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AI LITERACY AND TECHNO-PEDAGOGIC COMPETENCY OF PROSPECTIVE TEACHERS: AN EMPIRICAL STUDY

Arafa Beegum N S
Research Scholar, Mar Theophilus Training College, University of Kerala
arafabeegum20@gmail.com
Prof.Dr.Bindu B
Professor, Mar Theophilus Training College, University of Kerala
bindu.mttc@gmail.com

Abstract

The rapid advancement of Artificial Intelligence (AI) is transforming education and making AI literacy an important component of teacher competence. However, effective use of AI also requires techno-pedagogic competency to integrate technology according to pedagogical purposes, content and learners' needs. The present study investigated the level of AI literacy and techno-pedagogic competency of prospective teachers and examined the association between the two variables. A descriptive survey method was adopted, and 377 prospective teachers from Kerala were selected through simple random sampling. Data were collected using an AI Literacy Test and a Techno-Pedagogic Competency Scale developed and validated by the investigator. Descriptive statistics, Chi-square test, Contingency Coefficient and Cramer's V were used for analysis. The findings showed that the majority of prospective teachers had a moderate level of AI literacy (52.51%) and techno-pedagogic competency (72.94%). A significant association was found between AI literacy and techno-pedagogic competency ($\chi^2 = 67.31$, df = 4, $p < 0.01$). The findings highlight the need to strengthen AI knowledge, critical evaluation skills, ethical awareness and practical technology-integration skills through teacher education programmes.

Keywords: Artificial Intelligence, AI Literacy, Techno-Pedagogic Competency, Prospective Teachers, Teacher Education

Introduction

The educational landscape is undergoing significant transformation due to the rapid development of digital technologies and Artificial Intelligence (AI). AI technologies are increasingly being incorporated into teaching, learning, assessment, educational administration

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and content development. Generative AI applications can assist users in producing text, images, presentations, questions and other educational resources, while other AI-enabled systems can support adaptive learning, personalised instruction, automated feedback and learning analytics.

The proliferation of AI has created unprecedented access to large amounts of information and knowledge. Although such access creates opportunities for learning, it also creates challenges associated with information overload, misinformation, algorithmic bias, privacy, intellectual property and the reliability of AI-generated outputs. In educational contexts, these concerns become particularly important because teachers have a professional responsibility to provide learners with appropriate, accurate and contextually relevant information.

The use of AI in education therefore requires more than technical familiarity with AI tools. Teachers need to understand how AI systems work at an appropriate level, recognise their capabilities and limitations, critically evaluate AI-generated information and make responsible decisions about when and how AI should be used. Long and Magerko (2020) conceptualised AI literacy as a set of competencies enabling individuals to critically analyse AI technologies, communicate and collaborate effectively with AI, and use AI appropriately in different contexts. Contemporary research also emphasises that AI literacy among prospective teachers is important for preparing them for future educational environments. Recent research on pre-service teachers has identified AI knowledge, application, detection, ethics, creation and problem-solving as important dimensions of AI literacy.

At the same time, technological knowledge cannot be separated from pedagogical knowledge. The successful use of technology in teaching depends upon the teacher's ability to integrate technological possibilities with pedagogical purposes and subject content. The Technological Pedagogical Content Knowledge (TPACK) framework proposed by Mishra and Koehler provides an important theoretical basis for understanding teachers' knowledge required for meaningful technology integration.

Thus, a teacher may possess knowledge of AI but may not necessarily be able to use AI effectively for teaching. Conversely, a teacher may possess considerable technological and pedagogical competence but lack the knowledge required to critically evaluate emerging AI systems. Therefore, AI literacy and techno-pedagogic competency can be considered

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complementary competencies in preparing prospective teachers for contemporary and future classrooms.The present study attempts to examine these two dimensions together and determine whether an association exists between AI literacy and techno-pedagogic competency among prospective teachers.

Need and Significance of the Study

The rapid advancement of Artificial Intelligence (AI) has transformed the educational environment, making AI literacy an increasingly important competency for prospective teachers. AI-powered tools are now widely used for information searching, content generation, communication, assessment and other educational purposes. However, effective use of AI requires more than familiarity with technological tools. Prospective teachers need to critically evaluate AI-generated information, recognise inaccuracies and biases, understand issues related to privacy, copyright, academic integrity and responsible use, and make informed decisions about the appropriate use of AI in educational contexts. At the same time, teachers need techno-pedagogic competency to integrate technology meaningfully with content, pedagogy and learning objectives. Therefore, it is important to examine the AI literacy and techno-pedagogic competency of prospective teachers to understand their preparedness for teaching in increasingly AI-enabled educational environments.

The present study is significant because prospective teachers constitute the future teaching workforce, and their competencies will influence how AI is incorporated into classroom practices. Understanding the relationship between AI literacy and techno-pedagogic competency can provide useful evidence about whether prospective teachers are prepared to use AI critically, ethically and pedagogically rather than merely operating AI-based tools. The findings may help teacher educators and teacher education institutions identify areas requiring further training and may support curriculum planners in developing programmes that strengthen AI-related knowledge, ethical awareness, professional judgement and technology-integrated pedagogical practices. Thus, the study can contribute to preparing prospective teachers for responsible and meaningful integration of AI in future teaching-learning processes.

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Statement of the Problem

The rapid integration of Artificial Intelligence (AI) into education is creating new opportunities as well as challenges for teachers, particularly in relation to the ability to understand, evaluate and use AI tools appropriately in teaching-learning contexts. Although prospective teachers are increasingly exposed to AI-based applications, mere exposure or operational familiarity with such technologies does not necessarily ensure that they possess adequate AI literacy or the techno-pedagogic competency required to integrate AI meaningfully into classroom practices. They may face difficulties in critically evaluating AI-generated information, identifying inaccuracies and biases, addressing ethical concerns, and selecting and applying AI tools in accordance with learning objectives, content and pedagogical requirements. This creates a need to examine the extent to which prospective teachers are prepared to engage with AI both critically and pedagogically and to understand the relationship between their AI literacy and techno-pedagogic competency. Hence, the present study is entitled **"**AI Literacy and Techno-Pedagogic Competency of Prospective Teachers: An Empirical Study."

Objective of the Study

The study has the following objective:

1) To find out whether there exists any significant association between AI literacy and techno-pedagogic competency of prospective teachers.

Hypothesis

The following hypothesis was formulated:

1) There is a significant association between AI literacy and techno-pedagogic competency of prospective teachers.

Methodology

Research Design

The present study adopted a descriptive survey method. The design was considered appropriate because the study intended to describe the existing levels of AI literacy and techno-pedagogic competency among prospective teachers and examine the relation between the two variables without manipulating any experimental conditions.

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Population

The population of the study consisted of prospective teachers undergoing teacher education programmes in Kerala.

Sample

A sample of 377 prospective teachers was selected from different parts of Kerala.The sample was selected using the simple random sampling technique.

Variables of the Study

The major variables included in the study were:

Independent variable

- AI Literacy

Dependent variable

- Techno-Pedagogic Competency

Since the study is correlational/associational in nature, the variables are not treated as experimentally manipulated independent and dependent variables.

Tools Used for Data Collection

Two tools were used for collecting data.

AI Literacy Test

An AI Literacy Test was developed by the investigator for assessing the AI literacy of prospective teachers.

The test covered the following dimensions:

- AI awareness
- AI knowledge
- AI understanding
- Ethical AI

The tool was subjected to expert validation to ensure the relevance and appropriateness of the items.

Techno-Pedagogic Competency Scale

A Techno-Pedagogic Competency Scale was developed by the investigator to assess prospective teachers' knowledge and attitude towards incorporating technology into teaching-learning experiences.

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The tool was validated by experts in the field of education and educational technology.

Data Collection Procedure

The investigator obtained data from 377 prospective teachers selected from teacher education institutions in Kerala. The purpose of the study was explained to the participants, and the tools were administered to them.

The completed responses were collected, scored and organised for statistical analysis. The participants' scores on AI literacy and techno-pedagogic competency were classified into three levels: high, moderate and low.

Statistical Techniques Used

The following statistical techniques were used:

1. Mean
2. Standard deviation
3. Percentage analysis
4. Chi-square test of association
5. Contingency Coefficient
6. Cramer's V

The mean and standard deviation were used to describe the distribution of scores. Percentage analysis was used to classify prospective teachers according to the level of AI literacy and techno-pedagogic competency.The Chi-square test was employed to determine whether a statistically significant association existed between the categorical levels of AI literacy and techno-pedagogic competency.

Analysis and Interpretation of Data

Level of AI Literacy of Prospective Teachers

The mean and standard deviation of AI literacy scores of the 377 prospective teachers were found to be: Mean = 6.9 Standard Deviation = 2.2

The classification of prospective teachers according to their level of AI literacy is presented in Table 1.

Table 1 : Classification of Prospective Teachers Based on the Level of AI Literacy

Level	Number	Percentage
High	71	18.83

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Moderate	198	52.51
Low	108	28.64
Total	377	99.98

Interpretation

Table 1 indicates that 198 prospective teachers (52.51%) had a moderate level of AI literacy. This constituted the largest proportion of the sample. 108 prospective teachers (28.64%) belonged to the low AI literacy category, whereas only 71 prospective teachers (18.83%) demonstrated a high level of AI literacy.

The findings suggest that although a majority of prospective teachers possess at least a moderate level of AI literacy, a relatively small proportion have reached the high level. The presence of nearly three-tenths of the sample in the low category indicates a need for systematic development of AI-related knowledge and competencies within teacher education programmes. The finding is particularly relevant because AI literacy involves more than familiarity with AI applications. Prospective teachers need to understand AI concepts, critically evaluate AI outputs and recognise ethical and societal implications. Contemporary research similarly identifies gaps in AI understanding among prospective teachers and highlights the importance of structured training and practical experiences.

Level of Techno-Pedagogic Competency of Prospective Teachers

The mean and standard deviation of the techno-pedagogic competency scores of the 377 prospective teachers were: Mean = 26, Standard Deviation = 5. The classification is presented in Table 2.

Table 2: Classification of Prospective Teachers Based on the Level of Techno-Pedagogic Competency

Level	Number	Percentage
High	59	15.64
Moderate	275	72.94
Low	43	11.40
Total	377	99.98

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Interpretation

Table 2 shows that the majority of prospective teachers, 275 (72.94%), possessed a moderate level of techno-pedagogic competency. 59 (15.64%) demonstrated a high level, while 43 (11.40%) belonged to the low category.The predominance of the moderate category suggests that most prospective teachers have some knowledge and positive orientation towards integrating technology into teaching-learning processes, but many may require further opportunities to develop advanced technology-integrated pedagogical practices.This finding also indicates that teacher education programmes should move beyond providing exposure to digital tools. Prospective teachers need opportunities to design lesson plans, learning activities, assessments and classroom experiences in which technology is integrated purposefully according to learning objectives.

Association Between AI Literacy and Techno-Pedagogic Competency

To examine the relationship between AI literacy and techno-pedagogic competency, a 3 × 3 contingency table was prepared by classifying both variables into high, moderate and low levels.

Table 3: Contingency Table Showing the relationship Between AI Literacy and Techno-Pedagogic Competency

AI literacy / TPC	High	Moderate	Low
High	16	33	10
Moderate	55	122	98
Low	0	43	0

The reported Chi-square value was: $\chi^2 = 67.31$ Degrees of freedom: **df = 4,** Table value at 0.01 level: $\chi^2 = 13.277$**.** Since the obtained value of χ^2 (67.31) is greater than the table value (13.277), the null hypothesis is rejected at the 0.01 level of significance. Thus, the study indicates that: There exists a statistically significant relationship between AI literacy and techno-pedagogic competency among prospective teachers.

Interpretation of the Relationship

The contingency table provides an interesting picture of the distribution of prospective teachers across the two variables. Among prospective teachers with high techno-pedagogic

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competency, 16 had high AI literacy, 33 had moderate AI literacy and 10 had low AI literacy. Among those with moderate techno-pedagogic competency, 55 had high AI literacy, 122 had moderate AI literacy and 98 had low AI literacy. Among those with low techno-pedagogic competency, 43 had moderate AI literacy, while none were classified as having high or low AI literacy according to the supplied table. The statistically significant association suggests that the levels of AI literacy and techno-pedagogic competency are not distributed independently within the sample.

This finding can be understood conceptually through the complementary nature of the two competencies. AI literacy provides the knowledge and critical understanding necessary to interact with AI, whereas techno-pedagogic competency provides the pedagogical foundation for integrating technological resources into teaching.

The finding is consistent with the broader direction of current research in teacher education, which emphasises that AI competence should involve not only understanding AI but also its application, evaluation, ethics and integration into educational practice.

Major Findings of the Study

The major findings are summarised as follows:

1. The mean AI literacy score of the prospective teachers was 6.9, with a standard deviation of 2.2.
2. The majority of prospective teachers (52.51%) possessed a moderate level of AI literacy.
3. 18.83% of prospective teachers demonstrated a high level of AI literacy.
4. 28.64% of prospective teachers belonged to the low AI literacy category.
5. The mean techno-pedagogic competency score was 26, with a standard deviation of 5.
6. The majority of prospective teachers (72.94%) possessed a moderate level of techno-pedagogic competency.
7. 15.64% demonstrated a high level of techno-pedagogic competency.
8. 11.40% demonstrated a low level of techno-pedagogic competency.
9. The reported Chi-square value of 67.31 was greater than the table value of 13.277 at the 0.01 level of significance for 4 degrees of freedom.

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10. Therefore, a statistically significant association was reported between AI literacy and techno-pedagogic competency.
11. The finding indicates that AI literacy and techno-pedagogic competency represent related dimensions of prospective teachers' preparedness for technology-rich and AI-mediated educational environments.

Discussion

The present study demonstrates that most prospective teachers fall within the moderate category for both AI literacy and techno-pedagogic competency. This is an important finding because it suggests that prospective teachers have begun to develop competencies relevant to contemporary digital education, but their competence may not yet be sufficiently developed for advanced and independent integration of AI into teaching.

The moderate level of AI literacy may be associated with the increasing availability of AI applications in everyday digital environments. Prospective teachers may have become familiar with AI-powered applications through personal, academic or professional activities. However, familiarity with AI applications does not necessarily imply a deeper understanding of AI mechanisms, limitations or ethical implications.

This distinction is important. AI literacy should not be reduced to the ability to operate an AI application. A teacher should be capable of asking whether information generated by AI is accurate, whether the output is appropriate for the learners, whether bias is present, whether the use of the tool is ethically acceptable and whether the application contributes meaningfully to the intended learning outcome.

The finding regarding techno-pedagogic competency also indicates that the majority of prospective teachers are situated at the moderate level. This may indicate that technology has become increasingly familiar within teacher education, but the ability to integrate technology systematically with pedagogy still requires further development.

The significant association between AI literacy and techno-pedagogic competency provides an important dimension to the study. AI literacy may support teachers' understanding of emerging technologies, while techno-pedagogic competency may provide the pedagogical framework through which such technologies can be meaningfully used.

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However, the association should not be interpreted as evidence that one variable directly causes the other. Since the present study used a descriptive survey design, it establishes an association rather than a causal relationship.

Educational Implications

The findings of the study have several implications for teacher education.

1. AI literacy should be incorporated systematically into teacher education programmes. Instead of treating AI as an optional or isolated topic, it can be integrated across different teacher education courses.
2. Prospective teachers should receive opportunities to interact with AI tools through authentic educational tasks such as:preparing lesson plans;generating and evaluating learning resources;developing assessment questions;analysing classroom scenarios;creating differentiated learning materials;evaluating AI-generated content; and designing technology-supported learning activities.

Recent research similarly highlights the importance of practical and collaborative experiences in developing prospective teachers' AI literacy.

Suggestions for Further Research

Based on the findings, the following areas are suggested for future research:

1. Similar studies can be conducted with larger samples covering different states of India.
2. Comparative studies can be conducted between prospective teachers and practicing teachers.
3. Experimental studies can examine the effectiveness of AI-literacy training programmes.
4. Longitudinal studies can investigate how AI literacy develops throughout teacher education programmes.
5. Future studies can examine the relationship between AI literacy and TPACK/AI-TPACK.
6. Research can investigate the influence of AI literacy on actual classroom technology integration.
7. Studies can examine AI literacy according to teaching subject.
8. Studies can investigate gender, rural-urban and institutional differences in AI literacy.

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9. Qualitative studies can explore prospective teachers' experiences, concerns and ethical perceptions regarding AI.
10. Future research can develop performance-based assessments of AI literacy rather than relying only on conventional tests or self-report scales.

Conclusion

The rapid emergence of Artificial Intelligence has created new expectations for teachers and teacher education programmes. Teachers of the future will need to work in educational environments where AI-supported technologies are increasingly present in teaching, learning, assessment and educational decision-making.

The present study examined the AI literacy and techno-pedagogic competency of prospective teachers and investigated the association between these two competencies. The findings showed that the majority of prospective teachers were at a moderate level of both AI literacy and techno-pedagogic competency. The study also reported a statistically significant association between the two variables.

The findings suggest that preparing teachers for AI-mediated education requires a combination of technological knowledge, pedagogical understanding, critical thinking and ethical awareness. AI literacy should therefore not be understood merely as the ability to operate AI tools. It should encompass awareness, understanding, critical evaluation, responsible interaction and ethical decision-making.

Similarly, techno-pedagogic competency should extend beyond basic technological skills and focus on the purposeful integration of technology with learning objectives, pedagogical strategies, content and learner needs.

Consequently, teacher education programmes need to create opportunities through which prospective teachers can understand AI, critically evaluate AI outputs, recognise its limitations, address ethical concerns and integrate AI and other technologies meaningfully into teaching-learning experiences. The combination of AI literacy and techno-pedagogic competency can contribute to preparing prospective teachers for emerging educational environments while preserving the central role of professional teacher judgement.

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