



Sidrah Hanif¹, Saira Saeed²

¹PhD (Educational Technology) Ibadat international University Islamabad Email: sidraawan108@gmail.com

²PhD scholar, Department of Education, IBADAT International University Islamabad

Email: Sairasaeed4444@gmail.com

KEYWORDS	ABSTRACT
AI Literacy, AI-CFT, Human-Centred AI	The use of artificial intelligence (AI) is becoming more prevalent in education, which presents the challenge for educators to acquire the knowledge, skills, and ethical awareness needed to use AI in a responsible and effective way. An Assessment of AI literacy of teachers in institutions under the Federal Directorate of Education (FDE) in Islamabad was conducted in this respect drawing on UNESCO Artificial Intelligence Competency Framework for Teachers (AI-CFT) as its conceptual framework. The quantitative cross sectional survey design was used. The AI literacy assessment has been developed by researcher, based on the five UNESCO domains of AI literacy: Human-Centred Mindset, AI Ethics, AI Foundations and Applications, AI Pedagogy, and AI for Professional Learning. The instrument was validated by experts and pilot tested with 40 teachers who were not included in the main study. Pilot administration gave an acceptable overall Cronbach's alpha of .794, thus the instrument is reliable and suitable for the main administration. A total of 135 teachers in six administrative regions of FDE were then sampled and data collected. Descriptive statistics, Welch's independent-samples t-test, one-way ANOVA and thematic analysis of open-ended responses were used. The results demonstrated that the overall level of AI literacy was high with the mean score of 21.30 out of 25 (85.2 %), 86.7 % of teachers were identified as having high AI literacy, 11.1 % as moderate and 2.2 % as low AI literacy. AI Applications (91.1%), AI for Professional Learning (88.0%) and Human-Centred AI (86.1%) had the highest domain performance while AI Foundations (81.6%) and AI Ethics (80.4%) were comparatively weaker. There were no statistically significant gender or teaching level differences in AI literacy. The needs identified were formal AI training, infrastructure and internet connectivity, hands-on learning opportunities, time, equipment and institutional support, as identified by teachers. The study suggests that building teacher AI literacy necessitates ongoing, hands-on, ethical professional learning, provided with robust infrastructure, mentoring, and institutional support.
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Corresponding Author	Sidrah Hanif
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Introduction

The use of AI in education is a rapidly evolving field with schools increasingly relying on teachers to incorporate AI into their planning, assessment, feedback, and resource creation, while also educating students on living and learning in an AI-centric world (Abdilah & Haryono, 2026; Almuhan, 2024; Akram et al., 2022). In the K–12 sector, this transformation has turned the topic of AI literacy from a technical issue to a key educational priority; however, the research base is still nascent and fragmented, particularly in the realm of teacher development and implementation at the school level (Chiu et al., 2024; Wang & Lester, 2023).

In recent studies, AI literacy is not considered a mere component of digital literacy, but rather a new competence (Tenberga & Daniela, 2024; Mikeladze et al., 2024). An AI Competency Framework for Teachers, developed by UNESCO, offers valuable guidance for assessing AI competencies in teaching, as it defines five domains with three levels of progression and focuses on human agency, ethics, safe use, and professional growth (Dou & Zhao, 2025; Bai, 2025; Mikeladze et al., 2024). Furthermore, teachers often lack the infrastructure, training programs, and policy support needed to access or use AI in Pakistan and other Global South settings, which further inhibits their engagement with AI (Sagheem et al., 2025; Daher, 2025). There is an urgent need to systematically evaluate the AI literacy of teachers in public colleges and to understand the challenges and develop context specific strategies for improvement in the Federal Directorate of Education (FDE) colleges in Islamabad.

As students' learning depends on teachers' interpretation and enactment of the curriculum, teachers play a crucial role in any significant integration of AI literacy in schools (Casal-Otero et al., 2023; Velander et al., 2023; Chiu et al., 2024). But the literature consistently indicates that the teacher readiness is lagging behind the policy and technological changes. Many teachers continue to learn informally and incidentally, and there are significant gaps in content knowledge, pedagogical knowledge, and ethical understanding of AI in teacher preparation (Velandar et al., 2023; Kim & Kwon, 2023; Sperling et al., 2024). The gaps are relevant as AI literacy seems to affect teachers' professional self-efficacy, ethical awareness, and readiness to further develop their AI skills, which is why it is both a competency of teachers and a precondition for further professional development (Du et al., 2024; Tenberga & Daniela, 2024).

In developing country settings, the challenge is even greater due to varying teacher knowledge levels, infrastructure, policy support, professional development opportunities, and local contexts (Khatun et al., 2026; Abdilah & Haryono, 2026). The adoption of technological integration is already undergoing studies in Pakistan have revealed a pattern: while educational technology is mostly welcomed by teachers, its implementation is limited by weak institutional support, low level of training, and slow internet service (Akram et al., 2022). Such limitations are particularly relevant in the context of federal government colleges in Islamabad as they must consider the varying levels of digital competence among teachers in their college, limited resources, and

opportunities for ongoing professional learning before AI models can be seamlessly adopted in local practice and without adaptation (Tenberga & Daniela, 2024; Khatun et al., 2026).

In light of this, this study will measure the AI literacy of FDE public college teachers in Islamabad with a validated instrument based on UNESCO AI CFT and will look into barriers and enablers for improving AI literacy in this context. This focus is fitting since recent studies in the literature have found practice-based professional development, differentiated training, and context-sensitive institutional support as the most trustworthy pieces in enhancing teacher AI literacy in colleges (Abdilah & Haryono, 2026; Tenberga & Daniela, 2024; Zhao et al., 2022).

Literature Review

Teacher AI Literacy In Federal Government Schools

Teacher AI literacy increasingly is recognised as a multi-faceted competence, including knowledge of how AI works, knowledge of how to use and assess AI tools, and ethical and reflective judgment about the impact from using AI in the classroom. The literature indicated that the federal government elementary teachers in Islamabad should adopt an approach to building AI literacy on their current digital skills and to complement the existing gaps in infrastructure and policy, in addition to fostering sustained, practice-based professional development, rather than one-off technical workshops (Chiu et al., 2024; Ng et al., 2021; Abdilah & Haryono, 2026).

Conceptual Foundations

The concept of AI literacy in education has evolved from a specific technical term. It can be consistently identified by the four areas in the foundational reviews: understanding AI, using or applying AI, evaluating or creating with AI, and addressing ethical issues (Ng et al., 2021). More recent teacher-oriented frameworks suggest that this is not yet enough if teachers also need to demonstrate confidence, collaboration, impact and self-reflection in their real classrooms, as they need to know not only about AI concepts but also use their judgment to apply the tools in their own settings (Chiu et al., 2024; Zhou et al., 2025).

Additionally, research in the field of teacher education indicates that AI literacy is a different, but interconnected, competency from digital competence in general. AI readiness does not ensure AI literacy, particularly in its ethical assessment and critical use, with teachers who are more equipped to adopt AI. There is a need for more digital readiness but digital readiness does not guarantee AI literacy, particularly in ethical evaluation and critical use (Tenberga & Daniela, 2024). The difference is important in elementary, where teachers might require more general pedagogical skills or knowledge than specialist computer science skills (Kim & Kwon, 2023; Stolpe & Hallström, 2024).

Additionally, scoping and systematic reviews indicate that AI literacy is an emerging topic worldwide, though teacher education is not as well developed as the policy ambition. AI is

already being discussed in national and curricular conversations more frequently than in existing teacher preparation programs, and the professional knowledge of teachers is not well understood, particularly practical and ethical knowledge, in the research literature (Sperling et al., 2024).

Current understanding of Teacher AI Literacy

In K–12 research, teachers are always the central figure in the process of integrating AI. AI literacy education in schools has been reviewed, highlighting the importance of curricula being designed with teachers' knowledge and confidence in using AI and co-created with teachers rather than being imposed from outside (Casal-Otero et al., 2023; Wang & Lester, 2023). This is particularly true in elementary contexts, where teachers are responsible for teaching basic skills and are influential in developing students' initial perceptions of technology.

Empirical research indicates a lack of uniform low-level AI literacy among teachers, with some having higher levels than others. The results of the survey of 1013 primary and middle school teachers in China revealed that the application of AI significantly positively affected teachers' awareness and understanding of AI, evaluation of AI application and AI ethics, suggesting that the dimensions of teaching and learning are more likely to increase with the practical application of AI (Zhao et al., 2022). Likewise, 782 English teachers were examined, revealing that there was significant intra-group variability in AI literacy across four different profiles of AI literacy, ranging from low to high, rather than an average level (Pan & Wang, 2025).

Research on teacher learning further suggests that AI literacy influences teachers' motivation for continuing AI learning. In a sample of 318 K–12 educators, AI literacy had a direct relationship with self-efficacy in learning AI; awareness of AI ethics; and perceived social good; and an indirect relationship with behavioral intentions to learn more about AI (Du et al., 2024). This implies that AI literacy is not only a product of PD, but a requirement for continued PD.

Elementary school-specific evidence identifies common areas of weakness. Even in AI leading schools, the South Korean elementary teachers' confidence in AI content knowledge was lowest, followed by technological and pedagogical knowledge (Kim & Kwon, 2023). For teachers, the interviews in the same study revealed that a single competence model for using technology would not suffice as they needed to possess a multi-dimensional competence model, such as instructional design, anxiety reduction, data and code literacy, and AI ethics (Kim & Kwon, 2023).

Major Challenges

Three recurring challenges clusters have been identified in the literature: lack of teachers' preparation, poor enabling conditions, and ethical-contextual issues. First, the knowledge of AI is still acquired informally by many teachers, which can result in misunderstandings and lack of comprehensive understanding of AI, instead of solid pedagogical skills (Velandar et al., 2023). Developing AI more effectively in teacher preparation is still emerging in the teacher education

sector, and there is still insufficient attention to AI in educational practices, teacher training time, and curriculum (Dilek et al., 2025; Le et al., 2026).

Second, infrastructural and institutional obstacles will have a particular significance in the context of developing countries. In underdeveloped settings, persistent challenges that have been identified in the reviews are the lack of robust infrastructure, access to ongoing professional development, coordination of policies, and pedagogical preparation (Khatun et al., 2026). Throughout various technology-integration studies in Pakistan, low speed of internet, limited infrastructure, inadequate technology tools, power fluctuations, and low training potential are identified as the most recurring challenges in the application of technology in classrooms (Akram et al., 2022).

These barriers are made real with Pakistan specific evidence. Comparative literature further reveals that the teachers in Pakistan are not well-versed in digital literacy, and there are not enough computer labs or internet connections in the schools, making the integration of AI challenging before any specialized training has been conducted (Ahmed, 2025). The current study conducted in Peshawar revealed that teachers have basic digital skills but are weak in adopting advanced skills including using learning management systems, creating digital teaching aids, and using technology-based differentiated teaching; unreliable internet, lack of facilities, time constraints and lack of relevant training content were the main challenges faced (Ahmad, 2025).

Thirdly, the ethical and contextual issues are not just side-issues; they are at the core of teacher AI literacy. There is a growing consensus that AI Literacy should encompass topics such as bias, safety, privacy, and social impact, since uncritical use of AI can yield inaccurate, culturally inappropriate, and unfair outputs (Daher, 2025; Biagini, 2025; Landa-Blanco, 2026). Research in K-12 settings also reveals issues of misalignment of the curriculum and inability to tailor AI-generated materials to local culture and classroom contexts in multilingual and resource-constrained settings such as Pakistan (Filiz et al., 2025; Landa-Blanco, 2026).

Effective Strategies for Improvement

One consistent theme that emerges from the research is that, when effective, professional learning should be ongoing, hands-on and grounded in pedagogy. TPACK-based 75-hour PD course significantly enhanced the AI knowledge, AI teaching skills and AI teaching self-efficacy of inservice teachers (Sun et al., 2022). Moreover, a quasi-experimental study with pre-service teachers confirmed that the AI literacy professional development program contributes to the improvement of AI literacy skills which can be used in pre-service and in-service programs, in addition to the use of AI tools in both programs (Younis, 2024).

Shorter interventions are effective, but seem to be more effective when they include direct instruction and applied problem solving. To enhance teachers' AI literacy, we employed a case-based professional development program, which boosted the teachers' knowledge and

understanding of AI, and we used ill-structured case discussions to facilitate the application of acquired knowledge in pedagogical contexts (Ding et al., 2024). Concurrently, in the discussion, teachers' usage of AI knowledge was limited, which indicated that one-off or short-term level teaching and learning are unlikely to be enough (Ding et al., 2024).

There are also differentiated and progressive approaches to teaching that are also advocated in literature. Since teachers are coming to the learning process of AI with varying digital backgrounds and with different AI profiles, it is essential to customize professional development instead of standardizing it (Tenberga & Daniela, 2024). Teacher-focused and UNESCO-oriented approaches focus on incremental development and progression from initial learning to critical, ethical and context-appropriate practice over time (Dilek et al., 2025).

In Pakistan and other similar contexts blended and low-cost learning pathways seem to hold special promise. Research in Southern Pakistan showed that informal digital learning showed the highest impact on the development of teachers' competencies, while the impact of AI was enhanced with the addition of digital competencies and with a gradual and supported implementation (Majeed & Ahmad, 2025). Other studies found that AI technologies can enhance the impact of digital competencies on teachers' functional skills, whereas, in resource-limited contexts, peer-learning networks, culturally-relevant resource selection, and blended training are feasible suggestions (Majeed & Ahmad, 2025).

A concise synthesis of improvement strategies appears below.

Strategy	What the literature supports	Relevance to Islamabad federal elementary schools
Practice-based PD	Hands-on, TPACK-based, case-based training improves knowledge, skills, and self-efficacy (Sun et al., 2022; Ding et al., 2024)	Suitable for cluster-based workshops and follow-up coaching
Differentiated progression	PD should match teachers' starting digital and AI competence levels (Tenberga & Daniela, 2024; Pan & Wang, 2025)	Useful where teachers vary by age, experience, and school resources
Ethics-centered training	AI literacy must include bias, privacy, critical evaluation, and human oversight (Dilek et al., 2025; Landa-Blanco, 2026)	Important for safe use in public elementary classrooms
Blended and informal learning	Online platforms, peer learning, and self-paced study can extend scarce formal training (Zhao et al., 2022; Majeed & Ahmad, 2025)	Practical under budget and timetable constraints
Infrastructure plus policy	Training is ineffective without connectivity, devices, and institutional support (Daher, 2025; Landa-Blanco, 2026)	

Figure 1: Strategies for improving teacher AI literacy

Implications for Federal Government Teachers in Islamabad

The literature is supportive of a phased approach of introducing AI in FD schools for Islamabad. The initial stage should aim to build digital and AI readiness as research indicates that teachers across Pakistan may have varying levels of digital competence and require specific training before the idea of fully integrating digital and AI tools becomes viable (Jamil et al., 2025). In this stage teachers' knowledge, use in the classroom, awareness of the ethical implications and confidence should be assessed, preferably with a self-assessment instrument connected to the existing digital frameworks (Tenberga & Daniela, 2024).

The second phase should be more practical in the sense of applications of AI in different pedagogical contexts, which will not be overly theoretical. AI can be most useful to teachers when presented as a tool to support them in lesson planning, differentiation, assessment, translation, and accessibility, and when AI is guided by human oversight (Landa-Blanco, 2026). For Islamabad, this may involve adapting the Urdu/English medium lessons, creation of worksheets using AI, support for formative assessment, simplification of content, and other considerations in the context of clear school guidelines (Landa-Blanco, 2026).

Support should be institutionalised in the third phase. Several studies demonstrate that teacher AI literacy is a collective effort that requires government action, policy alignment, and organizational support (Zhao et al., 2022; Khatun et al., 2026). The difference between policy speech and teachers' informal experimentation is still very large in Pakistan, thus there is a need to provide professional development to federal teachers in Islamabad, which should not only include teachers' training but also teachers guidance on curriculum, mentoring, infrastructure support and ethical governance (Urooj et al., 2026).

In summary, the findings indicate that in Islamabad, empowering teachers is a multifaceted challenge involving AI literacy, both as a professional and ethical problem and a infrastructural question. The greatest change in the literature is the shift in perspectives from literacy as an ability to use AI tools to literacy as a competence that encompasses pedagogy, ethics, confidence, and reflection (Chiu et al., 2024; Tikhonova & Sabirova, 2025; Chee et al., 2024). The greatest remaining question is how these newly emerging frameworks of global scale can be adapted to, tested in, and sustained in the context of public elementary settings like Islamabad's where contexts of infrastructure, policy support, language and teacher preparation vary considerably from those in which existing evidence has been generated (Khatun et al., 2026; Landa-Blanco, 2026; Tan & Tang, 2025).

Research objectives

1. To find out the status of AI literacy (knowledge, application, evaluation and ethics) among FDE public school teachers in Islamabad.

2. To pinpoint the main difficulties teachers encounter in creating and implementing AI literacy.
3. To recommend sound solutions to enhance teachers' AI skills and incorporate AI into FDE schools.

Research Questions

1. How literate teachers in FDE colleges are in AI?
2. What are teachers' strengths and weaknesses in each of the domains of AI literacy?
3. Is there a gender gap in AI literacy levels and is there a teaching level gap in AI literacy levels?
4. Which are some of the difficulties teachers encounter in comprehending and applying AI?
5. What are the best practices to improve the in-service teachers' AI Literacy?

Research Hypothesis

H₀ There is no significant difference between teachers' overall AI literacy by gender.

H_a: There is a significant difference between the teachers' overall AI literacy by gender.

H_{1f}: The overall AI literacy of the teachers differs significantly based on gender.

H_{1b}: Teachers overall literacy on AI is not significantly different across primary, elementary and secondary school.

The overall AI literacy of the teachers in primary, elementary and secondary schools are significantly different.

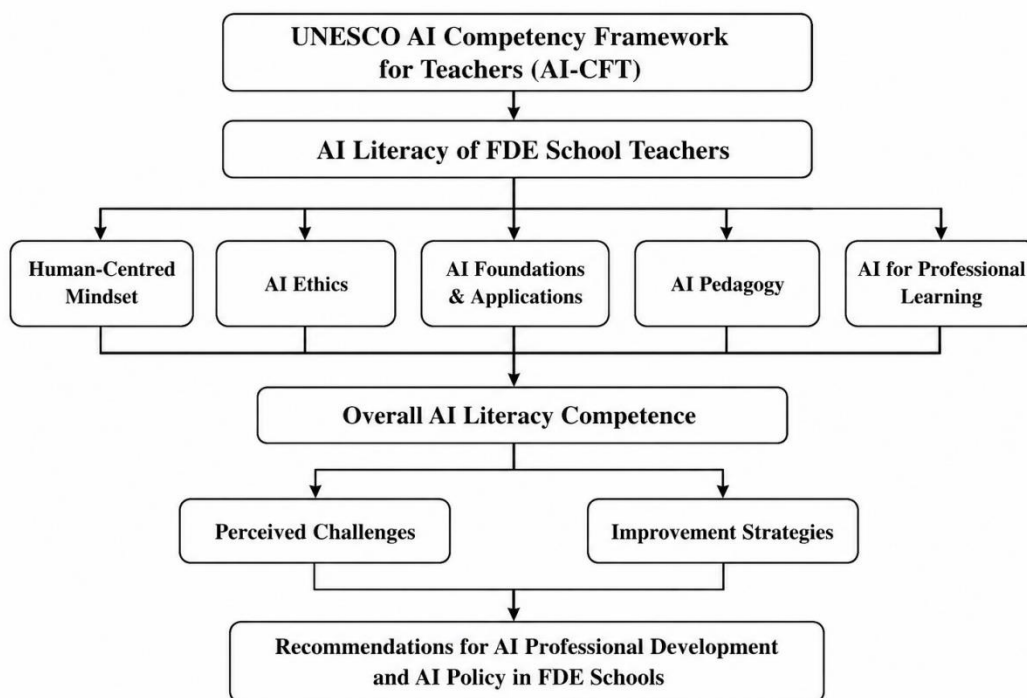
Conceptual Framework

This study is based on the UNESCO Artificial Intelligence Competency Framework for Teachers (AI-CFT), a framework that conceptualises AI literacy as a multidimensional construct with five interrelated competency domains: Human-Centred Mindset, AI Ethics, AI Foundations and Applications, AI Pedagogy, and AI for Professional Learning. These skills are all interconnected and contribute to teachers' readiness to embrace AI responsibly, ethically, and pedagogically in their teaching.

The framework suggests that teachers' AI literacy can be demonstrated through these five competencies, which impact their ability to effectively integrate AI technologies into teaching and learning. Teachers with high competencies will be more likely to have high levels of AI literacy and preparedness to use AI in their planning, assessment, professional learning, and ethical decision-making. Alternatively, lower levels of competency may identify the need for focused professional development and institutional support.

To provide a comprehensive understanding of AI literacy within the Federal Directorate of Education (FDE), Islamabad, the study further explores teachers' perceived challenges and recommended strategies for enhancing AI literacy. These contextual factors are in addition to the appraisal of AI competencies and are used for the formulation of recommendations for future teacher training programs and educational policy based on the evidence. Thus, the conceptual framework shows that the UNESCO AI-CFT becomes the theoretical framework for measuring the AI literacy of teachers, determining the competency gaps, looking at the contextual challenges and proposing ways to enhance AI integration in FDE schools.

Figure 1: Conceptual framework



Methodology

Research Design

The present study used quantitative cross-sectional survey design to measure the awareness of school teachers regarding the Artificial Intelligence (AI) under the Federal Directorate of Education (FDE, Islamabad). The study was supported by the UNESCO AI Competency Framework for Teachers (AI-CFT), which was used as the theoretical framework to develop the research instrument and teachers' AI literacy assessment. The use of a survey approach was

deemed suitable because it allowed for data to be gathered systematically from a large number of teachers, and the analysis of the AI literacy of teachers could be done across educational levels.

Research Context

It was carried out in model Colleges under the Federal Directorate of Education (FDE), Islamabad, under jurisdiction of six administrative regions namely Urban-I, Urban-II, Nilore, Bara Kahu, Tarnol and Sihala. The College Teachers from Primary, Elementary and Secondary level were included in the study, schools and universities were not included in the scope of the study. The chosen context presents a full picture of the teachers that operate within the FDE college system and provides valuable insights into the preparedness of the teachers for the implementation of AI into education.

Participants and Sampling Strategy

Target population consisted of all the primary, elementary and secondary school teachers working in FDE colleges in all the six administrative regions of Islamabad. The researcher also received institutional support from the Directorate of colleges, FDE in order to distribute the survey questionnaire, since there were no official records to indicate the number of teachers by college level in separate categories, it was not possible to get this information from the records.

The census survey approach was used, in which the questionnaire was sent to all teachers in the target population who met the criteria for inclusion instead of being sent to a sample of teachers. The participation was voluntary and the teachers were asked to fill up the questionnaire through the official communication channels organized by the Directorate of colleges. This was done to ensure that everyone participated and an overall picture would be formed of AI literacy among the FDE college teachers.

Research Instrument

Data was gathered by using the researcher-made questionnaire consisting of three sections. The first section collected data on demographic factors such as age, academic qualification, teaching experience, school level, region and preferred mode of professional training.

The second section evaluated teachers' AI literacy based on 25 multiple-choice questions created based on the UNESCO Artificial Intelligence Competency Framework for Teachers (AI-CFT). Five items were used to assess the five competency domains of the framework: Human-Centred Mindset, AI Ethics, AI Foundations and Applications, AI Pedagogy, and AI for Professional Learning.

The last two questions were open-ended to open up the space for teachers to examine the challenges they think they have in building their AI literacy and to give recommendations on how they think AI literacy and professionalization can be enhanced in FDE colleges.

Pilot Study and Reliability Analysis

Prior to the main study, a pilot study was conducted with 40 school teachers who were not included in the final sample. The purpose of the pilot study was to evaluate the reliability and clarity of the instrument before large-scale administration. Cronbach's Alpha was used to determine the internal consistency of the instrument. The AI Literacy Assessment Scale obtained an overall reliability coefficient of $\alpha = .794$, indicating acceptable reliability for a knowledge-based assessment instrument. Although individual domain coefficients were comparatively lower, the overall reliability exceeded the recommended threshold of .70 and was considered adequate for research purposes. The findings of the pilot study confirmed that the instrument was sufficiently reliable and suitable for administration in the main study involving school teachers.

Data Collection Procedure

Before collecting the data formal permission was taken from the Directorate of colleges, Federal Directorate of Education, Islamabad. After the approval of institutions, the questionnaire was sent to the teachers in the six regions of the FDE via official communication media. The teachers were provided with information about the study and were offered participation as a voluntary option. Data was collected anonymously to encourage the truthful responses and reduce response bias.

Ethical Considerations

Ethical guidelines of educational studies were followed in the study. Prior to the beginning of data collection, permission from institutions was sought. The participation was voluntary and informed consent was obtained from all participants prior to completion of the questionnaire. No personal identifiers were gathered and respondents were anonymous during the study. The participants were told their answers would only be used for research purposes and would be anonymous and kept in a confidential manner unless used in an aggregated form. All data collected was kept in a secure environment and was only accessible to the researcher and adhered to the accepted standards of research integrity and participant confidentiality.

Data analysis

To analyse quantitative data, quantitative statistical software will be used, such as SPSS: Descriptive statistics (means, standard deviations, frequencies) to summarise AI literacy scores by subscale and overall, and describe demographic characteristics (Zhao et al., 2022; Sagheem et al., 2025; Lérias et al., 2024).

Common challenges and proposed strategies were identified through descriptive and thematic analysis of open-ended responses with the quantitative data, and were triangulated with the qualitative data (Velandar et al., 2023; Sperling et al., 2024; Daher, 2025; Ding et al., 2024; Pei et al., 2025). The primary measure of AI literacy was used. The score was from 0 to 25. Scores 0-9 were considered low, 10-17 moderate and 18-25 were considered high. The domain scores were

the number of correct answers that could be achieved from 5 possible answers. The following data analysis was applied: Frequencies, Percentages, Means, Standard deviations, Welch's independent-samples t-test, and one way ANOVA. Welch's test was used for the gender comparison as the groups were highly unequal. Thematic coding was applied to the open-ended responses and the concepts that emerged were recurring themes of training, internet access, resources, time and practical support.

Results and Interpretations

Reliability of the Research Instrument

Internal consistency reliability was examined using Cronbach's alpha. For the 25-item AI literacy assessment, the final-sample reliability coefficient was $\alpha = .876$, indicating good internal consistency.

Table 1: Reliability of the Research Instrument

Scale	Number of Items	Cronbach's Alpha
AI Literacy Assessment	25	.876

These results demonstrate that the items used to measure AI literacy and perceived AI training needs demonstrated satisfactory to excellent internal consistency in the final sample.

Respondent profile

Table 2: Respondent profile

Characteristic	n	Percent
Female	124	91.9
Male	11	8.1
Urban college location	79	58.5
Rural college location	56	41.5
Primary teachers	68	50.4
Elementary teachers	21	15.6
Secondary teachers	46	34.1
Previous departmental AI training	82	60.7
No previous departmental AI training	53	39.3

Overall, AI literacy level

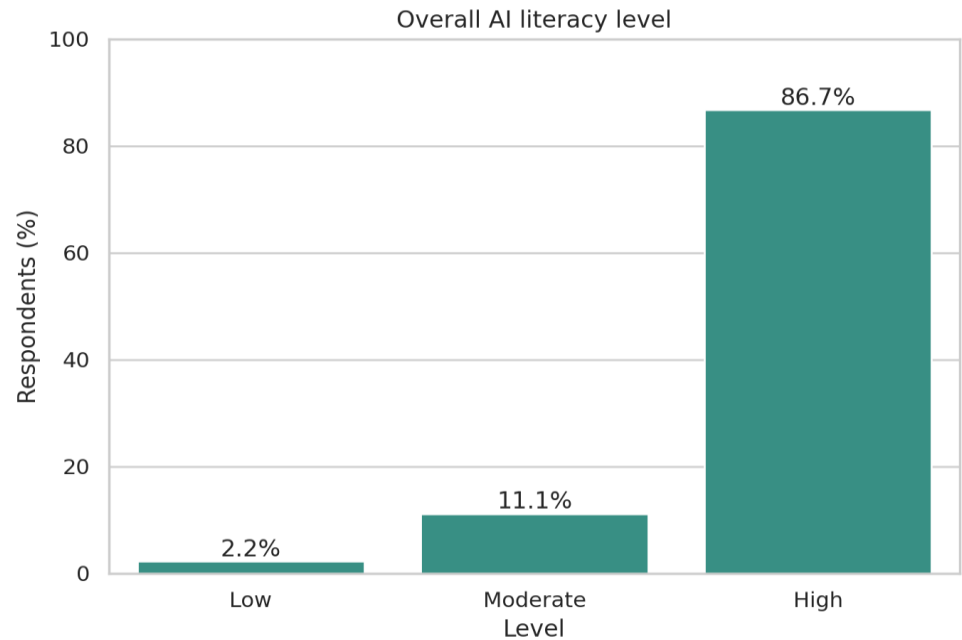
Table 3: Overall, AI literacy classification

AI literacy level	Frequency	Percent
Low	3	2.2
Moderate	15	11.1
High	117	86.7

The results indicated high level of AI literacy among the teachers in FDE institutions. The overall mean value of AI literacy score was 21.30 (85.2%) with standard deviation of 4.21. The total number of teachers is 135, of which 117 (86.7%) teachers are in the high AI literacy category, 15 (11.1%) teachers are in the moderate AI literacy category, and 3 (2.2%) teachers are in the low AI literacy category.

The highest scores at item level were recorded for questions related to: responsible classroom practice, digital consent, AI created content, teacher oversight and, curriculum alignment. The areas with poorest performances were related to deep learning, AI bias, ethical AI needs, respect for diversity and local educational needs, and the difference between machine learning and other computing devices. These vulnerabilities are significant because they relate to the conceptual and ethical aspects that are necessary for safe integration of AI.

Figure 2: Distribution of teachers across AI literacy levels



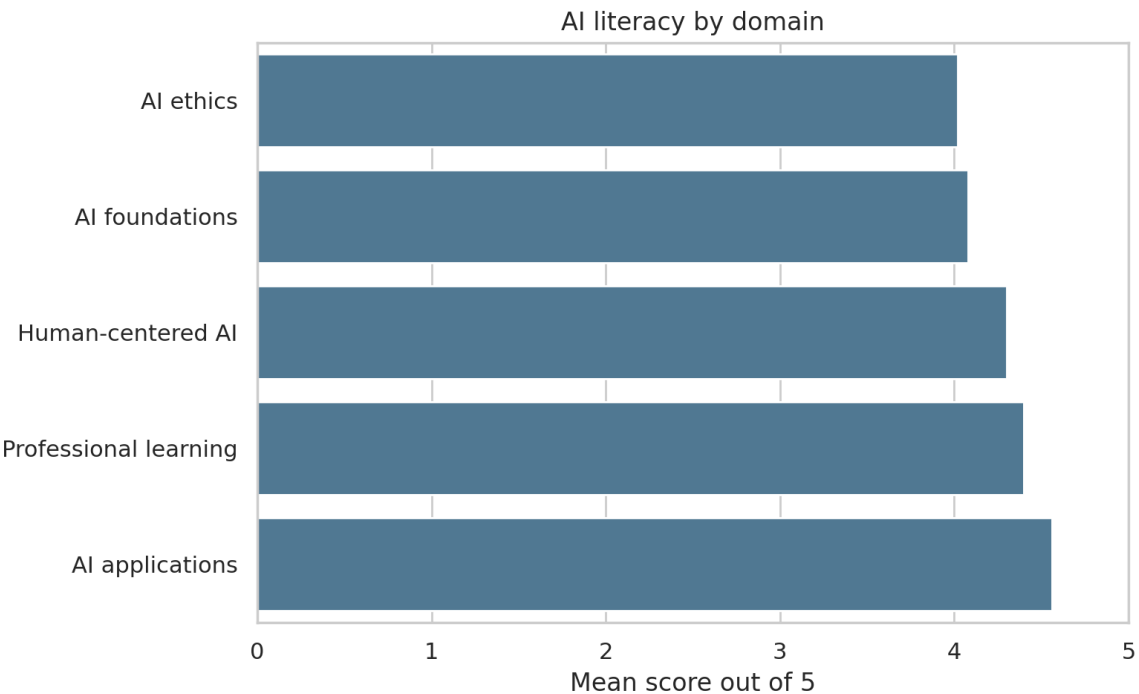
Strengths and weaknesses across AI literacy domains

Table 4: AI literacy by domain

Domain	Mean score out of 5	SD	Percent
AI applications	4.56	0.88	91.10
Professional learning	4.40	0.99	88.00
Human-centered AI	4.30	1.19	86.10
AI foundations	4.08	1.20	81.60
AI ethics	4.02	1.17	80.40

The results suggest that most educators have a solid base of knowledge and skills for comprehending and applying AI technologies. The scores, however, show that for a small minority of teachers, there is a need for targeted support in order to achieve the same level of competency. The domain level analysis revealed that the highest mean score (91.1%) was for the domain of AI Applications with a maximum of 5 points. This was followed by AI for Professional Learning (M = 4.40, 88.0%) and Human-Centered AI (M = 4.30, 86.1%). The comparatively weaker areas were AI Foundations (M = 4.08, 81.6%) and AI Ethics (M = 4.02, 80.4%).

Figure 3: Mean AI literacy scores by domain



Item-level strengths and weaknesses

Table 5: Eight weakest knowledge indicators

Item	Indicator	Correct responses (%)
8	Deep learning subset	68.1
16	AI bias	69.6
17	Ethical AI requirement	71.1
4	Respect diversity and local needs	72.6
7	Machine learning example	77.0
11	AI assessment use	77.8
21	Improve AI skills	78.5
10	Everyday AI example	79.3

Teachers performed relatively well in the areas of responsible classroom practices, digital consent, AI-generated content, teacher supervision, and curriculum alignment, at the item level. I did have some drawbacks in the deep learning ideas, AI bias, ethical AI needs, respect for diversity and local education needs, and especially in the ability to differentiate between machine learning and other computing.

Differences by gender

The analysis found **no statistically significant difference in AI literacy based on gender**. Female teachers obtained a mean score of 21.41, compared with 20.82 for male teachers. Welch's t-test showed that this difference was not statistically significant, $t = 0.57, p = .579$.

Differences by teaching level

Table 6: AI literacy by teaching level

Teaching level	n	Mean score	SD	Minimum	Maximum
Secondary teacher(class 9-10)	46	21.72	3.38	13	25
Primary teacher(class 1-5)	68	21.19	4.59	3	25
Elementary teacher(class 6-8)	21	21.14	4.21	7	25

The mean scores for secondary teachers, primary teachers and elementary teachers were 21.72, 21.19, and 21.14 respectively. No statistical significance was detected for the one-way ANOVA $F(2,132) = 0.25, p = .775$, very small eta-squared effect of .004. AI literacy was therefore relatively consistent among primary, elementary and secondary teachers.

Challenges reported by teachers

Table 7: Themes in open-ended responses

Theme	Respondents	Percent of sample
Need for formal AI training	95	70.4
Infrastructure and internet gaps	92	68.1
Time and workload constraints	49	36.3
Hands-on/practical learning	45	33.3
Rural access and equity	38	28.1
Funding and equipment limitations	37	27.4
Policy and institutional support	10	7.4

The open-ended responses highlighted a number of key issues. The most common problem was the lack of formal training on Artificial Intelligence reported by 70.4% of the population, followed by the lack of awareness on the subject (70.2%). The second-most prominent was infrastructure and internet limitations (followed closely by infrastructure and internet limitations with 68.1%). Limited opportunities to get hands-on experience (33.3%), time and workload constraints (36.3%), rural access and equity issues (28.1%), and funding and equipment constraints (27.4%) were other challenges.

This research highlights a lack of an individual competency problem with AI literacy. The institutional environment, such as connectivity, availability of devices, time for professional learning, funding, and opportunities for hands-on learning and experimentation, also impact teachers' understanding and application of AI.

Best practices for supporting teachers' AI literacy.

Implement a progressive AI literacy initiative Start with the basics of AI, machine learning, generative AI, bias, hallucinations, privacy, consent and responsible use. Upgrade to prompting, lesson planning, assessment, feedback, and multimedia production, and workflow automation.

Replace one time lecture with hands-on and classroom-embedded workshops. Every session should conclude in a lesson plan, rubric, feedback template, multimedia resource or administrative workflow that is usable.

Provide multiple pathways for learning Provide beginner, intermediate and advanced pathways. There should be mentoring, training and leadership development for teachers who have limited access, and low bandwidth and offline options for more experienced teachers.

Establish an AI teacher mentoring network Identify teachers with better practice and support of AI as peer mentors. Lesson observation and sharing of resources, troubleshooting and professional learning communities can serve as mentoring.

Create an FDE AI-use guide: guidance on data privacy, consent, academic integrity, AI-generated content, assessment, bias, hallucinations, transparency and teacher accountability.

Enhance infrastructure and equality of access Make stable internet, classroom displays, shared devices, updated computer labs, backup of electricity and access to the approved AI tools a priority. Targeted support and use of infrastructure should be provided for rural institutions.

Reserve time for ongoing learning: Allow time to practice during non-busy times and follow-up sessions for continued practice. Teachers explicitly recommended the organization of training at times when the workload is relatively less in the institutions.

Evaluate impact through evidence - pre and post testing, classroom artifacts, teacher reflection, student work, etc. to assess the effectiveness of training in improving safe and meaningful integration of AI.

Discussion

The overall trend is positive. The AI literacy score was high with the majority of teachers scoring at the high end of the scale and the mean score suggests that all the teachers in the sample have a good baseline understanding of AI. The results should not be taken as an indicator that AI literacy is uniform across all aspects. Overall, teachers were better on general professional learning, classroom applications than technical foundations and ethics. This is reflective of a situation where teachers are exposed to the challenges posed by AI mostly through tools and demonstrations, but not through deep conceptual and ethical exploration.

There is no significant difference in gender and teaching-level, indicating that professional development should not make assumptions about which groups or which teaching level are more AI-literate. Rather, needs and conditions of access and prior experiences, and the tasks teachers are expected to do, should differentiate supports. The close resemblance within the teaching levels enhances the possibility for institution-wide teacher training based on examples applicable to the primary, elementary and secondary levels.

The results are open-ended, providing an institutional perspective. The frequency of teachers' reference to AI literacy was tied to internet, devices, electricity, time, funding, and opportunities to experiment. Internet, devices, electricity, time, funding, and opportunities to experiment were all mentioned by teachers frequently with the concept of AI literacy. Therefore, a response that only relies on training would not be adequate. These key components are needed to implement effectively: infrastructure, shielded professional-learning time, direction on ethical usage, and local mentoring. The teachers need to be given special attention in the rural schools where the barriers to access the learned can be different.

Conclusion

The study finds that the teachers in FDE institutions have, overall, a high literacy level in the field of AI, and that in particular the teachers in the field of practical applications of AI and professional learning are highly competent. However, the performance of the AI foundations and ethics is relatively weak, which suggests that there are important aspects that need to be improved. Given the absence of significant differences across gender, and teaching level, the development of AI literacy should be considered as a professional learning issue for the institution as a whole, and not just confined to specific groups of people or teachers.

Simultaneously, the teachers surveyed cited obstacles when using AI, highlighting the need for more than just training to improve AI literacy. Effective implementation of AI is limited by a lack of formal education, insufficient internet and infrastructure, time, resources and limited hands-on experience. Hence, it is essential that FDE implement a long-term, practical, ethical, and institutional support framework for professional development on AI in education that fosters a solid understanding of AI and ethical considerations, allows for practical application in the classroom, provides mentorship, and enhances access to technology.

Limitations

Analysis was cross sectional and so is limited in its ability to make statements about change over time. Training needs were self-reported, and the open-ended themes were coded by applying a qualitative procedure (keyword-supported thematic review), which was not independently double coded. Larger and more balanced sample, reliability analysis, classroom observation, and pre-post evaluation of professional development are suggested for future research.

Recommendations

Based on the above findings, the following recommendations are made:

The continuous and structured AI literacy professional development programme for teachers, instead of one-off workshops, should be implemented by FDE.

AI ethics and AI foundations are comparatively weak areas of which more training is needed. Special care needs to be taken around AI bias, privacy, consent, hallucinations, ethical decision-making, machine learning, and responsible use of AI.

Professional learning should be very hands-on. During training teachers should be developing real lesson plans, assessment resources, multimedia items, prompts, rubrics, and administrative processes.

FDE should create peer mentoring and professional learning communities for teachers who have greater AI competencies to facilitate their colleagues through demonstration, resource sharing, and troubleshooting.

The infrastructure in the institution should be enhanced, especially the access of internet, electricity back up, computer facilities, classroom devices and access to proper AI tools.

Equity needs to be a part of the professional development of AI, and especially of those who are teaching and who are in institutions facing rural and connectivity challenges.

The institution must give teachers clear guidelines on the responsible use of AI which includes data security, consent, academic integrity, biases and hallucination, transparency, assessment and teacher accountability.

The training should be flexible to the level of previous training. Teaching level and gender were not significant factors but individual differences in competency and experience suggest value in the beginner, intermediate and advanced learning pathways.

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