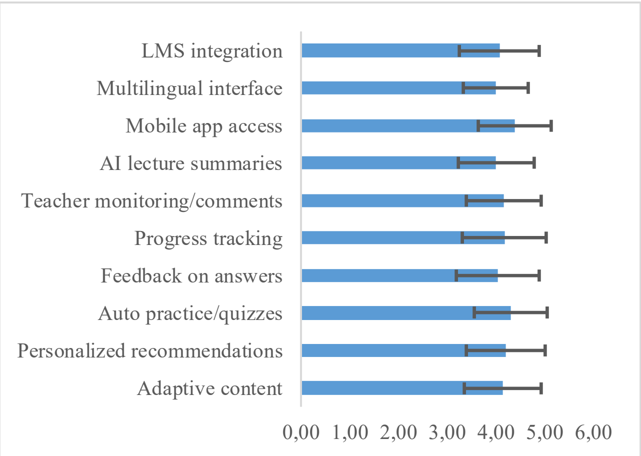

Fig. 3. Mean importance ratings (± SD) for desired features of an AI-supported learning platform.

Students also rank progress monitoring (M = 4.19, SD = 0.86) and teacher supervision and comments (M = 4.17, SD = 0.77) highly, which indicates that the learners do not see AI as educators' replacement and more as an ancillary source of feedback and shared monitoring efforts. Other desirable features included alignment with existing learning management systems (M = 4.08, SD = 0.82), AI-based lecture summaries (M = 4.01, SD = 0.78), and access to a multi-language interface (M = 4.01, SD = 0.67)—an important finding given the multi-language context of higher education in Kazakhstan. To conclude, the findings from this study show that students value functionality, personalization, mobility, and complementarity with teachers. Notably, they expect AI platforms that include scaffolding that adapts and supports continuous progress monitoring in a manner that is easy to access, situated in the students' primary language, and it is mobile.

In addition to these quantitative findings, qualitative responses provided a more nuanced view of how students are perceiving how AI would function in their programming education. In Fig. 4 there were four predominant functions coded from open-ended responses including, practice task generation, feedback/error explanation, assessment/progress monitoring, and learning that's some combination of adaptive or personalized. In addition to these coded responses, routine coding produced mentions of code checking and debugging tools, alignment with current systems, and algorithms visualizations that would provide a solution to each concern a leaner would identify in a common programming course. The themes of teacher interactions, gamifications, and multi-language accessibility were significant, but occurred less frequently, suggesting that while the primary themes are focused on intelligent automation and feedback, many students still view motivation and human guidance as important to effective learning. Taken together, these findings provide confirmation that students are seeking AI supported platforms that are interactive, adaptive, and transparent; they want systems that promote understanding through immediate feedback with an explanation, along with the benefits of teacher involvement and priorities for equitable language access students can and will utilize.

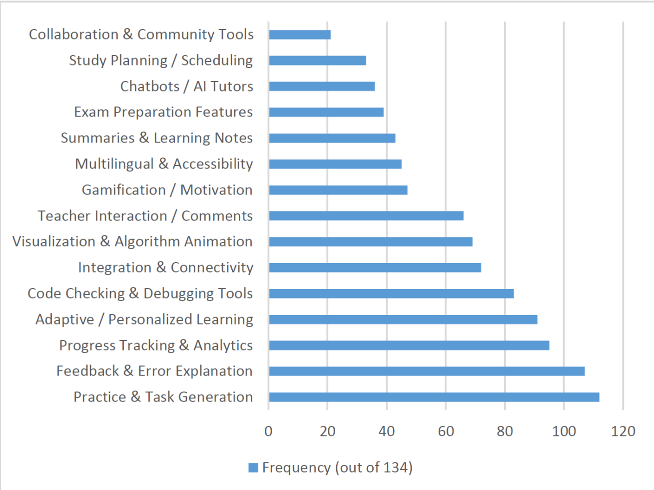

Fig. 4. Most frequently mentioned desired functions in students' open-ended responses.

D. Preferred Learning Environment and Use Scenarios

Student feedback on how they would prefer to interact with AI-supported learning systems provides important research opportunities into how they are thinking about educational human/AI-pedagogical balance. In Fig. 5, more than half (52%) of respondents preferred a learning experience where the teacher provides explanation after the

AI delivered feedback. This supports the idea that students do not want AI to act as a replacement for educators but in the role of an intentional intelligent teammate to follow the explanation, reflection, and synthesis of knowledge. Furthermore, 36% of the subjects preferred that the AI provide hints and more support that would lead to solving, which points out that many students prefer adaptive support for future tasks and want to still have the human educator as part of their learning experience. Only 12% preferred an environment where the environment could provide the correct answer on behalf of the learner, thus students appreciate the investment of effort that being cognitively engaged and being part of the interpretation of their learning experiences provides to the process. Overall these preferences communicate a hybrid model of instructional engagement where AI tools supplement rather than supplant a teacher's role. A hybrid model aligns with human-centered AI frameworks focus on aspects of transparency, wide-ranging possibilities of co-agency, and guided autonomy's that we know are dimensions of sustainability that educators can engage with for AI-supported learning.

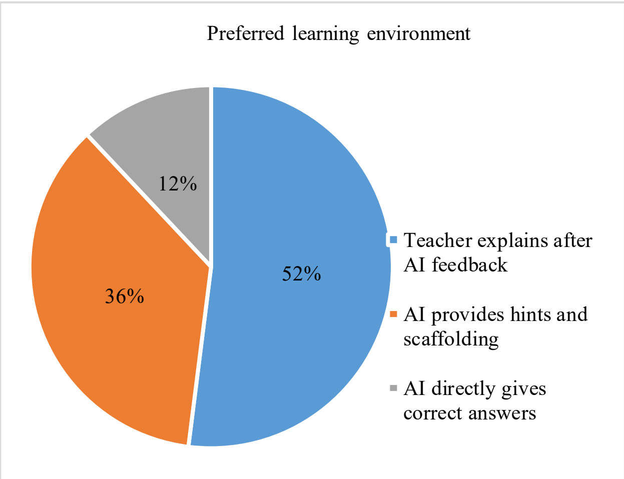

Fig. 5. Students' preferred learning environment in relation to teacher and AI roles.

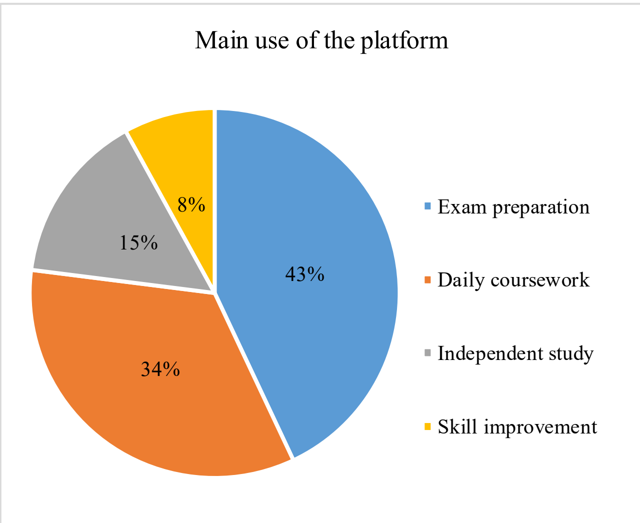

Fig. 6. Students' primary intended uses of an AI-supported learning platform.

As shown in Fig. 6, students reported their primary intended uses for an AI-supported learning platform. Most students (43%) would use these types of systems primarily for the purposes of exam preparation. Another 34% anticipated using AI primarily on a day-to-day basis in their coursework. Together these two categories amount to a nearly complete response rate indicating students believed AI technology will be primarily used in a formal and academically assessed context rather than a carefree exploration and enrichment mode. Only 15% reported they would use the tools independently in controlled studies. Finally, 8% anticipated using the tools to improve skills related to the course content but outside the course structure. The distribution of purpose of use suggests students already see AI as a viable and useful support tool with structured academics—students perceive even more potential uses of flexible, self-paced lifelong learning opportunities.

E. Students' Concerns Regarding AI Use

Although students generally viewed AI-supported learning positively, their responses also reflected measured caution. As shown in Fig. 7, the mean ratings for the concern items (Q22–Q25) suggest that students' worries are moderate rather than alarmist. The two most salient concerns were the possibility of errors in AI-generated materials (M = 3.60, SD = 0.49) and data privacy and the use of learning progress data (M = 3.61, SD = 0.49). Together, these results indicate that students are attentive to both accuracy risks and ethical/data-governance issues when AI is used in learning—concerns that align with broader discussions in the AI-in-education literature about trust, transparency, and responsible deployment.

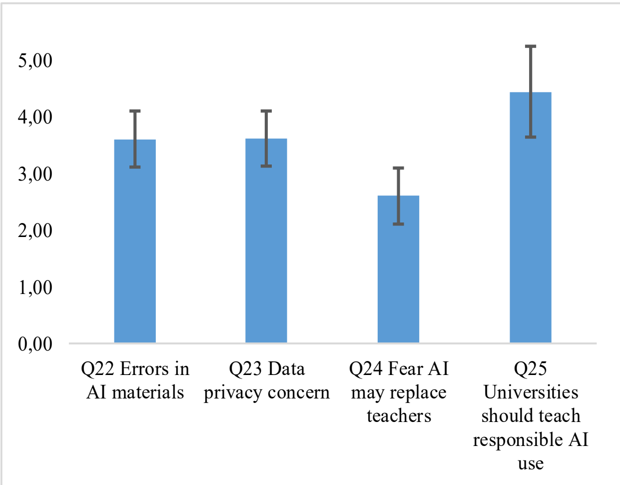

Fig. 7. Mean concern ratings (± SD) regarding AI use in learning.

Importantly, the concern that AI may replace teachers received the lowest mean score (M = 2.60, SD = 0.49), suggesting that students do not view AI as a substitute for educators. This finding is consistent with earlier results showing a preference for learning environments where the teacher remains present as an interpreter, mentor, and quality controller of AI feedback. Finally, the strongest agreement was observed for the statement that universities should teach students to use AI responsibly (M = 4.44, SD = 0.80). This reflects a clear expectation that higher education institutions should support AI adoption not only through access to tools, but also through AI literacy, ethical awareness, and guidance on appropriate use.

F. Thematic Analysis of Perceived Barriers

Open-ended responses provided further insight into the barriers that may reduce students' willingness to use AI-supported learning platforms. As summarized in Fig. 8, the qualitative coding revealed recurring themes that clustered primarily around technical reliability, trust in outputs, usability, and contextual compatibility. The most frequently mentioned barrier was technical problems and bugs (49 mentions), indicating that students associate adoption with basic system stability and smooth performance. Closely related was concern about inaccurate or wrong AI feedback (44 mentions), which students described as confusing and discouraging, particularly in programming contexts where incorrect guidance can undermine learning and problem-solving. Together, these two themes show that for students, "trust" in AI systems is strongly tied to reliability and correctness in practice, not only to general attitudes toward AI.

These barriers were also reflected in students' direct comments. Technical instability was described as a clear deterrent (e.g., "If it crashes or doesn't work on my phone, I wouldn't use it," and "If the system lags or freezes, I won't use it."). Trust was tightly linked to correctness ("If it gives wrong answers often, I wouldn't trust it,"), alongside concerns about constant connectivity ("If it requires constant internet,") and data governance ("If we don't know where the data goes," and "If my data is visible to other users."). Several respondents also noted that adoption depends on instructional alignment ("If the teacher doesn't use it," and "If it's not connected to the university LMS,"), reinforcing that usability and teacher integration are practical conditions for sustained use.

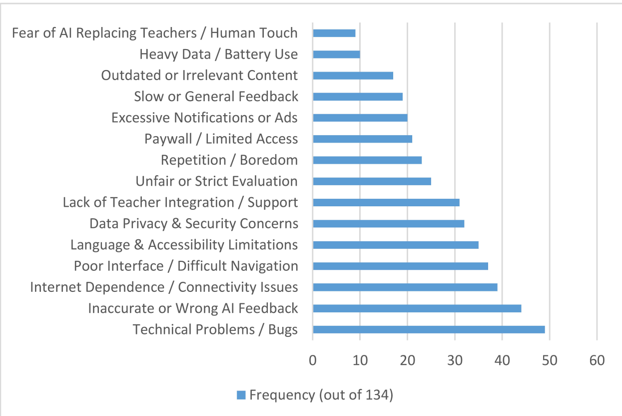

Fig. 8. Commonly reported barriers to using AI-supported learning platforms based on qualitative coding.

A second group of high-frequency barriers concerned infrastructure and usability. Internet dependence and connectivity issues were reported by 39 respondents, and poor interface design or navigation difficulties were mentioned by 37 respondents. These barriers are especially relevant in Kazakhstan's digital learning environment, where access and platform quality can vary across contexts, and where mobile-first usability is often essential. Language and accessibility limitations (35 mentions) further highlighted frustrations with English-only interfaces or low-quality translations, reinforcing the importance of localization in multilingual higher education settings. In addition, data privacy and security concerns were noted by 32 respondents, indicating that students are not only aware of privacy risks but also consider them practical barriers to engagement.

Pedagogical and motivational barriers appeared somewhat less frequently but still matter for implementation. Lack of integration and instructor support (31 mentions) emphasizes that students want AI tools to be connected to existing learning systems and teaching practices rather than functioning as isolated applications. Lower-frequency themes such as unfair or overly strict evaluation (25), repetition/boredom (23), and paywalls or limited access (21) point to concerns about fairness, engagement, and affordability. Finally, only a small number of respondents (9 mentions) expressed fear that AI could eliminate the human teacher, which mirrors the relatively low quantitative concern about teacher replacement in Section 5. Overall, the barrier profile suggests that students' reluctance is driven primarily by practical constraints—system performance, accuracy, usability, localization, and privacy—rather than by rejection of AI as a concept.

G. Thematic Analysis of Student Suggestions for Improvement

Students not only identified barriers but also provided an array of constructive ideas to help design, usability, and pedagogical success in AI-supported learning environments. The themes identify a strong alignment between students' concerns and their recommendations, emphasizing the pragmatic and workable priorities for developers and educators. The frequencies of the main themes are illustrated in a format in Fig. 9. The recommendation most often characterized by 53 of 134 students was technical optimization and stability. The component of technical optimization related to the speed and reliability of the application to quickly provide answers to learning needs as well as being bug and glitch free, with the application able to avoid crashing or destroying students' input on high user load. This finding relates directly back to the most frequent barrier noted earlier of technical malfunction. Stability as a feature of AI, therefore, becomes a baseline expectation of education technology.

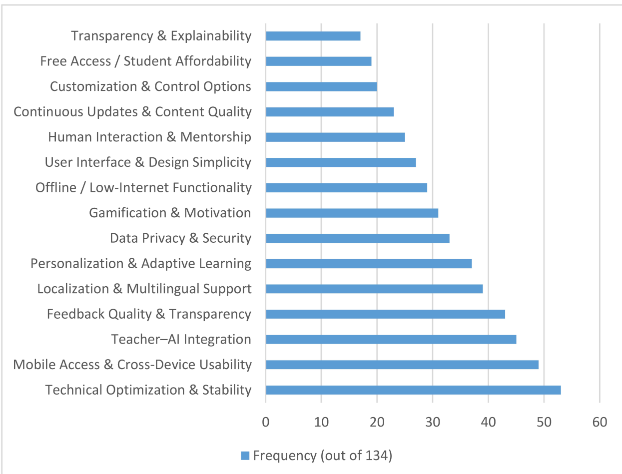

Fig. 9. Student suggestions for improving AI-supported learning platforms based on qualitative coding.

Students' suggestions closely matched these barriers and translated them into concrete requirements. Many emphasized stability and pre-release testing ("Test the platform before big exams," and "Run stability tests before deployment,") and mobile-first access ("Optimize for mobile—many students use only a phone."). They also asked for stronger teacher-AI integration ("Include teacher verification for AI feedback," and "Allow teachers to edit or correct AI answers,") and more transparent, instructive feedback ("Show clearly how AI got the answer," and "Provide a clear explanation for every error."). Finally, respondents highlighted localization ("Make the interface in Kazakh and Russian; let us choose the language,") and offline support ("Allow offline mode or export tasks to PDF,") as essential for usability in real study conditions.

The second and third most commonly cited themes were mobile access and cross-device usability (49 mentions) and AI in teaching, learning, and assessment (45 mentions). Students want seamless synchrony between their phones, tablets, and laptops, which is consistent with mobile learning habits of students at universities. They also want the system to include teachers when feedback and assessments are in the loop, reinforcing the notion that students see AI as a partner in learning, not a substitute for the instructor. A theme that emerged more moderately is feedback quality and transparency (43 mentions), where students asked for feedback that included explicit reasoning in AI-generated answers, better identification of errors, and clear explanation of the AI's reasoning so that students could build trust and support their metacognitive learning strategies. Along with feedback, another high priority was localization and multilingual support (39 mentions), consistent with Kazakhstan's multilingual education environment along with frustration with an English-only application interface. Other, recurrent suggestions included personalization and adaptive features (37 mentions) and more robust data privacy and ethical security features (33 mentions), suggesting students want to engage with a platform that adapts intelligently to their progress while also being ethically responsible with their data. Suggestions that arose less frequently but were still insightful included gamification and other motivational features (31 mentions), offline or low-internet user functionality (29 mentions), and simplifying the application/ interaction design (27 mentions) to boost usability and engagement amid constrained technology and internet access. Finally, a few students remarked about the importance of human mentoring and continual updating of content, free or affordable options for participation, all suggestions to induce equitable participation and engagement for ongoing valued learning. A few students also mentioned the importance of transparency and explainability (17 mentions) which is due in part to their growing consciousness of the ethics of AI in education. In summary, these results depict students as (pro)actively productive co-designers expecting engaging AI systems that are functionally stable, inclusive, transparent and pedagogically integrated. Students are envisioning human-centered, multilingual and ethical access and engagement with educational AI in their higher education.

Across sections C–G, the qualitative findings generally confirmed and clarified the quantitative patterns. In particular, high quantitative ratings for mobile access and automated practice generation were reinforced by frequent qualitative requests for mobile optimization/cross-device usability and task-generation support; moderate quantitative concerns about AI errors and data privacy were echoed in barrier themes related to incorrect feedback and data governance; and the quantitative preference for teacher involvement after AI feedback was reflected in repeated suggestions for teacher verification and teacher–AI integration. These convergences increase transparency of the mixed-methods interpretation by showing how open-ended responses contextualized the main quantitative trends.

H. Exploratory Subgroup Analysis by Year of Study

To explore whether students' needs and concerns differed by academic experience, an exploratory comparison was conducted between first-year and second-year students. Given the descriptive and needs-assessment nature of the study, this analysis was treated as exploratory and interpreted cautiously. The subgroup sample included 59 first-year students and 75 second-year students.

Overall patterns were largely consistent across year groups. Both first-year and second-year students reported positive views toward AI-supported learning and similar preferences for teacher-supported use. For the concern item on AI-generated errors, subgroup differences were minimal (Year 1: $M = 3.59$, SD = 0.50; Year 2: $M = 3.61$, SD = 0.49) and not statistically significant (Welch's $t = -0.234$, $p = 0.815$, Cohen's $d = -0.041$), indicating a trivial effect size.

No substantial differences were observed between year groups in concerns related to data privacy (Year 1: $M = 3.61$, SD = 0.49; Year 2: $M = 3.61$, SD = 0.49). The difference was not statistically significant (Welch's $t = -0.037$, $p = 0.971$, Cohen's $d = -0.006$). Likewise, group differences in preferred teacher-AI role were not statistically significant ($\chi^2(2) = 0.055$, $p = 0.973$, Cramér's $V = 0.020$). In both cohorts, the majority preferred teacher-in-the-loop models (Year 1: teacher explains after AI feedback = 27/59, AI provides hints/scaffolding = 24/59, AI gives direct answers = 8/59; Year 2: 33/75, 31/75, and 11/75, respectively).

Similarly, intended use of the platform did not differ meaningfully by year group ($\chi^2(3) = 0.035$, $p = 0.998$, Cramér's $V = 0.016$). In both cohorts, the most common intended use was exam preparation (Year 1: 29/59; Year 2: 37/75), followed by daily coursework (Year 1: 16/59; Year 2: 21/75). Given the modest size of subgroup differences and the exploratory nature of this analysis, these patterns should be interpreted cautiously.

IV. Discussion

This discussion interprets findings from a pre-implementation, hypothetical needs assessment and should not be read as evidence of actual AI-platform adoption or instructional effectiveness. The results of this investigation yield a complex but coherent picture of how undergraduate ICT students in Kazakhstan understood, engaged, and imagined AI-supported educational contexts. In combination, the quantitative and qualitative outputs corroborate students' enthusiasm for the educational potential of AI, but their expectations were more fundamentally linked to pragmatic considerations about functionality, transparency, and continuing teacher presence. The subsequent discussion interprets these results in relation to established international and local literature and discusses pedagogical, technological, and contextual implications for the design and implementation of learner-centered AI systems in the two participating universities and similar ICT/programming contexts.

A. Interpretation of Main Findings in Relation to Existing Research

Empirically, students rated adaptive content, automatic practice generation, and progress tracking highly. Interpretively, this pattern suggests that, in this sample of ICT students, the AI component is viewed mainly as a personalized learning partner. This aligns with earlier studies which found adaptive learning and immediate feedback to be the most desired affordances of intelligent tutoring systems [1, 2]. Students also rated mobile access and cross-device compatibility highly, which suggests that ubiquitous learning has become an expectation rather than a convenience in this context. In practice, the prominence of mobile access likely reflects students' everyday learning habits (short, frequent study sessions, commuting, and reliance on smartphones), suggesting that "anytime/anywhere" access is a prerequisite for sustained engagement rather than an optional feature.

At the same time, the results indicate a complex form of conditional trust towards AI. Respondents saw AI as effective and were willing to use it (Q6–Q9), but moderate levels of concern remained about reliability (Q22–Q23) and impacting independent thinking. Although these concerns were not extreme, they are meaningful because even moderate doubts about correctness and data handling can reduce willingness to rely on AI for high-stakes coursework (e.g., graded programming tasks). This ties in with Weidlich's [6] arguments that uncritical use of AI could lead to passive learning patterns when AI systems value correctness over reasoning. Learners' interest in transparency and explanatory feedback as expressed by scales and qualitative answers emphasize the importance of explainable AI (XAI) in educational design [8]. Learners wanted not only to know the right answer, but to understand why it was right-an essential condition for metacognitive growth.

Another important finding connected to the teacher-AI relationship. More than half of students preferred it when "the teacher explains after AI feedback," and qualitative comments stressed again the role for the teacher in moderation and mentorship. This supports international evidence suggesting that hybrid human-AI learning models can support strong learning outcomes because they keep social accountability, empathy and interpretation of context [4, 7]. Put differently, students in this sample described AI more as a collaborator than as a replacement; AI as a co-tutor extends the ability of the teacher to provide personalized support. This preference implies that adoption is most likely when AI is positioned as "supportive infrastructure" for teaching, rather than an autonomous tutor that bypasses the instructor.

B. Pedagogical Implications

In this sample of ICT students, the findings suggest that AI is more likely to be accepted pedagogically when it is integrated into existing teaching frameworks rather than introduced as a separate or parallel system. Students certainly appreciate adaptive feedback and adaptive practice generation, but they also rely on a teacher's judgement to validate, interpret and/or extend an AI-generated explanation. This aligns with a "human-in-the-loop" approach in which the teacher maintains the authority over pedagogy while the AI system takes over the repetitive and/or time-consuming aspects of teaching such as quiz generation, analytics of student's progress data and decision-making for timely feedback (ex. preliminary feedback).

Empirically, students preferred "AI hints and scaffolding" over direct answers. Interpretively, this suggests that AI systems should scaffold learning rather than merely automate it. Students' preference of "AI hints and scaffolding" in responses as opposed to "answers", indicates an awareness of being too reliant on automation for direct answers can halt the deeper understanding of concepts. Therefore, if the purpose of AI is teaching programming and algorithmization, the design of the AI should focus on guided discovery with hints, error analysis and partial answers that encourage problem solving rather than providing procedural answers as substitutes.

Lastly, student consensus for universities to teach responsible use of AI demonstrates an emerging awareness that AI literacy is an academic capability. This will encourage the addition of a critical, ethical and interpretative dimension of AI within ICT courses. This may also require instructors to explicitly teach how to interpret feedback from AI and validate its accuracy and reflect on the limitations of AI - which extend beyond technical skill to digital ethics and self-regulated learning.

C. Design Implications for AI-supported learning Platforms

Taking into account the implications for design, our data point toward a specific set of concrete priorities for developers and institutions hoping to develop learner-directed AI platforms. Across the results, students stressed stability and accuracy, as well as interface quality, as important attributes of learner-directed AI systems. Technical robustness is a baseline requirement because trust with technology diminishes quickly if the system is unreliable or buggy.

Another key design implication relates to language accessibility. The expressed need for interfaces to include multilingual and localized options, while reflecting the trilingual education system in Kazakhstan, suggests that language is not only a cultural preference but a functional requirement for effective learning. If students had an interface that included at least their first languages, they would be able to access educational opportunities and the national emphasis on inclusion aligned as part of the "Digital Kazakhstan" approach.

Equally important, students expressed that any features developed for use with AI should be seamlessly integrated with their existing learning ecosystems (e.g., Moodle or Canvas). Students also reported frustration with fragmented or disconnected learning environments. This preference aligns with other international work supporting that technology adoption increases when new technologies fit existing workflows and integrate with institutional learning management systems (e.g., [9]).

Finally, students expressed a need for transparency about the quality and the learning engagement from feedback, so AI platforms should include the reasons for learner generated feedback as visible responses to learners. For example, using "How this answer was generated" notices would provide more transparency and trust for students rather than creating false notions about AI as being faultless but rather providing valid reasoning, whether approximate or suggestive, on what the data suggest based on AI.

Based on these findings, the following design requirements emerge as priorities for AI-supported programming platforms:

- Stability and low-latency performance (bug reduction, fast response time).
- Accuracy safeguards and clear error-handling (to reduce the impact of wrong feedback).
- Explainable feedback (why an answer is correct; how errors occurred; guidance rather than only final answers).
- Teacher-in-the-loop features (teacher dashboard, monitoring, and commenting/feedback loop).
- Multilingual, localized UI (Kazakh/Russian/English) with high-quality translation.
- Integration with existing LMS (e.g., Moodle) to reduce fragmentation of learning workflows.
- Privacy-by-design (transparent data handling, storage, and user control over learning data).

D. Contextual Significance for Kazakhstan

These findings are contextually relevant to Kazakhstan, where digitalization has accelerated through initiatives such as Digital Kazakhstan and related policies [10, 11]. While the nation has a very explicit digitalization agenda and a developed macro view of digital infrastructure, the present results suggest a continuing gap between macro-level digitalization goals and micro-level learning experience in this sample, including concerns about access, English-only interfaces, and limited teacher mediation [14, 16].

In capturing voices of students from two participating universities in Kazakhstan, we take the international discourse about AI in education to a less researched geographical and linguistic context. The emphasis on multilingual support, mobile access, and teacher/AI roles likely reflects contextual and cultural aspects of a multi-lingual, multi-cultural educational setting that varies widely from western European and North American experiences. If these patterns are confirmed in broader samples, effective AI uptake in Kazakhstan's higher education system may require stronger contextual adaptation beyond policy-level deployment.

Likewise, given the issues tied to stability, localization, and human involvement expressed by students, these patterns may reflect the broader cultural emphasis on relational pedagogy: learning through engagement with others and dialogue and mentorship. Thus, the introduction of AI into Kazakhstan's post-secondary education has to be based on local pedagogical educational traditions as well as the infrastructures already established.

E. Limitations and Directions for Future Research

Similar to other studies that present useful baseline data, this research has its limitations. Although students from the two universities had a relatively diverse sample, students were largely from ICT-related programs; students from other disciplines (e.g., the humanities or teacher education) may have a different opinion about usefulness or ethical issues created by the technology. Self-reported data was used in this study, which may create response bias; students may have been overstating their knowledge of or confidence in using AI technology. This study was also conducted at a time when no AI tool was operational, and thus students were responding to anticipated beliefs not their actual experience; therefore, the findings should not be interpreted as evidence of actual adoption behavior or instructional effectiveness.

As next steps, future studies should build from this study and conduct experimental or longitudinal studies that assess changes in student perceptions when AI Tools are experienced by students in real coursework. Comparative study designs would also compare disciplines or different schools (public or private) in the context of adoption. Finally, participatory design research, whereby students and/or instructors are involved as co-designers of an AI Tool interface would elucidate the integration of the findings from this study into AI design prototypes that will create practices reflecting human-centered AI.

V. Conclusion

The objective of this study was to understand the ways undergraduate ICT students in Kazakhstan conceptualize and evaluate the potential role of AI in programming education before the creation of any AI-supported learning platform. To address this aim, the study used a mixed-methods survey design with quantitative Likert-scale items and qualitative open-ended responses collected from 134 programming students at two universities. As a pre-implementation needs assessment based on students' responses to a hypothetical AI-supported learning scenario, this study does not provide evidence of actual platform adoption, learning outcomes, or instructional effectiveness.

Overall, the findings show that students are receptive to AI-supported learning, but their acceptance is conditional on practical and ethical requirements. Key priorities were: (1) mobile access and flexible, on-demand use, (2) adaptive practice and feedback that explains errors and reasoning, and (3) trust conditions, especially accuracy and data privacy, alongside a clear preference for teacher-in-the-loop use rather than teacher replacement.

This study contributes user-derived design priorities for AI-based adaptive learning platforms in the Kazakhstan higher education context, highlighting the importance of stability, transparency, multilingual accessibility, LMS integration, and responsible-use guidance. These conclusions are limited to the present exploratory sample of undergraduate ICT students in programming-related courses at two universities and should not be generalized to other disciplines without further research. Future work should translate these requirements into a working prototype and evaluate its educational impact through pilot implementation and experimental and/or longitudinal studies in authentic coursework settings to test real use, adoption, and learning outcomes.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

K.D. conceptualization, methodology, writing of the main manuscript, data analysis, interpretation of results, and supervision. T.D. research design, data collection, interpretation of findings, and editing of the manuscript. Z.A. methodological support, interpretation of findings, and editing of the manuscript. T.G. literature review, interpretation of findings, and editing of the manuscript. All authors read and approved the final version of the manuscript.

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References

[1] L. Toldi and T. Lengyel-Molnár, "Development options for artificial intelligence supported intelligent tutoring systems via the integration of the ChatGPT," *MNy*, vol. 148, no. 5, pp. 618–628, 2024. doi: 10.38143/Nyr.2024.5.618

[2] M. Younas, I. Ismayil, D. A. S. El-Dakhs, and B. Anwar, "Exploring the impact of artificial intelligence in advancing smart learning in education: A meta-analysis with statistical evidence," *Open Praxis*, vol. 17, no. 3, pp. 594–610, 2025. doi: https://doi.org/10.55982/openpraxis.17.3.842

[3] M. Bokan, J. Abdimalikkyzy, A. Babaeva, A. Keldibekova, S. Makpyr, and Y. Smagulov, "Enhancing logical thinking skills of future informatics teachers through artificial intelligence," *QAJ*, vol. 5, no. 1, pp. 543–551, Mar. 2025. doi: 10.48161/qaj.v5n1a1329

[4] B. R. Collins, E. W. Black, and K. E. Rarey, "Introducing AnatomyGPT: A customized artificial intelligence application for anatomical sciences education," *Clinical Anatomy*, vol. 37, no. 6, pp. 661–669, Sept. 2024. doi: 10.1002/ca.24178

[5] K. Hartley, M. Hayak, and U. H. Ko, "Artificial intelligence supporting independent student learning: An evaluative case study of ChatGPT and learning to code," *Education Sciences*, vol. 14, no. 2, 120, Jan. 2024. doi: 10.3390/educsci14020120

[6] J. Weidlich, D. Gašević, H. Drachsler, and P. Kirschner, "ChatGPT in education: An effect in search of a cause," *Computer Assisted Learning*, vol. 41, no. 5, e70105, Oct. 2025. doi: 10.1111/jcal.70105.

[7] A. Watanabe, "Have courage to use your own mind, with or without AI: The relevance of Kant's enlightenment to higher education in the age of artificial intelligence," *EJEL*, Mar. 2024. doi: 10.34190/ejel.21.5.3229

[8] A. A. Bennett *et al.*, "Exploring business doctoral students attitudes, training, and use of classroom experiential learning activities," *The International Journal of Management Education*, vol. 19, no. 2, 100493, 2021. doi: https://doi.org/10.1016/j.ijme.2021.100493

[9] S. Mamanazarov *et al.*, "Innovating human capital development: The role of education, law, and economics through digital transformation," *QAJ*, vol. 5, no. 3, pp. 78–113, July 2025. doi: 10.48161/qaj.v5n3a1698

[10] A. Assanova, A. Issaeva, Z. Dzhubalieva, R. Arzikulova, and A. Uchkampirova, "Financial-digital investments in human capital as a factor of sustainable economic growth: assessment, dynamics and impact of artificial intelligence (a Kazakhstan case study)," *EA-XXI*, vol. 213, no. 1–2, pp. 18–29, Feb. 2025. doi: 10.21003/ea.V213-02

[11] O. Bazyl, O. Abilova, O. Karpenko, H. Mierienkov, and A. Poliakova, "Assessing the impact of artificial intelligence integration on educational processes in higher education institutions of Ukraine and Kazakhstan," *Sustainable Engineering and Innovation*, vol. 7, no. 1, pp. 97–116, Mar. 2025. doi: 10.37868/sei.v7i1.id418

[12] Z. Karatayeva, G. Abildinova, C. Karaca, and K. Mukhtarkyzy, "Integrated application of digital technologies in interconnected energy sources in renewable energy education," *World Transactions on Engineering and Technology Education*, vol. 22, no. 3, pp. 196–204, 2024.

[13] K. Mukhtarkyzy, G. Abildinova, and O. Sayakov, "The use of augmented reality for teaching Kazakhstani students physics lessons," *Int. J. Emerg. Technol. Learn.*, vol. 17, no. 12, pp. 215–235, June 2022. doi: 10.3991/ijet.v17i12.29501

[14] A. B. Nassoura, "Applied artificial intelligence applications in higher education institutions: A systematic review," *Webology*, vol. 19, no. 3, 2022.

[15] Y. Smagulov, Z. Zhiyembayev, and M. Bokan, "Artificial intelligence in education: Impact, applications and future prospects," *Bulletin Series of Physics & Mathematical Sciences*, vol. 89, no. 1, Mar. 2025. doi: 10.51889/2959-5894.2025.89.1.028

[16] B. Zholdigaly, L. O. Zhumabayeva, and E. A. Abdykerimova, "Artificial intelligence in the education sector of Kazakhstan: Opportunities and prospects," *YSJ*, vol. 48, no. 3, pp. 77–82, Oct. 2024. doi: 10.56525/DQHG9635

[17] A. Behera, P. Trivedi, S. K. Patra, and C. Makeni, "Artificial intelligence and higher education: A systematic review," *STEM*, vol. 11, pp. 27–52, May 2025 doi: https://doi.org/10.32674/0x43s107

[18] W. J. Marín Rodriguez *et al.*, "Artificial intelligence and augmented reality in higher education: A systematic review," *Data and Metadata*, vol. 2, 121, Nov. 2023. doi: 10.56294/dm2023121

[19] S. M. Nimbalagundi, A. S. Bagawan, and C. S. Katageri, "Artificial intelligence in higher education," *Int Res J Adv Engg Mgt*, vol. 2, no. 9, pp. 2790–2795, Sept. 2024. doi: 10.47392/IRJAEM.2024.0406