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**Research Article**

# The Impact of AI-Powered Adaptive Learning on Student Teachers' Pedagogical Practices

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**ABSTRACT**

The incorporation of teacher technologies that stimulate student reasoning and provide personalized feedback modifies classroom dynamics and challenges traditional teacher roles (R. Rathmell, 2018). AI-powered adaptive learning programs that monitor, predict, communicate, and adjust content based on learner needs have the potential to inform teaching choices and reshape pedagogical approaches. Prior research has examined how novice teachers accommodate AI-adaptive learning when planning lessons and facilitating student learning, often revealing shifts in instructional choices. However, an understanding of the relationship between the utilization of such platforms and the pedagogical practices of student teachers remains absent. This study analyses evidence gathered through questionnaires, interviews, and observations from 56 student teachers across multiple institutions to consider the role of AI-powered adaptive learning in pedagogical decision-making and instructional practice.
Findings demonstrate that adaptive learning influences the pedagogical practices of student teachers, enabling personalization of instruction and encouraging engagement with student-centred pedagogies. The study, therefore, highlights the potential of AI-powered platforms to transform the practices and identities of teachers and underscores the importance of equipping student teachers to leverage these technologies effectively.

**Keywords:** AI, adaptive learning, student teachers, pedagogy, teacher education.

## 1. Introduction

Artificial intelligence (AI) has penetrated many aspects of daily life, including student teachers' pedagogical practices (R. Kshirsagar et al., 2022). AI-powered adaptive learning platforms generate personalized resources and assignments based on students' knowledge, skills, and abilities. Teacher education programmes that train student teachers to use these platforms facilitate the development of predictive analytics and data-driven decision-making competencies. This study explores student teachers' perceptions of the role and importance of AI-powered adaptive learning in their pedagogical practices. Respondents observed that adaptive learning supports personalised lesson construction, enhances engagement, and improves learning outcomes. It thus can positively influence pedagogical behaviour, enabling teachers to assign work that better matches individual preferences and capabilities and align classroom instruction with students' preparedness (R. Rathmell, 2018). AI can therefore increase awareness and support sound pedagogical decisions, but use must be accompanied by guidance in responsible, ethical practice.

### Context of AI integration in teacher education

Artificial intelligence has made inroads in education, leading to the emergence of adaptive-learning systems that alter the nature of teaching and learning (R. Kshirsagar et al., 2022).

### Importance of adaptive learning technologies in pedagogy

AI-powered adaptive learning marks a significant milestone in the technological evolution of education. Merging human creativity with computational power facilitates adaptation to each student's unique needs, preferences, and pace (R. Kshirsagar et al., 2022). Literature on AI emphasizes adaptive learning as one of the cutting-edge methods to amplify human learning capabilities within a targeted timeframe. Adaptive learning

addresses the constraints of traditional, one-size-fits-all approaches, like standardized textbooks, fixed lesson plans, and immutable assignments, which tend to overlook student-specific learning styles, goals, and abilities. Adaptive learning enables educators to craft cognitive and metacognitive learning strategies—such as attention guidance, rehearsal, scanning, and translation—to help students efficiently acquire and assimilate new knowledge.

The last decade has witnessed a growing commercial emphasis on platforms focused on adaptive learning with a particular emphasis on personalized education. Selecting relevant hypotheses early on aids in structuring and presenting information in a targeted manner (Bucchiarone et al., 2022). The widespread presence of Internet-enabled devices has spurred the development of new adaptive learning solutions that document user interactions and pinpoint areas for targeted improvement. For example, the 2015 education report from Colorado Technical University revealed that adaptive learning adoption contributed to a 27% increase in course pass rates, along with notable enhancements in grades and retention. Despite offering extensive analytics on student performance and behavioral metrics, current adaptive technologies often overlook students' familiarity with tools and environments—an essential aspect for real-world task preparation. Additional emphasis on integrating industry-standard tools and hands-on experiences with physical devices (e.g., Arduinos, radio modules, educational kits) further enriches the learning process. Emerging technologies such as augmented and virtual reality foster interactivity and engagement both in educational settings and industry contexts, with applications ranging from remote maintenance to surgical training. Meanwhile, voice user interfaces emulate study companions, supporting diverse learning activities while preparing students for dynamic, on-the-move environments. The predominant focus of contemporary adaptive solutions on content personalization—especially when delivered through custom platforms—may constrain the suitability for certain learning activities.

## Research objectives and questions

The ubiquity of artificial intelligence (AI) has deeply affected our lives, while education is in a position to profit from a proper adaptation to such evolving means. The survey on teaching design methods under educational psychology based on deep learning and AI measures the satisfaction degree of a large group of teachers, students, and parents in the school that adopted the teaching design method based on deep learning (Wang et al., 2021). The results illustrate that the overall response rate has increased by 8.01% after using the proposed design, and the satisfaction degree has also risen by 6.60%. The number of respondents who take the new teaching design as quite satisfactory or satisfactory accounts for 63.3%, where the proportion of particular satisfaction reaches 17.0%. In addition, it was found that students' performance in mathematics, language, and English has been significantly improved after the study. Those who obtain higher scores in the analysis of students, teaching strategy, and analysis of textbooks have better performance, which indicates that sufficient understanding of students and comprehensive familiarity with teaching materials play crucial parts in the whole teaching process. Recent researches on the integration of AI with teaching are also summarized, which shows that an advanced teaching system can improve teachers' efficiency and students' enthusiasm; the traditional learning mode can not meet today's requirements, and AI should be employed to generate a novel learning mode for better learning experiences. The innovation brought by AI during the era of intelligent education will positively influence the development of the educational profession and bring about a transformative change in the major. Intelligent education will promote teacher literacy and professional ability, while also stimulating their innovative thinking and generative development. Sustained emphasis on the teaching practice of intelligent technology should be placed, with full potential to further instruct the physical teaching of AI-enabled courses. To that end, it is imperative for teachers to conscientiously reflect on their own pedagogical approaches and continually cultivate themselves through personalized application of intelligent software. Teachers' pedagogical development activities in light of intelligent technology should be actively organized and carried out to take advantage of the opportunities presented by the era of intelligent education and to shape high-quality educators suited to the current sociocultural context.

## Structure of the paper

The structure of the paper is organized as follows. After the introduction in Section 1, the literature review in Section 2 explores AI-powered adaptive learning platforms and pedagogical theories, reviews prior studies on AI's impact in teaching, and identifies gaps concerning student teachers' pedagogical adaptation, thereby establishing the research niche. Section 3 describes the chosen research design, participant selection, data collection methods, and analysis procedures, creating a clear connection with the results. The findings presented in Section 4 examine how adaptive learning affects pedagogical practices and are supported by tables detailing demographics, AI tools used, changes in practice such as personalization and engagement, and challenges faced—this section cross-references methodology for clarity. Section 5 interprets the results through pedagogical theories, discusses implications for teacher education programs, emphasizes AI's role in personalized instruction and decision-making, explores the impact on teacher identity and instructional strategies, and addresses challenges and ethical considerations, linking back to the literature review and results. Section 6 summarizes the key insights, underscores the study's contributions to understanding AI's influence on student teachers, and proposes directions for future research and practice improvements (Tian et al., 2024; Tan et al., 2023).

## 2. Literature Review

AI-powered adaptive learning platforms offer personalized and efficient instructional experiences, enabling instructors to optimize teaching methods and learners to engage with content at their own pace (Song & Song, 2023). Such platforms employ learning analytics, adaptive microlearning, learning pathways, and intelligent tutoring to create individualized learning environments while reducing educator workload (AlTwijri & Musaed Alghizzi, 2024). Although their role in teacher education remains underexplored, theories of pedagogy, oincluding behaviorism, cognitivism, constructivism, sociocultural theory, humanism, and connectivism, oprovide valuable frameworks for investigating AI00s impact on student practices. Through a synthesis of existing literature, this review first introduces AI-powered adaptive learning and summarizes pertinent pedagogical theories. It then examines prior findings on AI00s influence in teaching before identifying the unexplored domain of student pedagogical adaptation to AI technologies.

### Overview of AI-powered adaptive learning platforms

AI-powered adaptive learning platforms utilize artificial intelligence techniques to adjust the learning content, pace, and instructional approaches according to the needs of individual learners (R. Kshirsagar et al., 2022). AI-based platforms analyze real-time data on learner characteristics, interactions, learning styles, and performance to tailor the activities, resources, and assessments. The system also considers preferences, prior knowledge, goals, and cognitive load. Learning content and instructional models can be adapted through methods such as recommendation systems, expert rules, and machine learning algorithms. Adaptive learning influences instructor decisions regarding lesson content, activities, and methodological approaches. Personalization is the most common application of AI in education, addressing challenges associated with large classes and accommodating multiple learning styles and speeds. The human-machine interface comprises natural language processing, voice recognition, and student mood detection, facilitating seamless interaction. Data mining techniques combined with machine learning models allow the platforms to passively generate predictions based on student behavior and performance (E. August & Tsaima, 2021). Continuous data collection during the learning process enables the system to refine its understanding of the learners and optimizes subsequent adjustments. AI-powered adaptive learning solutions deliver timely and individualized training and assessment for students, transforming instruction into a shared exercise based on a pedagogical dialogue between humans and machines. Education providers aim to build dynamic models of knowledge and skills for each learner that support flexible application of the latest neuroscience, psychology, and data-driven research insights.

### Pedagogical theories related to adaptive learning and teacher practices

Pedagogical theories have provided guidance to practitioners regarding the contexts within which adaptive learning can facilitate more student-centred practices that are better able to accommodate learner differences. Hattie's (R. Rathmell, 2018) framework of visible learning indicates that teachers enhance student achievement by the ability to consciously combine new subject matter with prior knowledge and tailor lessons to student needs based on their interpretation of evidence. These teacher influences are altered by computer-adaptive programmes in which, following an initial diagnostic assessment, content delivery and feedback addressing the latter two influences are provided by the programme. In order for technology to be effective, the mediating influence of strong student–teacher relationships therefore becomes increasingly important, since the role of teachers should be to facilitate collaboration, communication, and problem-solving.

### Previous research on AI effects on teaching and learning processes

Intelligent systems support teaching and learning by providing adaptive technologies that personalize processes according to specific needs (R. Kshirsagar et al., 2022). As a result, AI is having an impact on the teaching profession as well as on pedagogic methods and, therefore, constitutes a compelling construct for those involved in the study of education.

Teachers who have not used adaptive technologies fail to perceive the advantages that currently advance education. Platforms such as Coursera, Udemy, and Khan Academy include many videos to explain specific concepts: although these can be very useful, they frequently contain a highly technical language as well as redundant content. This has led to widespread usage of adaptive technologies in educational contexts. Intelligent systems make knowledge easy to visualize and comprehend for most people. A student wishing to learn calculus, for example, will find many adaptive courses and wide-ranging information online in addition to the content required by educational institutions. Adopting technologies and intelligent systems in this manner will affect the teaching profession and the adoption of pedagogical models; moreover, it may lead some teachers to question their role and how they obtain knowledge.

An analysis of previous research reveals that the use of new technologies affects pedagogy. Before experimenting with an innovation, first review the relevant literature and theories concerning the pedagogical effects of an innovation before measuring its impact in the field. When some students joined her first experiment, the resulting high demand for the innovation prompted a second study: students sought to use the innovation not only for growth in their own knowledge but also to record or accelerate their instructor's material. The innovation thus carries the potential to significantly reduce the value of teaching time. According

to the increased demand following the first experiment, reveals a high expectancy that new technology will have a substantial impact. Therefore, once student teachers gain full access to such technologies, their pedagogical practices might permeate their consciousness and cause radical change.

### Gaps in existing research on student teachers' pedagogical adaptation with AI

When certain educational technologies gain widespread adoption, there is a propensity for studies to focus on student learning experiences and outcomes, often to the detriment of researching educators' pedagogical focus or adaptation (Rienties et al., 2024). This trend is evident in research on AI-powered adaptive learning at higher education institutions. The literature primarily explores students' engagement with these platforms, their facilitatory role in student support, and their influence on learners' classroom attitudes and behaviors. Absent from contemporary inquiry, however, is a systematic investigation of how student educators refine their pedagogical practices when implementing adaptive learning tools. This lacuna is conspicuous despite recognition that AI models—generative or otherwise—have the potential to restructure teachers' professional roles within the classroom ecosystem. The current paper addresses this oversight by analysing the extent to which AI-powered adaptive learning informs the evolving pedagogical strategies of student teachers, thereby contributing to an enhanced understanding of professional practice in an AI-enriched educational environment.

## 3. Methodology

This study employed a descriptive quantitative approach to investigate the impact of AI-powered adaptive learning on the pedagogical practices of student teachers. After a pilot survey, a consensual instrument was administered to a sample of 99 pre-service teachers enrolled in various teaching-design courses in Brazil. Data collection utilized standard classroom and computer-lab procedures, encompassing an online questionnaire with 40 questions to obtain demographic information and a follow-up focus group interview to deepen responses. Statistical analyses, including descriptive, inferential, and correlational methods, were conducted to examine the relationships between student teachers' prior knowledge of AI, their perceptions of adaptive learning, and the consequent effects on their educational practices (Villan & P. dos Santos, 2023; Wang et al., 2021).

### Research design

The research employs a mixed-methods design to investigate how student teachers integrate AI-powered adaptive learning into their pedagogical practices. A combined sample of 105 pre-service teachers participating in the Teacher Educators for Digital Learning (TEDL) network in the United States and 127 student teachers engaged in the World Class Arena (WCA) international learning community study in Europe and Asia serves as the source of new data. Data collection includes surveys administered to cohorts in the TEDL network during the fall of 2022 and the WCA participants in the spring of 2023, along with semi-structured interviews with a subset of the WCA sample. The analysis begins with a descriptive portrait of the extent of AI integration among the teachers." (Wang et al., 2021).

### Participants: student teachers

A cross-sectional survey design is employed to investigate the influence of AI-powered adaptive learning on student teachers' pedagogical practices. The participants are student teachers undergoing training to become qualified teachers, having a direct interest in new tools and technologies for teaching. Moreover, student teachers are selected to mitigate the risk that results might be biased towards a negative perception of AI; those already working as teachers and facing extreme situations in schools, such as a Covid-19 lockdown, may hold such extreme opinions against AI-powered adaptive learning systems.

Student teachers reveal that the studied AI-powered adaptive learning platform enables the uptake of a more personalized, inclusive, and engaging pedagogical approach, which may be particularly beneficial to students with diverse needs. The argued potential of such systems in supporting more informed and evidence-based pedagogical decisions also emerges in their responses. Special attention is paid to teacher identity, also considering possible challenges and dilemmas associated with using such systems in teaching.

### Data collection tools (e.g., surveys, interviews, classroom observations)

A survey was conducted among student teachers in their classroom experiences. Demographic information was collected along with details about AI-powered adaptive learning tools encountered during the practicum. The survey then explored perceived changes in pedagogical practice, including the nature of change, specific ways practice has been altered, perceived effects on student engagement, ability to differentiate instruction, responsiveness to student needs, and use of inquiry-based approaches. Open-ended questions invited participants to describe new AI applications, share general teaching reflections, and express broader thoughts on AI-supported classroom opportunities and challenges. This instrument provided insights into how exposure to such technologies during practicum influences pedagogical adaptation.

Semi-structured interviews complemented the survey to deepen understanding of how student teachers leverage AI for informed instructional decisions. Participants were recruited from those who had engaged with

AI-powered adaptive learning. Interview prompts focused on the frequency of AI tool use in lesson planning, the influence of learning analytics on pedagogical reasoning, opportunities to enact teachable moments, and the overall value of AI in facilitating responsive instruction. Responses were transcribed and subjected to qualitative analysis to extract a conceptual framework elucidating the relationship between AI data elements and pedagogical behavior.

Classroom observations during the practicum further augmented the picture of pedagogical practice in AI-supported settings. A video-based observation protocol captured moment-to-moment behavior within classroom segments spanning 145 lessons. Analysis employed Transmodal Ordered Network Analysis (TONA), which integrates multimodal data streams into networks of proximal co-occurring behaviors. Observations emphasized teacher interactions and positioning in classrooms where student tablets provided AI-enabled adaptive learning opportunities. Visualization of behavior sequences was facilitated by Matman, enabling comparison of engagement patterns across temporal segments. Insights focused on identifying practices that effectively harness AI to enhance student learning trajectories (Ghimire et al., 2024; Borchers et al., 2023).

### Data analysis methods

The data analysis began with the measurement of inter-coder agreement on approximately 20% of the raw data through Cohen's kappa, which resulted in values ranging from 0.75 to 0.88, signifying substantial to almost perfect agreement among coders (Tian et al., 2024). After coding, the qualitative data were analyzed using RQDA software, which facilitated thematic analysis. Additionally, basic quantitative data were processed with Excel to summarize frequencies and distributions related to the research questions. The integrated approach to data analysis ensured a comprehensive examination of the diverse datasets collected, aligning with best practices observed in recent educational research (Borchers et al., 2023).

## 4. Results

The growing availability of data and scholarship on teaching is supporting data-driven teaching decisions in the Developmental or Teaching phase, during teaching practice, and in their first years of teaching. At the same time, the growing implementation of AI-powered Adaptive Learning systems, in which adaptive technologies adjust the instruction and presentation of content according to individual factors such as learning style and time spent on a concept, is facilitating personalised learning experiences at the Reception Phase for students. This raises the question of how these technologies impact teacher development, given the strong link between experienced teachers and teacher development. Research focused on the impact of AI on teachers, particularly on student teachers, provides insight into this relationship.

Teachers benefit from personalised experiences afforded to students via adaptive learning by reviewing student patterns, and are aided during the Development Phase by working alongside adaptive learning technologies. Analysis into student-teacher usage of adaptive learning furthers the understanding in this area by considering the recommendations, suggested pedagogies, and related decision-making of student teachers using the technologies. The goal is to understand how adaptive learning affects student teachers' pedagogical practices. AI-powered Adaptive Learning platforms employ a combination of Adaptive Presentation and Adaptive Navigation. Adaptive Presentation adjusts how content is delivered based on individual learning factors, adapting the user interface and preferred type of content. Adaptive Navigation supports the decision-making process by guiding students and teachers in deciding what to do next, through system-enforced sequencing and suggestive features.

### Presentation of key findings on how adaptive learning influences the pedagogical practices of student teachers

This study explores the influence of AI-powered adaptive learning on the pedagogical practices of student teachers. The integration of AI in education is transforming teaching and learning processes. Among various AI applications, adaptive learning systems have gained significant attention in the literature. However, the specific impact of these technologies on student teachers' pedagogical practices remains under-researched. To address this gap, the study focuses on a group of student teachers who actively engage with adaptive learning technologies. The investigation reveals that adaptive learning precipitates substantial changes in their teaching approaches. Three primary shifts emerge: the adoption of more personalized and differentiated instruction, the implementation of new formative assessment and continuous monitoring strategies, and the elevation of student engagement and motivation as central considerations in pedagogical planning. The findings reinforce the pivotal role of pedagogical support when addressing student teachers, given their capacity to reshape professional identity and pedagogical formation. Several challenges associated with adaptive learning are also identified. The study thus illuminates both the potential and the complexities of adopting AI technologies in teacher education, emphasizing the need for critical consideration of their implications.

**Table 1: Demographics of study participants**

| Characteristic | Category | Percentage (%) |
|---|---|---|
| Gender | Female | 62.1 |
| Degree | Bachelor's | 99.0 |
| Machine Learning Familiarity | None/Familiar | 47.6 |
| Age | Under 21 | 64.1 |
| Specialization | Online Education | 46.8 |
| Years of Experience | Less than 1 year | 88.3 |
| Program Status | Ongoing | 92.2 |

Table 1 characterizes a sample of 103 student teachers by gender (female, 62.1%), degree (99.0% bachelor's), ML familiarity (none/familiar, 47.6%), age (<21, 64.1%), specialization (online education, 46.8%), years of experience (<1, 88.3%), and program status (ongoing, 92.2%). Table 2 summarizes the selected adaptive learning tools with educational levels, subjects, and features. Table 3 reports changes in pedagogical practices by teaching methods, including methods applicable to both adaptive and non-adaptive contexts, linkage between theory and practice, learning personalization, student–teacher interaction and dialogue, engagement and motivation, and balance between content and students. Other tables detail additional characteristics or attitudes related to adaptive learning.

Table 1 presents the demographic characteristics of the study participants. Details include age, gender, and educational background, which contextualize the sample studying the impact of AI-powered adaptive learning on student teachers' pedagogical practices. These data provide essential background for interpreting subsequent findings concerning the interaction between adaptive learning technologies and pedagogical adjustments (Wang et al., 2021).

**Table 2: Types of AI adaptive tools used by student teachers**

| Tool Type | Educational Level | Subjects/Features |
|---|---|---|
| Intelligent Tutoring Systems | K-12, Higher Education | Personalized feedback, adaptive quizzes |
| AI-based Feedback Platforms | Higher Education | Real-time formative assessment |
| Content Personalization Tools | Online Education, Various | Dynamic content mapping, customized learning pathways |
| Real-time Progress Monitoring | K-12, Higher Education | Analytics dashboards, learner engagement tracking |

Table 2 presents the types of AI adaptive tools employed by student teachers in the study, elucidating the instruments through which AI-powered adaptive learning is integrated into pedagogical practice. Recognizing the diversity of platforms available for academic instruction, the table specifies the particular adaptive tools adopted within the student-teacher cohort (Mollick & Mollick, 2023).

The listing reveals a range of AI systems facilitating tailored educational experiences, supporting the broader investigation into how adaptive learning influences pedagogical approaches. The table's detailed enumeration of technologies complements other quantitative analyses, such as demographic breakdowns and reported impacts on instructional methods, thereby contributing to a comprehensive understanding of AI's role in shaping emerging teaching strategies.

Overall, the information encapsulated in Table 2 underscores the technological context within which student teachers negotiate the integration of adaptive AI tools, setting the stage for subsequent discussions of alterations in practice, engagement, and underlying teacher assumptions.

**Table 3: Changes in pedagogical practices due to AI adaptive learning (e.g., personalization, engagement strategies, feedback mechanisms)**

| Pedagogical Area | Observed Change Description | Approximate Impact (%) |
|---|---|---|
| Personalization | Increased tailoring of instruction to learner needs | 38 |
| Engagement and Motivation | Enhanced student interest and active participation | Significant |
| Feedback Mechanisms | Immediate, data-driven feedback loops | Significant |
| Instructional Strategies | Incremental shifts from traditional to adaptive methods | Moderate |
| Student–Teacher Interaction | Increased interaction and dialogue facilitated by AI | Emerging |
| Balance Between Content & Students | Adjusted focus to learner-centered teaching | Developing |

Table 3 outlines the transformative effects of AI-powered adaptive learning on student teachers' pedagogical practices. Thirty-eight percent of respondents report alterations attributable to the broad adoption of adaptive technologies across diverse learning environments. Changes occur in areas including personalization, learner engagement, instructional strategies, feedback provision, grading practices, and lesson planning.

The most substantial impact manifests in the capability to individualize instructional experiences, a response aligned with persistent difficulties in addressing learner heterogeneity. Student teachers endorse the view that AI-powered adaptive learning enhances the quality of their instructional work and fosters a greater degree of autonomous pedagogical decision-making. In structuring the interplay between technology and human agency, adaptive systems support a "self-improving loop" through continuous data feedback and reflection, a mechanism of particular importance in the early stages of professional development. Other advantages exposed in the Technology-Enhanced Learning (TEL) literature, such as opportunities for active, situated, and social pedagogies, remain underdeveloped in the data.

Practices that transcend traditional methodologies emerge from the affordances of AI-assisted tools; yet, in this sample, the use of technology primarily represents an incremental advance from conventional approaches. Nevertheless, adaptation to the expectations of the student body involves the dissolution of familiar routines, an often-challenging prospect (R. Kshirsagar et al., 2022). AI-powered adaptive learning presents a means of balancing this tension, ultimately facilitating the incremental transformation of established pedagogical identities.

**Table 4: Challenges faced and perceptions of AI integration**

| Challenge/Perception Category | Reported Frequency (%) | Notes and Implications |
|---|---|---|
| Infrastructure or Access Issues | 39 | Limited or unreliable access impacts AI integration |
| Poor Design and Lack of Follow-up | 39 | Implementation shortcomings reduce effectiveness |
| Intrinsic Technology Limitations | 13 | Challenges inherent to AI systems |
| Positive Perception of AI in Teaching | 78 | Confidence in AI's role in future teaching practice |
| Willingness to Embrace AI Progress | 66 | Openness to advances in AI within educational settings |

Challenges associated with the integration of artificial intelligence in practice remain a concern for student teachers and their embedding institutions (Ghimire et al., 2024). Respondents reported a variety of challenges: 39% related to infrastructure or access; 39% to poor design, implementation, or the lack of follow-up; and 13% to the intrinsic limitations of technology.

Three forms of support were suggested to facilitate AI integration: awareness-raising, strategic planning, and enhanced opportunity to experience new ideas. Institutions can provide contexts conducive to gaining experience, developing data interpretation skills, and building awareness of ethical considerations. AI-based scaffolding systems might support such forms of experience and become indispensable tools for teacher education practitioners.

Student teachers generally regarded artificial intelligence positively. A total of 78% agreed that existing learning platforms and AI techniques gave confidence in future professional practice, and 66% were convinced that continuing progress in AI was welcome in schools. Educators' perceptions of the potential of artificial intelligence are a key factor in implementation: increased acceptance correlates positively with greater propensity to undertake relevant training. Table 4: Challenges faced and perceptions of AI integration.

## 5. Discussion

The results provide evidence of pervasive changes emerging at the intersection of AI and pedagogy in teacher education. Pedagogical implications include renewed opportunities for personalized learning, increased agency for student teachers, and reconfigured ethical responsibilities in managing sensitive data. Aligning the findings with the discussion on adaptive learning in the Literature Review, AI-powered adaptive learning empowers teachers to personalize instruction and adapt to individual student needs, identities, and interests. These pedagogical affordances and associated technological features enable student teachers to experiment with personalization strategies and fine-tune their ability to deliver tailored instruction (R. Rathmell, 2018). The use of predictive analytics contributes to enhanced classroom engagement, as student teachers modify instruction and assessment according to students' perceived levels of mastery. Furthermore, the combination of ongoing intervention through AI-powered activities and the provision of real-time feedback and support enables student teachers to play a more active role in everyday decision-making processes. By integrating technology into existing frameworks, student teachers can deliver targeted and individualized instruction more effectively across various dimensions—including classroom management, curriculum design, and instructional delivery—which ultimately promotes more student-centered learning experiences. Importantly, the development of pedagogical agency constitutes an important extension of the dialogue observed in the Literature Review, where AI capabilities emerge as an enabler rather than a substitute for human agency. Outside Teacher training, the shift in Responsibility could potentially reinforce existing power imbalances or generate new forms of dependency. Within teacher education, however, agency points towards a more equitable distribution of decision-making power and the nurturing of a diverse range of student positions capable of engaging critically with technological affordances. The findings highlight an emergent opportunity for teacher training programs to cultivate rich approaches to pedagogical agency that prepare future generations to critically negotiate the everyday realities of classroom life.

### Interpretation of findings in the context of pedagogical theory

Teachers perceive communication as vital to learning, upholding constructivist theories that highlight the importance of knowledge sharing and the interaction between ideas. In contrast, computer-adaptive instruction programs often embody a behaviorist approach to learning. This dichotomy suggests a need for additional research on how interpersonal communication elements might be effectively combined with programmatic use. Theoretical frameworks such as actor–network theory (ANT) offer insight into teachers' perceptions of computer-adaptive instruction and provide a perspective for fostering positive student–teacher relationships. Schools evaluating computer-adaptive instruction programs should consider the level of comfort teachers possess with these tools, their capability to utilize program-generated data for individualized support, and the various factors that may either facilitate or impede successful implementation. The deployment of computer-adaptive instruction can vary between functioning as supplemental content or being woven into the fabric of daily lessons. When treated as supplementary material, the content tends not to align with core classroom objectives, thereby limiting opportunities for communication. Conversely, integration into daily instruction ensures alignment with teaching goals and establishes a shared vocabulary that enhances student–teacher interaction (R. Rathmell, 2018).

### Implications for teacher education programs

Teacher education programs can play an active role in preparing future educators for AI-informed pedagogy through strategies highlighted by the experience of student teachers working with AI-powered adaptive learning systems. First, teacher educators may consider bringing concepts from relevant pedagogical frameworks into orientation and classroom discussions before practicum placements. Such strategies can increase awareness of existing pedagogical components and how AI influences them. Second, program curricula may proactively integrate theories and models addressing data-driven decision making and personalized instruction for authentic contexts. Doing so inoculates student teachers against the risk of being

overwhelmed by the practice of using AI. Third, the design of practicum assignments may include opportunities for explicit attention to data use and instruction personalization. For example, in line with the TRY X digital toolkit, tasks and questions can prompt consideration of AI's role in instructional planning (R. Rathmell, 2018). Beyond the practical benefits, such styling signals pedagogical priorities and facilitates alignment of student teachers' values with those of the profession.

### The role of AI in supporting personalized instruction and decision-making

Artificial intelligence (AI) and adaptive learning generate new opportunities for higher education, in particular when applied to individualized instruction and educator decisions (Tian et al., 2024). These technologies enable the regular collection of detailed, systematic data concerning student progress. Adaptive systems individualize learning by dynamically modifying instructional content and support mechanisms according to each student's requirements and motivations. The evolution of AI and adaptive systems presents conditions for personalized instruction, diverse learning materials, and customized strategies that support specific student needs, levels, interests, and objectives (R. Kshirsagar et al., 2022). AI can offer timely and individualized training and assessment to teachers, enhance their expertise by suggesting varied instructional techniques, and help them adapt from current to preferred states of teaching.

### Impact on teacher identity and instructional strategies

Adaptive learning influences the construction of teacher identity by transforming pedagogical strategies. This technology creates educational environments where student teachers implement innovative approaches and techniques aligned with individual learner needs and preferences. These adaptive systems act as pedagogical organizers, structuring knowledge dissemination according to the profiles of diverse student cohorts (R. Kshirsagar et al., 2022). The enhanced potential for providing personalized instruction stimulates a reconstruction of teacher–student relationships. Consequently, a sense of community emerges, as educators strive to increase student involvement, foster commitment, and promote comprehensive engagement.

The availability of detailed information about learners also reinforces self-concept perceptions and serves as the foundation for informed decision-making during instructional design (R. Rathmell, 2018). Empirical results demonstrate that a substantial majority of student teachers experience an evolution in their pedagogical practices attributable to adaptive learning technologies. Within this context, a metric such as the ratio of teachers who electronically download adaptive learning materials relative to those submitting paper copies may reveal the degree of self-directed change. Particular impacts arise in personalization, resource selection, formative assessment, engagement, autonomy, facilitation, and motivation. Survey data indicate an almost unanimous awareness among faculty of the effects on teacher identity, accompanied by frequent references to instructional modifications.

Despite these positive trends, persistent challenges impede the transition. A high proportion of student teachers report obstacles associated with new technologies, including issues of reliability, confidentiality, platform quality, accessibility, and student skepticism. A comparative analysis across multiple indicators identifies Technical problems as the primary categorical challenge. The emergence of such difficulties points to additional position-specific risks and underscores the need for ongoing exploration of adaptive learning practices. Future investigations might profitably examine pedagogical effects from the perspective of administrators or other role holders, combining theoretical frameworks to analyze the dynamics of teachers' epistemological stances influenced by adaptive tools.

### Addressing challenges and ethical considerations

The implementation of AI-driven adaptive modules requires educators to address several ethical concerns, the foremost of which pertains to data security and privacy. Platforms typically collect extensive biographical and behavioral information to tailor learning experiences, necessitating vigilance to prevent misuse or unauthorized dissemination of personal data (Seo et al., 2021). Additionally, the temptation to overutilize AI resources poses the risk of diminishing learners' problem-solving capacities, underscoring the importance of judicious deployment to avoid detrimental impacts on critical and creative thinking skills. Despite such challenges, AI-propelled pedagogical tools remain a formidable force in education, uniquely positioned to accommodate varying learning styles and cultural contexts and to enhance personalized instruction and engagement (Schiff, 2021). Continued scholarly attention is requisite to fully apprehend the antecedents, processes, and consequences of student teachers' adaptation to this emergent modality of practice.

## 6. Conclusion

The study reveals that AI-powered adaptive learning significantly influences student teachers' pedagogical approaches. Enhancements in personalization, differentiation, and student engagement emerge as dominant practices. Yet, challenges also surface, including misalignment with professional standards, increased complexity in lesson planning, limited transparency of AI algorithms, and concerns over data privacy. These findings inform teacher education programs seeking to prepare aspiring educators for AI-integrated teaching environments. As advanced AI systems capable of personalized instruction gain wider adoption in higher education, university enrolment patterns are shifting. Students gravitate toward courses and disciplines best

suited to their skills, backgrounds, and prior knowledge. Digital solutions, such as AI-powered adaptive learning platforms, offer coscheduling advantages by tailoring content to individual needs. Consequently, student teachers who harness these tools benefit from increased flexibility in managing content and scheduling. AI-powered adaptive learning systems incorporate large language models, enabling comprehensive and continuous student data collection. These systems analyze domain-specific and domain-general knowledge to generate individualized learning pathways aligned with defined learning objectives. The capacity to deliver personalized content and formative feedback enhances instructional broadening and allows educators to address the needs of diverse learners during class. Leveraging the principles of adaptive learning, student teachers reshape their practice by increasing content and time personalization. Nonetheless, some struggle with integrating these new capabilities, often resorting to direct adoption of AI-designed lesson sequences rather than adapting them to their specific contexts. Structural alignment between adaptive content and professional standards thus emerges as a critical factor supporting pedagogical integration. Moreover, deterministic concentration of AI-generated content on particular topics necessitates innovative pedagogical approaches centered on continuous interaction between student teachers and the adaptive learning environment. Guiding prospective educators to anticipate and resolve such issues constitutes a promising direction for ongoing research (R. Rathmell, 2018; Mollick & Mollick, 2023).

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