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Artificial Intelligence in Secondary Education: Teacher's Knowledge, Attitudes, Teaching Effectiveness, and Challenges

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Abstract: *Artificial Intelligence (AI) is increasingly influencing teaching and learning processes across secondary education systems. This present study investigates secondary school teachers' knowledge of AI, their attitudes towards its use, perceived teaching effectiveness, and challenges associated with AI integration. A descriptive survey method was adopted, and data were collected from 120 secondary school teachers (60 male and 60 female) from government and private schools in Khatima city, Udham Singh Nagar district, Uttarakhand, India. A self-constructed 45-item scale covering four dimensions was used, and satisfactory reliability 0.94 and validity 0.85 were established. Statistical techniques including mean, standard deviation, t-test, and Pearson's correlation were applied. The finding revealed no significant gender-based differences across AI-related dimensions. However, teachers' AI knowledge and attitudes were positively associated with perceived teaching effectiveness, whereas challenges showed a weak negative relationship with effectiveness. The findings suggest that although teachers generally demonstrate positive perceptions towards AI, practical constraints such as insufficient training, limited infrastructure, and ethical concerns restrict its effective classroom use. The study emphasizes the importance of systematic professional development and institutional support to ensure responsible and meaningful integration of AI in secondary education.*

Keywords: *Artificial Intelligence, Knowledge, Attitudes, Teaching Effectiveness, Secondary School Teacher's Challenges.*

1. INTRODUCTION:

Artificial Intelligence (AI) is rapidly reshaping educational practices by enabling data-driven decision-making, adaptive instruction, and automated support systems. In secondary education, AI-based applications—such as intelligent tutoring systems, adaptive learning platforms, automated assessment, and learning analytics—are increasingly recognized for their potential to enhance instructional efficiency and address learner diversity (1, 2). These technologies are particularly relevant at the secondary stage, where teachers' are required to balance curriculum demands, large class sizes, and individualized learner needs.

However, the effectiveness of AI integration in classrooms depends less on technological availability and more on teachers' readiness to engage with such innovations. Teachers' knowledge of AI concepts, their attitudes towards technology, and their perceived teaching effectiveness collectively determine whether AI is meaningfully integrated or remains a superficial addition to instructional practice. According to the Technology Acceptance Model, users' knowledge and attitudes significantly influence perceived usefulness and effective technology adoption (3, 4). In educational contexts, studies have consistently shown that teachers' with higher AI literacy and positive perceptions are more likely to integrate AI tools in ways that support pedagogy rather than merely automate tasks (5, 6).

Although global research on AI in education has expanded rapidly, much of the existing literature concentrates on higher education settings or pre-service teacher populations. Empirical studies focusing on in-service secondary school teachers'—particularly those that examine AI-related knowledge, attitudes, teaching effectiveness, and challenges as

interconnected dimensions—remain limited (1, 7). Moreover, many studies address these variables in isolation, providing an incomplete understanding of how they jointly influence AI adoption in real classroom settings.

The need for such integrated evidence is especially pressing in developing countries like India, where policy initiatives strongly promote the use of emerging technologies, yet implementation varies widely across school contexts. The National Education Policy, 2020 emphasizes the integration of AI and digital competencies to improve educational quality and equity. Nevertheless, teachers' at the secondary level continue to face constraints related to professional training, digital infrastructure, and ethical concerns surrounding AI use (9, 10). These contextual challenges underscore the importance of examining teachers' perspectives alongside systemic factors.

Against this backdrop, the present study investigates secondary school teachers' AI-related knowledge, attitudes, perceived teaching effectiveness, and challenges within the Indian educational context. By adopting a quantitative survey approach and analysing the relationships among these dimensions, the study seeks to generate empirical insights that can inform teacher professional development, institutional support mechanisms, and evidence-based policy decisions for responsible and sustainable AI integration in secondary education.

2. NEED AND IMPORTANCE OF STUDY:

Education has continuously evolved in response to social and technological changes. In recent years, rapid advancements in digital technologies have significantly altered teaching–learning processes, particularly following the shift towards online and blended modes of instruction during the COVID-19 pandemic. This transition highlighted both the potential of technology-enhanced learning and the existing gaps in teachers' technological preparedness.

Artificial Intelligence has emerged as a promising tool to support instructional delivery, assessment, and learner engagement. However, the effectiveness of AI in classrooms largely depends on teachers' awareness, skills, and attitudes. At the secondary school level, teachers' are expected to prepare students for higher education and future employment, making it essential for them to engage with emerging technologies responsibly and effectively.

There is a need to examine whether secondary school teachers' possess adequate knowledge of AI-based tools, how they perceive their usefulness, and what challenges they face while integrating them into classroom practices. The present study is important as it provides insights into these aspects within the Indian secondary education context, thereby informing teacher training programs, institutional planning, and policy-level interventions related to AI integration.

3. RELATED REVIEW OF LITERATURE:

Artificial Intelligence (AI) has increasingly gained attention in educational research due to its potential to support personalized learning, instructional efficiency, and data-driven decision-making. Recent reviews highlight that AI applications such as adaptive learning systems, automated assessment, and learning analytics are being explored across different educational levels (1, 2). However, scholars consistently emphasize that the effectiveness of AI in education depends not merely on technological availability but on how teachers' understand, perceive, and pedagogically apply these tools. Teachers' attitudes play a central role in determining the acceptance and classroom use of emerging technologies. According to the Technology Acceptance Model, positive attitudes significantly influence perceived usefulness and actual technology adoption (3, 4). Recent empirical studies report that many teachers' view AI as a supportive tool that can reduce workload and enhance instructional planning (6). At the same time, cautious or neutral attitudes are often linked to uncertainty, limited exposure, and lack of hands-on experience with AI tools. This suggests that attitudes towards AI are shaped by both individual beliefs and contextual factors such as training and institutional support (12).

AI literacy has emerged as a critical component of teachers' professional competence in technology-rich classrooms. Ng et al. (2021) define AI literacy as an understanding of AI concepts, applications, and ethical implications necessary for informed use in educational contexts (6). Studies indicate that teachers' with higher AI literacy are more confident in integrating AI tools and are more likely to perceive improvements in teaching effectiveness (7). Recent research further suggests that AI knowledge enables teachers' to move beyond superficial use of technology and adopt pedagogically meaningful practices, particularly in assessment, feedback, and differentiated instruction (13). However, knowledge alone does not automatically translate into effective practice unless supported by positive attitudes and contextual opportunities.

Despite increasing interest in AI, several challenges continue to constrain its effective integration in schools. Commonly reported barriers include inadequate professional development, lack of technological infrastructure, ethical and privacy concerns, and uncertainty regarding pedagogical alignment (9). These challenges are often systemic in nature and persist even among teachers' who hold positive attitudes and possess basic AI knowledge. Recent global reports emphasize that without institutional and policy-level support, the potential benefits of AI may remain underutilized in classroom settings (10).

In India, the integration of AI in school education is strongly influenced by national policy and board-level initiatives. The National Education Policy (NEP) 2020 highlights the importance of introducing emerging technologies such as Artificial Intelligence and coding at appropriate stages of schooling to promote competency-based and future-ready education (8). NEP 2020 places particular emphasis on teacher professional development, recognizing that teachers' knowledge, attitudes, and pedagogical competence are central to the success of technology-driven reforms.

In alignment with NEP 2020, the Central Board of Secondary Education (CBSE) has introduced Artificial Intelligence as a skill subject at the secondary and senior secondary levels. The CBSE curriculum emphasizes conceptual understanding, ethical awareness, and interdisciplinary applications of AI (14). Additionally, CBSE has initiated capacity-building programmes to enhance teachers' preparedness for AI integration. However, variations in training access, infrastructure, and institutional support across schools have led to differences in teachers' readiness and classroom implementation experiences.

Recent studies conducted between 2021 and 2024 indicate a growing focus on teachers' perceptions, attitudes, and AI literacy, particularly in school education contexts (7, 6). While these studies provide valuable insights, many of them examine individual variables in isolation or focus predominantly on higher education and pre-service teachers'. There remains limited empirical evidence that simultaneously examines teachers' knowledge, attitudes, perceived teaching effectiveness, and challenges related to AI, especially within the Indian secondary school context.

3.1 RESEARCH GAP:

The review of existing literature reveals several gaps. First, although international and Indian studies have explored teachers' attitudes and AI literacy, most investigations examine these dimensions separately, offering a fragmented understanding of teachers' readiness for AI integration. Second, empirical research focusing on in-service secondary school teachers', particularly in the Indian context shaped by NEP 2020 and CBSE initiatives, remains limited. Third, there is a lack of integrated studies that simultaneously examine teachers' AI-related knowledge, attitudes, perceived teaching effectiveness, and challenges within a single analytical framework.

Therefore, there is a clear need for an empirical study that comprehensively examines these interconnected dimensions to understand teachers' readiness for Artificial Intelligence integration at the secondary school level. The present study seeks to address this gap by providing context-specific evidence that can inform teacher professional development, institutional planning, and policy implementation related to AI in education.

4. OBJECTIVES OF THE STUDY:

The objectives of the study are:

- To study secondary school teachers' knowledge related to AI.
- To study secondary school teachers' attitudes towards the use of AI.
- To study secondary school teachers' perceptions of AI-related teaching effectiveness.
- To study challenges faced by secondary school teachers' in integrating AI.
- To examine the relationship among AI-related knowledge, attitude, teaching effectiveness, and challenges.

5. HYPOTHESES OF THE STUDY:

Ho_1. There is no significant difference between male and female teachers' in secondary schools regarding knowledge related to AI.

Ho_2: There is no significant difference in attitudes toward AI between male and female teachers' in secondary schools.

Ho_3: There is no significant difference between male and female teachers' of secondary schools in the effectiveness of teaching related to AI.

Ho_4: There is no significant difference between male and female teachers' in secondary schools regarding challenges related to AI use.

Ho_5: There is no significant relationship between AI-related dimensions of secondary school teachers'.

6. RESEARCH METHODOLOGY:

6.1 Research method:

In present study Descriptive Survey Method was used.

6.2 Sample and Sampling Techniques:

In the present research, the sample has been selected from Udham Singh Nagar district in two stages: In the first stage, secondary schools located in urban and rural areas of Khatima city of Udham Singh Nagar district were selected by a stratified random sampling technique, and government and private secondary schools were selected by a lottery method under a simple random method. In the second stage, all the teachers' teaching in class IX and X from each selected secondary school has been selected by a cluster random sampling technique. So, a total of 120 teachers' were selected from the selected schools, which included 60 male and 60 female teachers'.

The distribution of the sample in the research is presented as follows:

Table 1: Demographic Data of the Participants

Total Sample (120)								
Area	**Urban**				**Rural**			
School	**Government**		**Private**		**Government**		**Private**	
Teachers'	Male (10)	Female (10)	Male (10)	Female (10)	Male (20)	Female (20)	Male (20)	Female (20)

6.3 Research Instruments:

A self-constructed scale was developed with four dimensions related to Artificial Intelligence: Knowledge, Attitude, Teaching effectiveness, and Challenges. The scale consisted of 45 items. All the test items were based on 5-point Likert scale.

6.4 Reliability and Validity:

The reliability of the scale was established using the split-half (internal consistency) method, which came out to be 0.94 and the validity of the scale was established using face validity (S-FVI/Ave), which was found to be 0.85.

6.5 Statistical Techniques:

In the study Mean, Standard deviation, t-test, and Pearson correlation coefficient methods were used.

7. ANALYSIS AND FINDINGS OF THE STUDY:

1. To study AI-related Knowledge of Male and Female Teachers' of Secondary Schools.

Table 2: AI-related knowledge of Male and Female Teachers'

Variable	Gender	N	Mean	Std. deviation	df	t-value	Result
Knowledge	Male	60	22.25	5.31	118	0.40	Not significant
	Female	60	21.53	3.83			

Table 2 presents the mean and std. deviation of male and female teachers' of secondary schools. The mean score of male teachers' (22.25) is slightly higher than that of female teachers' (21.53); however, the obtained t-value (0.40) indicates that the difference is not statistically significant at the 0.05 level. Therefore, the null hypothesis (H_{01}) stating that there is no significant difference between male and female teachers' in secondary schools regarding knowledge related to AI is accepted. This result suggests that gender does not play a significant role in determining teachers' knowledge of Artificial Intelligence. The acceptance may be attributed to the generally limited exposure to formal AI training among teachers', irrespective of gender. At the secondary school level, AI-related professional development opportunities are still emerging, resulting in a relatively uniform level of knowledge across male and female teachers'. Previous studies have similarly reported that the absence of structured AI training programs leads to minimal variation in teachers' AI knowledge (1, 9).

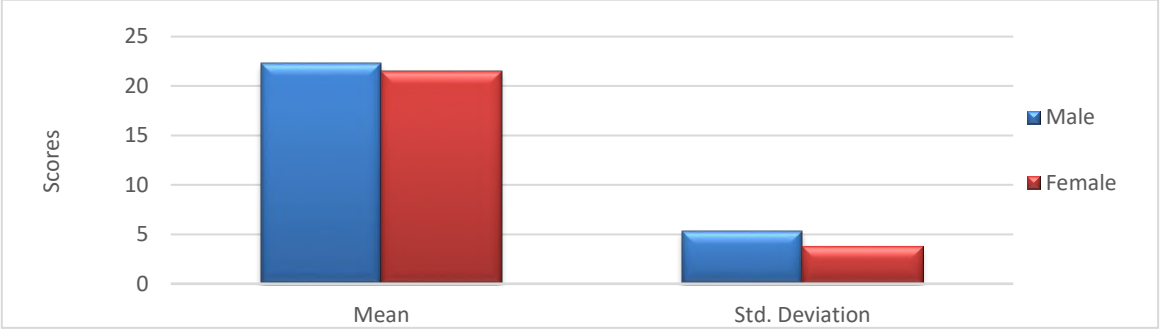

Figure 1: Comparison between male and female teachers' on AI-related knowledge

2. To study attitudes towards AI of Male and Female Teachers' of Secondary Schools.

Table 3: Attitudes towards AI of Male and Female Teachers'

Variable	Gender	N	Mean	Std. deviation	df	t-value	Result
Attitude	Male	60	65.5	9.86	118	0.18	Not significant
	Female	60	67.77	8.38			

Table 3 shows the attitudes towards Artificial Intelligence between male and female teachers' of secondary schools. Although female teachers' demonstrate a marginally higher mean attitude score (67.77) than male teachers' (65.5); however, the obtained t-value (0.18) indicates that the difference is statistically insignificant at the 0.05 level. Therefore, the null hypothesis (H_{02}) stating that there is no significant difference in attitude towards AI between male and female teachers' in secondary schools is accepted. This finding indicates that teachers' attitudes towards AI are shaped more by shared professional experiences than by gender differences. Similar levels of technological exposure, limited hands-on experience with AI tools, and uniform institutional environments may contribute to this outcome. Earlier studies have also found no significant gender-based differences in teachers' attitudes towards AI, emphasizing that attitude formation is influenced primarily by training and perceived usefulness rather than gender (17, 18).

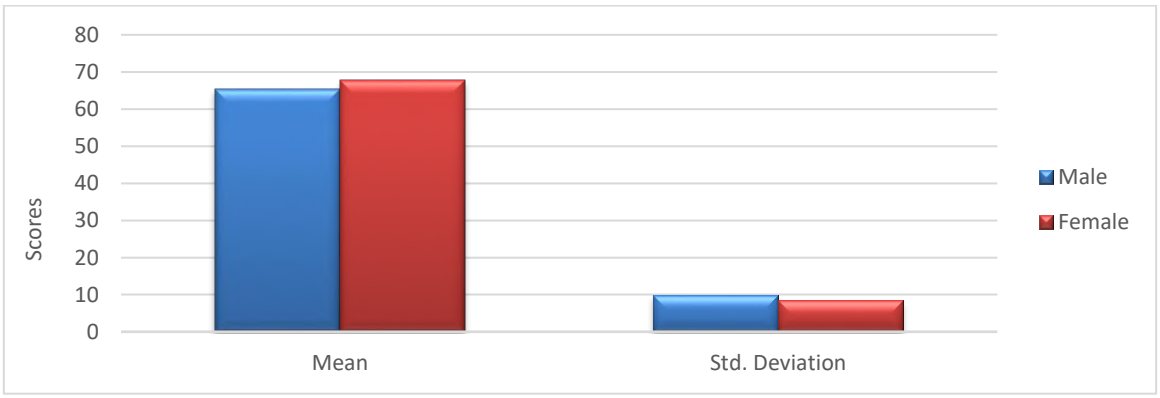

Figure 2: Comparison of Attitude between male and female teachers'

3. To study the effectiveness of AI-related teaching by Male and Female Teachers' in Secondary Schools.

Table 4: AI-related Teaching Effectiveness of Male and Female Teachers'

Variable	Gender	N	Mean	Std. deviation	df	t-value	Result
Teaching effectiveness	Male	60	50.98	7.83	118	0.08	Not significant
	Female	60	53.4	6.99			

Table 4 presents the AI-related teaching effectiveness between male and female teachers' of secondary schools. While female teachers' show a slightly higher mean score (53.4), than male teachers' (50.98); however, the obtained t-value (0.08) indicates that the difference is statistically insignificant at the 0.05 level. Therefore, the null hypothesis (H_{03}) stating that there is no significant difference between male and female teachers' of secondary schools in the effectiveness of teaching related to AI is accepted. This result indicates that teaching effectiveness related to AI integration is not influenced by gender but rather by access to resources, institutional support, and pedagogical opportunities. Since both male and female teachers' operate within similar curricular and technological environments, their perceived teaching effectiveness remains comparable. Supporting this view, Kumar and Sharma (2020) observed that familiarity with educational technology tends to be similar across genders, resulting in comparable instructional effectiveness (19).

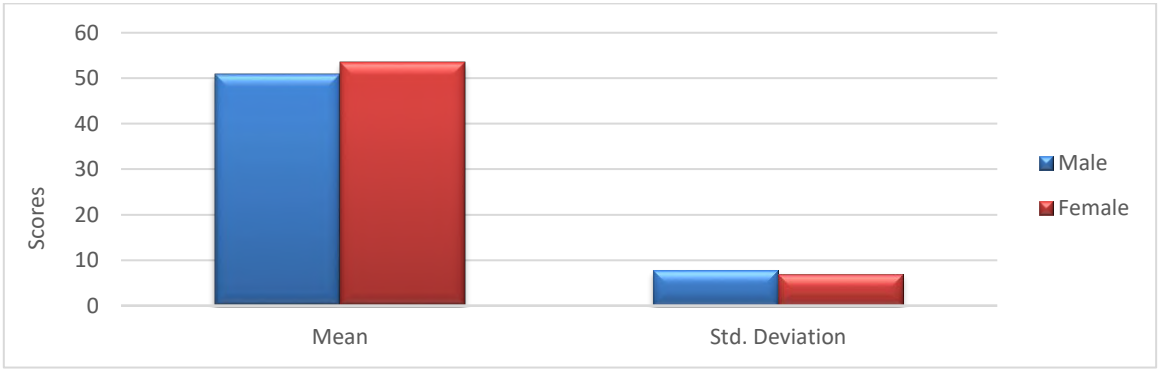

Figure 3: Comparison of teaching effectiveness between male and female teachers'

4. To study the AI-related challenges in Male and Female Teachers' of Secondary Schools.

Table 5: AI-related challenges between male and female teachers'

Variable	Gender	N	Mean	Std. deviation	df	t-value	Result
Challenges	Male	60	16.28	4.04	118	0.76	Not significant
	Female	60	16.08	3.17			

Table 5 illustrates the AI-related challenges faced by male and female teachers' of secondary schools. The mean scores of male teachers' show a slightly higher mean score (16.28), than female teachers' (16.08); however, the obtained t-value (0.76) indicates that the difference is statistically insignificant at the 0.05 level. Therefore, the null hypothesis (H_{04}) stating that there is no significant difference between male and female teachers' in secondary schools regarding challenges related to is accepted. The similarity in challenges experienced by male and female teachers' suggests that barriers to AI integration are largely systemic rather than individual. Issues such as inadequate infrastructure, lack of institutional training, and limited policy guidance affect teachers' uniformly, regardless of gender. Recent studies highlight that such challenges are common across teaching populations and are influenced more by organizational and policy factors than by personal characteristics (10, 20).

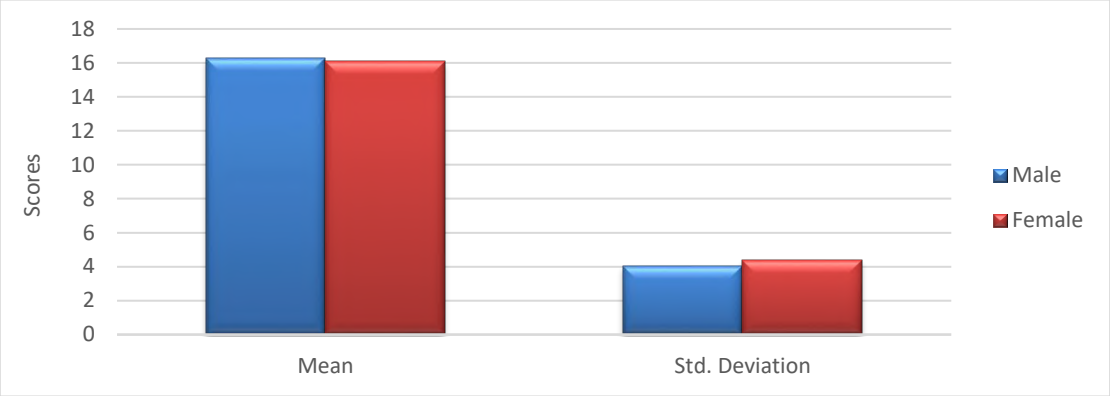

Figure 4: Comparison of AI-related challenges between male and female teachers'

5. To study relation among AI-related dimensions of Secondary School Male and Female Teachers'.

Table 6: Correlation among AI-related dimensions

Dimension	Knowledge	Attitude	Teaching effectiveness	Challenges
Pearson correlation coefficient				
Knowledge	-	0.629	0.588	0.004
Attitude	0.629	-	0.777	0.185
Teaching effectiveness	0.588	0.777	-	-0.055
Challenges	0.004	0.185	-0.055	-

There is a strong positive correlation was observed between AI-related knowledge and teachers' attitudes towards AI (r = 0.629). This relationship suggests that teachers' who possess greater conceptual understanding and awareness of AI tend to develop more positive attitude towards its use. From a theoretical perspective, increased knowledge reduces uncertainty and perceived risk, thereby fostering favourable attitudes towards technology adoption. This finding is consistent with the Technology Acceptance Model (TAM), which emphasizes that understanding a technology enhances perceived usefulness and acceptance (3, 15). Similar results have been reported in studies on AI literacy among teachers', where higher knowledge levels were associated with more positive attitudes towards AI integration (1, 7).

A positive correlation was also found between AI-related knowledge and perceived teaching effectiveness (r = 0.588). This association indicates that teachers' who are more knowledgeable about AI tools perceive themselves as better equipped to integrate these technologies into instructional practices. Knowledge enables teachers' to use AI for lesson planning, assessment, and personalized instruction, thereby enhancing perceived effectiveness. Prior research supports this explanation, suggesting that technological competence directly influences teachers' confidence and instructional efficiency (5, 13).

The strongest relationship emerged between teachers' attitudes towards AI and perceived teaching effectiveness (r = 0.777). This strong positive correlation highlights attitude as a critical motivational factor in effective technology integration. Teachers' who believe that AI is beneficial and relevant are more likely to experiment with AI-based strategies and perceive improvements in their teaching practices. This finding aligns with TAM and subsequent extensions, which identify attitude as a key predictor of actual and perceived technology use (4). Similar observations have been reported in recent educational AI studies, where positive teacher attitudes were linked to higher instructional engagement and innovation (6).

The correlations between challenges and AI-related knowledge (r = 0.004) and challenges and attitudes (r = 0.185) were weak, suggesting that challenges are not strongly dependent on teachers' personal knowledge or perceptions. This implies that even teachers' who are knowledgeable and positively inclined towards AI may face difficulties due to

external constraints such as institutional support, access to digital resources, and regulatory clarity. Comparable findings have been reported in studies conducted in developing educational contexts (12, 21).

The relationship between AI-related challenges and teaching effectiveness was weak and negative ($r = -0.055$). Although minimal, this negative association suggests that challenges such as inadequate infrastructure, lack of training, and ethical concerns may slightly hinder effective AI integration. However, the weak magnitude of the correlation indicates that these challenges are largely systemic and contextual, rather than reflections of individual teachers' abilities. UNESCO has similarly emphasized that infrastructural and policy-related barriers often limit AI adoption, even among competent and motivated teachers' (9, 10).

8. DISCUSSION:

The findings of the study indicate that secondary school teachers' generally demonstrate positive attitudes towards Artificial Intelligence, even though their practical exposure remains limited. The absence of gender-based differences across AI-related dimensions suggests that access to training and institutional support may play a more significant role than demographic variables.

The strong positive relationship between AI knowledge, attitudes, and teaching effectiveness highlights the interconnected nature of these dimensions. Teachers' who possess greater awareness of AI tools are more confident in using them and perceive improvements in their instructional practices. At the same time, challenges such as insufficient infrastructure, limited professional development opportunities, and ethical concerns appear to restrict the effective use of AI in classrooms.

The findings indicate that teachers' generally possess positive perceptions of AI, although their practical exposure remains limited. The absence of gender-based differences suggests that institutional factors may be more influential than demographic variables. The strong association between knowledge, attitude, and teaching effectiveness highlights the importance of AI literacy and positive beliefs for successful integration. Challenges such as inadequate infrastructure and limited training appear to be systemic rather than individual in nature.

In the Indian secondary education context, these challenges are often systemic rather than individual in nature. Addressing them requires coordinated efforts involving teacher education institutions, school administrations, and policymakers. The findings reinforce the importance of capacity-building initiatives that focus not only on technical skills but also on ethical and pedagogical considerations related to AI use.

9. LIMITATIONS OF THE STUDY:

Future research should expand the sample to multiple regions and diverse school types (government, private, urban, rural) across India to enhance the generalizability of the results.

1. The study was limited to one city.
2. Classroom practices were not directly observed.
3. Institutional and policy variables were not examined in depth.

10. CONCLUSION:

The study concludes that secondary school teachers' exhibit generally positive knowledge and attitudes towards Artificial Intelligence, which are positively associated with perceived teaching effectiveness. However, challenges related to training, infrastructure, and ethical concerns continue to limit the effective classroom integration of AI. For AI to contribute meaningfully to secondary education, a balanced approach combining professional development, institutional support, and ethical safeguards is essential. Strengthening teachers' preparedness will play a critical role in ensuring that AI serves as a supportive tool rather than a disruptive force in education.

11. EDUCATIONAL IMPLICATIONS OF THE STUDY:

Theoretical Implications: The results support the Technology Acceptance Model (TAM), which posits that perceived usefulness and ease of use drive adoption. Teachers' positive attitudes and correlations with teaching effectiveness validate this framework. Additionally, UNESCO's, (2024) AI Competency Framework is reinforced, as teachers' knowledge and attitudes were linked to improved pedagogical perceptions (10).

Policy Implications: Embed AI literacy in teacher education programs. Address infrastructural disparities, especially in rural schools. Develop ethical and regulatory frameworks for AI in classrooms. Create monitoring systems to evaluate AI adoption.

Practical Implications: Provide continuous professional development. Foster peer-learning communities among teachers'. Encourage AI use in lesson planning and formative assessments. Ensure technical support systems in schools.

Research Implications: Future research should adopt longitudinal and experimental designs, include larger and more diverse samples, and link teacher AI literacy with student outcomes. Incorporating qualitative methods such as teacher interviews, focus group discussions, or narrative accounts will enrich insights into the lived realities of classroom teaching with AI.

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