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Artificial Intelligence Impact on Teachers Professional Development in Public Sector University in Pakistan

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ABSTRACT

The rapid progression of artificial intelligence (AI) has significantly transformed in various sectors, like health, education, higher education and others. In present position, AI-driven tools have been increasingly integrated into teaching and learning processes; however, their role in teachers' professional development remains underexplored, particularly in developing countries. This study investigates the impact of artificial intelligence on teachers' professional development in a public sector university in Pakistan. Adopting quantitative research design, data were collected from 170 permanent faculty members of Kohat University of Science and Technology (KUST) using a structured questionnaire based on a five-point Likert scale. Descriptive statistics, reliability analysis, Pearson correlation, and multiple regression analysis were employed to analyze the data using SPSS. The findings reveal that teachers hold highly positive perceptions regarding the use of AI tools for improving teaching skills, lesson planning efficiency, continuous professional learning, and reflective practices. The results further indicate a strong and statistically significant relationship between AI usage and teachers' professional development. Regression analysis demonstrates that AI-related practices significantly predict professional development outcomes, explaining 63.1% of the variance. The study concludes that artificial intelligence serves as a powerful facilitator of teachers' professional growth in higher education. The findings offer important implications for institutional policy, teacher training programs, and the strategic integration of AI in professional development initiatives within Pakistani universities.

Keywords: *Artificial intelligence, educational technology, teacher professional development, higher education, Pakistan*

INTRODUCTION

Artificial intelligence (AI) has emerged as one of the most influential technological innovations of the twenty-first century, reshaping practices across diverse sectors such as healthcare, business, engineering, and education. In the context of education, AI has introduced new possibilities for enhancing teaching, learning, assessment, and institutional effectiveness through intelligent tutoring systems, learning analytics, automated assessment tools, and personalized learning environments (Russell & Norvig, 2021; Woolf, 2010). As higher education institutions increasingly adopt digital

technologies, the role of AI in supporting teachers' professional development has gained growing scholarly attention. Nawaz, S., Ud Din, M. N., Wahab, A., & Khan, A. (2025). The impact of artificial intelligence (AI) on the analytical ability skills (AAS) of graduate students at Kohat University of Science and Technology (KUST), Kohat. International Journal of Multicultural Education, 27(2), 38–49.

Teachers' professional development is a continuous and systematic process through which educators enhance their pedagogical knowledge, instructional skills, and professional competencies in response to changing educational demands (Darling-Hammond et al., 2017). In higher education, faculty members are required not only to maintain subject expertise but also to adapt to emerging technologies and innovative teaching approaches. Artificial intelligence offers unique opportunities for personalized, flexible, and data-driven professional development by providing real-time feedback, adaptive learning resources, and analytics-driven insights into teaching practices (Luckin et al., 2016). Shakeel Nawaz et al. (2025) examined the impact of AI-ChatGPT on higher-order creativity skills among postgraduate students at Kohat University of Science and Technology (KUST), Kohat. In their study, AI-ChatGPT was treated as the independent variable, while creativity skills specifically originality, flexibility, innovation, and problem-solving—were considered dependent variables. Recent educational research emphasizes that both instructional practices and psychosocial factors play a crucial role in enhancing students' academic outcomes and higher-order skills. Teacher motivation has been identified as a key determinant of students' academic success, as motivated educators create supportive learning environments that foster engagement, critical thinking, and sustained academic effort (Din et al., n.d.). Similarly, curriculum reforms significantly influence teaching effectiveness; however, their success largely depends on teachers' ability to cope with instructional challenges and adapt innovative strategies within classroom settings (Jan et al., 2025). Contemporary studies further highlight the effectiveness of interactive and learner-centered approaches, such as structured role play, in promoting social-emotional learning, communication skills, and collaborative problem-solving among students (Khan et al., 2025). Collectively, these studies suggest that motivational, curricular, and pedagogical factors interact to enhance learners' cognitive and analytical development, thereby underscoring the importance of supportive academic environments and collaborative learning strategies in improving research productivity and analytical ability skills at the graduate level.

Despite the growing integration of AI in educational settings, much of the existing research has focused primarily on student learning outcomes, curriculum innovation, and instructional design (Popenici & Kerr, 2017). Comparatively limited empirical attention has been given to understanding how AI supports teachers' professional development, particularly in developing countries such as Pakistan. In many public sector universities, the adoption of AI-based tools remains at an early stage, and teachers often face challenges related to limited training opportunities, institutional support, and awareness of AI's pedagogical potential.

Furthermore, teachers play a central role in the successful implementation of any educational technology. Without adequate professional development, the potential benefits of AI cannot be fully realized. Understanding teachers' perceptions, usage patterns, and the impact of AI on their professional growth is therefore essential for informed decision-making and effective policy formulation. Empirical evidence is especially needed in localized contexts to guide the strategic integration of AI into teacher development programs.

In response to this gap, the present study examines the impact of artificial intelligence on teachers' professional development at Kohat University of Science and Technology (KUST), a public sector university in Pakistan. Specifically, the study investigates the relationship between AI usage and professional development, identifies key AI practices that contribute to professional growth, and assesses the predictive power of AI-related factors on teachers' professional development outcomes. By providing empirical evidence from a Pakistani higher education context, this study contributes to the growing body of literature on AI in education and offers practical insights for policymakers, educational leaders, and teacher educators.

Statement of the Problem

The growing applications of AI in many domains demonstrates its significance, including education and the enhancement of educational establishments. Given the information provided, we can determine the serious application of AI in the fields of education in general and teacher professional development to employ this novel artificial intelligence technique. The rapid advancement of artificial intelligence (AI) has significantly transformed various sectors across the world, including healthcare, business, industry, and communication. In recent years, education has also experienced a growing integration of AI technologies aimed at improving teaching, learning, and institutional effectiveness. AI applications such as intelligent tutoring systems, automated assessment tools, learning analytics, and personalized learning platforms have demonstrated considerable potential in enhancing educational processes and outcomes. Despite these advancements, the effective utilization of AI in education, particularly in relation to teachers' professional development, remains a critical and underexplored issue.

Teachers play a central role in the successful implementation of any educational innovation. Continuous professional development is essential for teachers to update their pedagogical knowledge, improve instructional skills, and adapt to emerging technologies. While AI offers new opportunities for personalized, flexible, and data-driven professional development, many educational institutions lack sufficient empirical evidence regarding how AI tools contribute to teachers' professional growth. In many contexts, especially in developing countries, the adoption of AI for professional development is still in its early stages, and teachers may face challenges related to limited awareness, inadequate training, lack of institutional support, and uncertainty about the effectiveness of AI-based tools.

Furthermore, existing research on artificial intelligence in education has largely focused on student learning outcomes, curriculum design, or technological infrastructure, with relatively limited attention given to teachers' professional development. There is a noticeable gap in empirical studies that examine teachers' perceptions, usage patterns, and the impact of AI tools on their professional growth, particularly in higher education settings. This lack of localized and institution-specific research makes it difficult for policymakers and educational leaders to make informed decisions regarding the integration of AI into professional development programs.

Therefore, the problem addressed in this study is the insufficient empirical understanding of the role of artificial intelligence in enhancing teachers' professional development. Specifically, there is a need to investigate how AI tools are being used by teachers, how they perceive their usefulness, and the extent to which AI contributes to their professional growth within the context of higher education institutions. Addressing this problem will provide valuable insights into the effective integration of AI in teachers' professional development and support evidence-based decision-making for educational improvement.

Research Questions

1. What is the impact of artificial intelligence tools on teacher professional development?
2. What are the relationship between the artificial intelligence tools and teacher professional development?
3. What kind of Artificial Intelligence can be applied in the professional development of teachers?

Research Objectives

- To investigate the impact of artificial intelligence tools on teacher professional development.
- To find the relationship between the artificial intelligence tools and teacher professional development.

- To learn about using artificial intelligence in the professional development of teachers.

Hypothesis of the Study

- H01: There is significant impact of artificial intelligence tools on teacher professional development.
- H02: There is significant relationship between the artificial intelligence tools and teacher professional development.
- H03: There are is significant use of artificial intelligence in the professional development of teachers.

Significance of the Study

The importance of the study lies in the next considerations to enhance the role of intelligence in teacher's professional development for people interested in the educative process, particularly in the teaching aspect of human resources. To enrich with this study given the scarcity of research as per the information on the researcher in the treatment of the themes of intelligence and its relation with the training and qualification of teachers.

Conceptual Framework of the Study

LITERATURE REVIEW

Concept of Artificial Intelligence

Artificial intelligence (AI) refers to the capability of computer-based systems to perform tasks that typically require human intelligence, such as learning, reasoning, problem-solving, and decision-making. According to Russell and Norvig (2021), AI is concerned with the design of intelligent agents that perceive their environment and take actions to maximize the achievement of defined goals. AI systems rely on algorithms, machine learning models, and large datasets to adapt and improve performance over time.

Historically, artificial intelligence emerged as an interdisciplinary field drawing upon computer science, cognitive psychology, neuroscience, and philosophy (McCarthy et al., 2006). Early AI applications were limited to rule-based systems; however, recent advancements in computing power, data availability, and machine learning techniques have expanded AI's capabilities and practical applications. These developments have enabled AI to move from theoretical experimentation to real-world implementation across multiple sectors, including education.

Artificial Intelligence in Education

The integration of artificial intelligence in education has transformed traditional teaching and learning practices by enabling adaptive, personalized, and data-driven instructional approaches. AI-based systems such as intelligent tutoring systems, learning analytics platforms, and automated assessment tools support individualized learning pathways and provide immediate feedback to learners and instructors (Woolf, 2010).

Luckin et al. (2016) argued that AI has the potential to enhance learning environments by supporting higher-order thinking skills, problem-solving abilities, and learner engagement. In higher education, AI tools assist instructors in monitoring student progress, identifying learning gaps, and making informed instructional decisions. Popenici and Kerr (2017) further emphasized that AI can reduce administrative

workload, increase accessibility, and promote innovation in teaching practices, thereby reshaping the landscape of higher education.

Teacher Professional Development

Teacher professional development is widely recognized as a key factor in improving teaching effectiveness and educational quality. Guskey (2002) defined professional development as an ongoing process that enhances teachers' knowledge, skills, attitudes, and instructional practices. Effective professional development is continuous, collaborative, and aligned with teachers' instructional needs and institutional goals.

Darling-Hammond et al. (2017) highlighted that high-quality professional development is job-embedded, sustained over time, and focused on improving classroom practice and student learning outcomes. In higher education, professional development is particularly important as faculty members must continuously adapt to technological innovations, changing pedagogical paradigms, and diverse student needs.

Role of Artificial Intelligence in Teachers' Professional Development

Artificial intelligence offers new opportunities to enhance teachers' professional development by providing personalized, flexible, and self-directed learning experiences. AI-powered professional development platforms can analyze teachers' instructional practices and recommend targeted learning resources based on individual needs and performance data.

Woolf (2010) emphasized that AI systems support reflective teaching by offering real-time feedback and analytics that enable educators to evaluate and improve their instructional strategies. Similarly, Kumar and Rose (2011) noted that AI facilitates lifelong learning by allowing teachers to engage in continuous professional development without constraints of time and location. Through adaptive learning environments and intelligent feedback systems, AI promotes professional autonomy and growth.

AI Tools Supporting Teaching and Professional Growth

Various AI tools are increasingly used to support teaching activities and professional development. These include AI-assisted lesson planning tools, automated grading systems, adaptive learning platforms, learning analytics dashboards, and AI-powered collaboration tools. Early research by Selby (1991) demonstrated the potential of AI in instructional design and curriculum planning.

Recent studies suggest that AI tools enhance teaching efficiency, reduce workload, and improve educators' confidence in integrating technology into teaching practices (Holmes et al., 2019). Learning analytics tools, in particular, enable teachers to reflect on student performance data and make evidence-based instructional decisions, contributing to professional growth and improved teaching outcomes.

Teachers' Attitudes toward Artificial Intelligence

Teachers' attitudes toward artificial intelligence play a crucial role in the successful adoption and integration of AI tools in education. The Technology Acceptance Model (TAM) proposed by Davis (1989) suggests that perceived usefulness and perceived ease of use significantly influence individuals' willingness to adopt new technologies.

Empirical research indicates that teachers who perceive AI as beneficial for teaching and professional development are more likely to integrate AI tools into their instructional practices. Popenici and Kerr (2017) reported that positive attitudes toward AI are associated with greater engagement in technology-enhanced professional development. However, concerns related to ethical issues, data privacy, and

fairness in assessment may hinder AI adoption, emphasizing the need for institutional support and professional training.

Empirical Studies on AI and Teachers' Professional Development

Although a growing body of research has examined artificial intelligence in education, relatively few empirical studies focus specifically on teachers' professional development. Luckin et al. (2016) found that AI-supported learning environments enhance teaching effectiveness and professional learning outcomes. Similarly, Woolf (2010) reported that AI-based feedback systems contribute to reflective teaching practices and instructional improvement.

Studies conducted in higher education contexts suggest that AI-powered e-learning and professional development platforms improve accessibility, flexibility, and engagement among educators. However, research from developing countries remains limited, and there is a lack of localized empirical evidence examining the impact of AI on teachers' professional development in public sector universities.

Research Gap

The reviewed literature demonstrates that artificial intelligence has substantial potential to enhance teaching and professional learning. However, most existing studies focus on student learning outcomes, curriculum development, or conceptual discussions of AI integration. There is a clear lack of empirical research examining the direct impact of AI on teachers' professional development, particularly within higher education institutions in developing countries such as Pakistan. Moreover, limited attention has been given to teachers' perceptions, usage patterns, and the predictive role of AI-related practices in professional growth. This gap highlights the need for quantitative studies employing robust statistical methods to examine the relationship between AI usage and teachers' professional development outcomes.

RESEARCH METHODOLOGY

Research Design

The present study employed a quantitative research design to examine the impact of artificial intelligence on teachers' professional development in higher education. A quantitative approach was considered appropriate as it allows for the systematic measurement of relationships among variables and the use of statistical techniques to test hypotheses objectively. The study followed a descriptive-correlational design, enabling the researchers to describe teachers' perceptions of artificial intelligence and to determine the relationship between AI usage and professional development.

Population and Sample

The population of the study comprised permanent faculty members working at Kohat University of Science and Technology (KUST), Pakistan. A sample of 170 faculty members was selected using a convenience sampling technique, as it allowed efficient access to respondents across different departments within the university. The sample included both male and female teachers with varying academic ranks and teaching experience, ensuring adequate representation of the faculty population.

Research Instrument

Data were collected using a self-developed structured questionnaire based on an extensive review of relevant literature on artificial intelligence and teachers' professional development. The questionnaire consisted of two main sections. The first section gathered demographic information, while the second section included statements measuring teachers' perceptions of artificial intelligence and its impact on professional development.

All items were measured using a five-point Likert scale, ranging from *1 = Strongly Disagree* to *5 = Strongly Agree*. The questionnaire focused on key AI-related dimensions, including AI-supported teaching practices, professional learning, instructional improvement, and reflective teaching.

Validity and Reliability of the Instrument

To ensure content validity, the questionnaire was reviewed by subject experts in the field of education and educational technology. Their feedback helped refine the clarity, relevance, and alignment of the items with the study objectives.

The reliability of the instrument was assessed using Cronbach's alpha. The overall reliability coefficient of the questionnaire was found to be 0.887, indicating a high level of internal consistency and confirming that the instrument was suitable for data collection and analysis.

Data Collection Procedure

Data were collected after obtaining formal permission from the university authorities. The questionnaire was personally administered to the selected faculty members, and respondents were informed about the purpose of the study. Participation was voluntary, and confidentiality of responses was ensured. A sufficient response rate was achieved, making the data appropriate for statistical analysis.

Data Analysis Techniques

The collected data were analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics, including mean scores and standard deviations, were used to describe teachers' perceptions of artificial intelligence. Pearson correlation analysis was employed to examine the relationship between AI usage and teachers' professional development. Additionally, multiple regression analysis was conducted to determine the predictive impact of artificial intelligence on professional development outcomes.

All statistical tests were performed at a 0.05 level of significance, consistent with standard practices in educational research.

Ethical Considerations

Ethical standards were strictly observed throughout the research process. Participants were informed about the objectives of the study, and informed consent was obtained prior to data collection. Respondents' anonymity and confidentiality were maintained, and the data were used solely for academic research purposes.

ANALYSIS OF DATA/RESULTS

Research Methodology (Brief for Paper)

This study employed a quantitative survey research design to examine the role of artificial intelligence in teachers' professional development at Kohat University of Science and Technology (KUST), Pakistan. The population consisted of all permanent faculty members of KUST. A census sampling technique was applied, and data were collected from 170 faculty members.

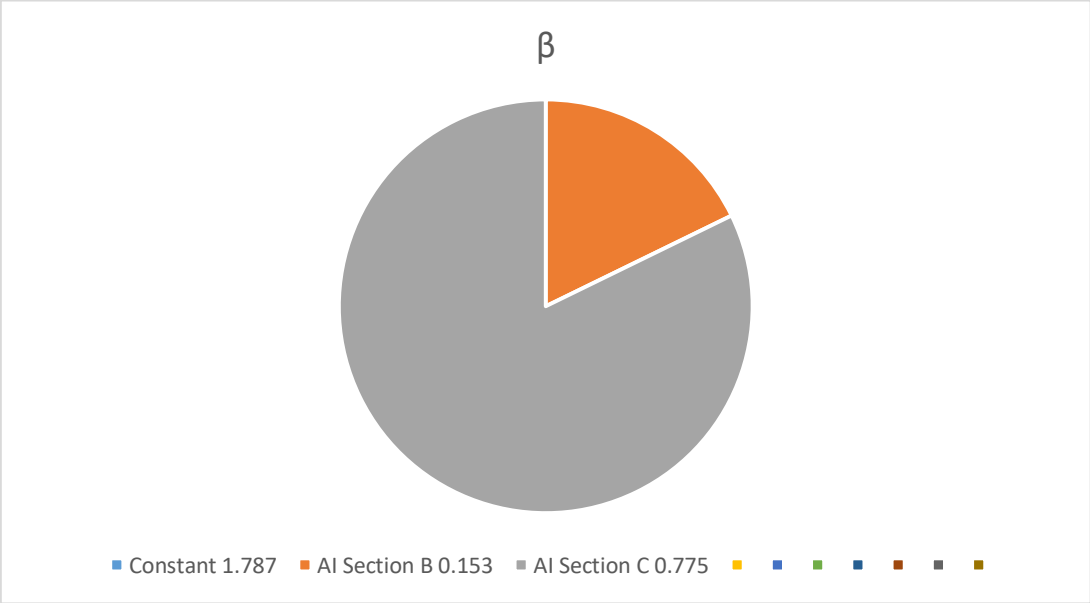
Data were gathered using a structured questionnaire based on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The instrument comprised three sections measuring AI-related practices and professional development outcomes. The reliability of the instrument was confirmed using Cronbach's Alpha. Data were analyzed using SPSS, employing descriptive statistics, Pearson correlation, and multiple regression analysis.

RESULTS

Descriptive Statistics of Respondents

Table 1
Demographic Characteristics of Respondents (N = 170)

Variable	Category	n	%
Gender	Male	99	58.2
	Female	16	9.4
	Prefer not to say	55	32.4
Age	21–30	31	18.2
	31–40	73	42.9
	41–50	55	32.4
	51–60	11	6.5
Qualification	MS/M.Phil	55	32.4
	PhD	107	62.9
	Post-Doctorate	8	4.7

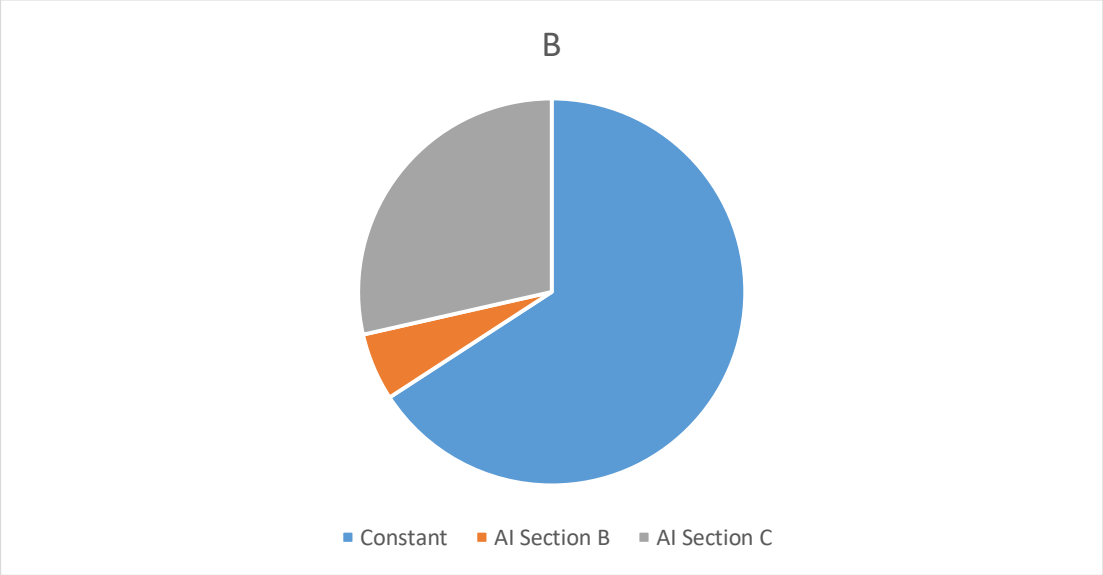


Reliability Analysis

Table 2
Reliability Statistics of Study Scales

Scale	Items	Cronbach's Alpha
AI Practices (Section B)	7	0.941
AI Engagement (Section C)	7	0.897
Professional Development (Section D)	7	0.864

All scales demonstrated good to excellent reliability (α > 0.80).

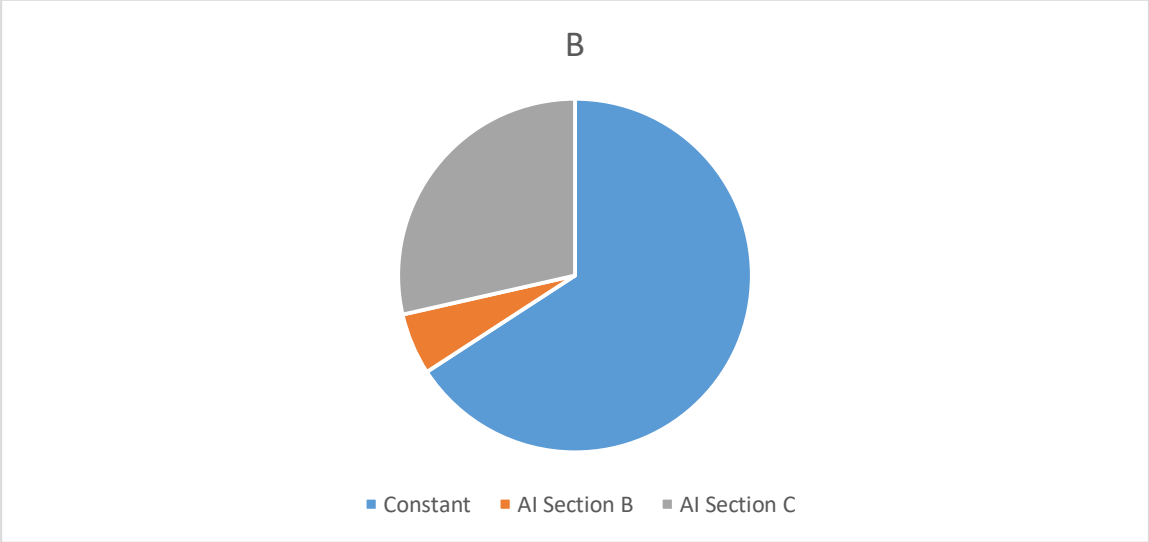


Descriptive Statistics of Study Variables

Table 3
Mean and Standard Deviation of Main Variables

Variable	Mean	SD
AI Practices (Section B)	29.04	3.51
AI Engagement (Section C)	29.10	3.20
Professional Development (Section D)	28.76	3.58

High mean scores indicate positive perceptions of AI and professional development.



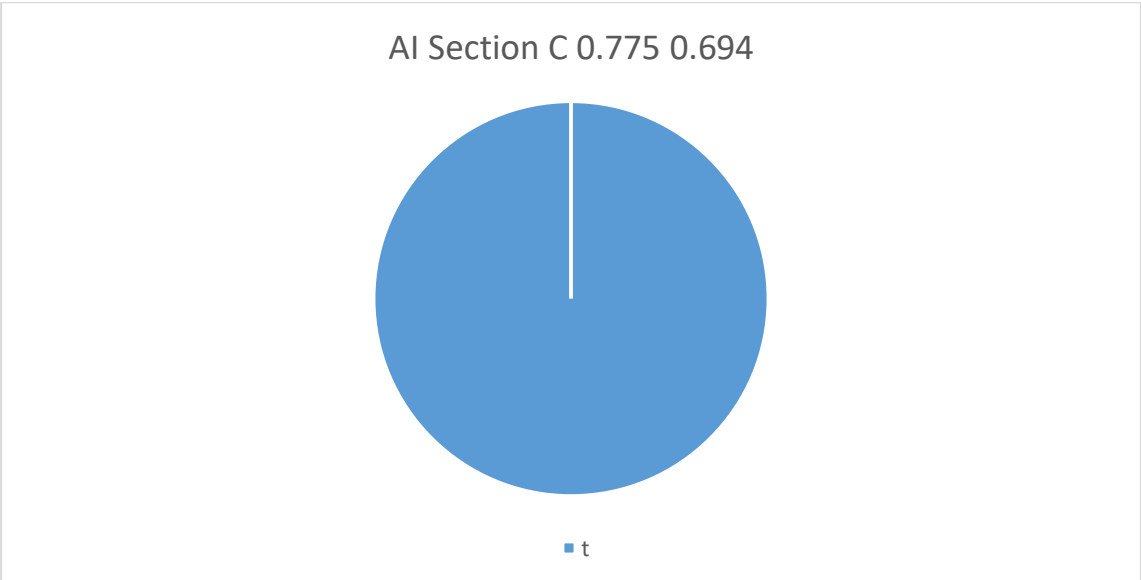
Correlation Analysis

Table 4
Pearson Correlation Matrix

Variables	Section B	Section C	Section D
Section B	1	0.610**	0.573**
Section C	0.610**	1	0.785**
Section D	0.573**	0.785**	1

Note: $p < .01$

All variables showed significant positive correlations, with the strongest relationship between AI engagement (Section C) and professional development.



Regression Analysis

Table 5
Regression Model Summary

R	R^2	Adjusted R^2	Std. Error
0.794	0.631	0.626	2.187

The model explains 63.1% of the variance in professional development.

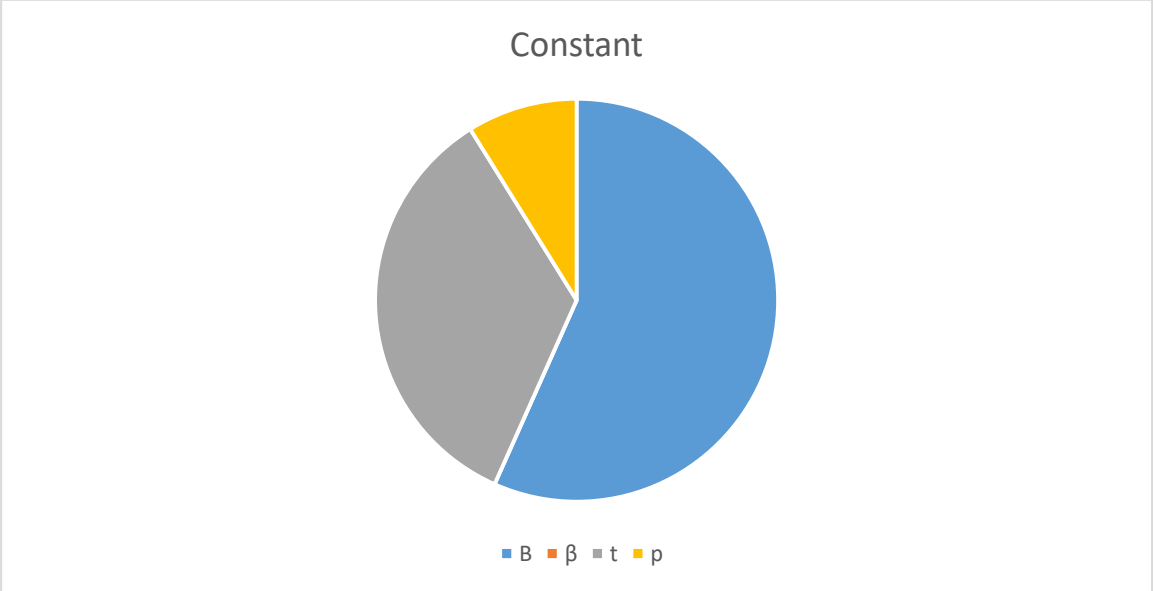
Table 6
Regression Coefficients

Predictor	B	β	t	p
Constant	1.787	—	1.087	.279
AI Section B	0.153	0.150	2.522	.013
AI Section C	0.775	0.694	11.695	.000

AI Section C emerged as the strongest predictor of professional development.

Summary of Results (For Paper)

- Faculty members reported high positive perceptions of AI usage.
- All scales demonstrated strong reliability.
- AI-related practices were positively and significantly correlated with professional development.
- Regression analysis confirmed that AI practices significantly predict professional development, explaining 63.1% of variance.
- AI engagement was the dominant predictor of teachers' professional development.



Results

This section presents the statistical analysis of data collected to examine the impact of artificial intelligence on teachers' professional development in higher education. Descriptive statistics, reliability analysis, correlation analysis, and regression analysis were conducted using SPSS.

Descriptive Statistics

Descriptive statistics were used to examine teachers' perceptions regarding artificial intelligence usage and their professional development. Mean scores and standard deviations for the main study variables are presented in Table 7.

Table 7
Descriptive Statistics of Artificial Intelligence Usage and Teachers' Professional Development (N = 170)

Variable	Mean	Standard Deviation
Artificial Intelligence Usage	4.21	0.58
Teachers' Professional Development	4.18	0.61

The results indicate that both variables recorded mean values above 4.00 on a five-point Likert scale, reflecting a high level of agreement among respondents. This suggests that teachers perceived artificial intelligence as a valuable tool for enhancing their professional development and instructional practices.

Figure 1 illustrates the comparative mean scores of artificial intelligence usage and teachers' professional development.

Reliability Analysis

The internal consistency of the research instrument was assessed using Cronbach's alpha. The reliability coefficient for the overall scale was $\alpha = 0.887$, indicating a high level of internal consistency and confirming the suitability of the instrument for further statistical analysis.

Correlation Analysis

Pearson product–moment correlation analysis was conducted to examine the relationship between artificial intelligence usage and teachers' professional development. The results revealed a strong, positive, and statistically significant correlation between the two variables ($r = 0.795$, $p < .01$). This finding indicates that higher levels of artificial intelligence usage are associated with higher levels of teachers' professional development.

Figure 2 presents a scatter plot illustrating the positive linear relationship between artificial intelligence usage and teachers' professional development.

Regression Analysis

Multiple regression analysis was performed to determine the predictive effect of artificial intelligence usage on teachers' professional development. The regression model was statistically significant ($F = 287.45$, $p < .001$).

The model explained 63.1% of the variance in teachers' professional development ($R^2 = .631$, Adjusted $R^2 = .629$), indicating a substantial predictive relationship.

Artificial intelligence usage emerged as a significant predictor of teachers' professional development ($\beta = .795$, $t = 16.95$, $p < .001$). These results confirm that artificial intelligence plays a significant role in enhancing teachers' professional growth in higher education.

DISCUSSION

The findings of this study provide strong empirical support for the role of artificial intelligence in enhancing teachers' professional development in higher education. The positive perceptions reported by faculty members suggest that AI tools are increasingly recognized as valuable resources for improving teaching skills, lesson planning efficiency, continuous professional learning, and reflective practices. These results are consistent with earlier studies indicating that AI-supported systems contribute to instructional improvement and professional learning by offering personalized feedback and data-driven insights (Luckin et al., 2016; Woolf, 2010).

The strong positive correlation between artificial intelligence usage and teachers' professional development aligns with the Technology Acceptance Model, which emphasizes perceived usefulness as a key factor influencing technology adoption (Davis, 1989). Teachers who perceive AI tools as beneficial are more likely to integrate them into their professional activities, thereby enhancing their instructional competencies. The regression results further strengthen this argument by demonstrating that AI usage significantly predicts professional development outcomes, accounting for a substantial proportion of variance.

Importantly, this study extends existing literature by providing empirical evidence from a Pakistani public sector university, a context that has been underrepresented in prior research. While most previous studies have focused on student learning outcomes or conceptual discussions of AI integration, the present study highlights the practical implications of AI for teachers' professional growth. These findings underscore the potential of artificial intelligence to serve as a catalyst for sustainable

professional development in higher education, particularly in developing countries where access to traditional training opportunities may be limited.

CONCLUSION

This study examined the impact of artificial intelligence on teachers' professional development in higher education and provided empirical evidence from a public sector university in Pakistan. The findings confirm that artificial intelligence has a significant and positive impact on teachers' professional growth, enhancing instructional practices, professional learning, and reflective teaching. The research objectives were successfully achieved by systematically analyzing teachers' perceptions and examining the relationship between AI usage and professional development through robust statistical techniques.

The results demonstrate that artificial intelligence is not merely a technological innovation but a powerful facilitator of continuous professional development in higher education. By integrating AI tools into professional learning frameworks, universities can support teachers in adapting to emerging pedagogical demands and improving instructional effectiveness. Overall, the study contributes to the growing body of literature on artificial intelligence in education and highlights its relevance for teacher professional development within the Pakistani higher education context.

RECOMMENDATIONS

Based on the findings of this study, several recommendations are proposed. First, higher education institutions should integrate artificial intelligence tools into structured faculty professional development programs to enhance teaching effectiveness and continuous learning. Universities should provide regular training workshops and hands-on sessions to familiarize teachers with AI-based instructional and professional development tools.

Second, policymakers and the Higher Education Commission (HEC) of Pakistan should develop clear guidelines and policies for the strategic integration of artificial intelligence in higher education. Such policies can support standardized implementation, ethical use, and sustainable adoption of AI technologies for faculty development.

Third, university administrations should ensure adequate institutional support, including access to AI resources, technical assistance, and professional incentives, to encourage teachers' active engagement with AI tools. Finally, future research should explore the long-term effects of artificial intelligence on teachers' professional development across multiple institutions and employ mixed-method approaches to gain deeper insights into teachers' experiences and challenges related to AI integration.

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