

# Knowledge, Critique, and Practice: A Conceptual Model for Understanding and Designing Pre-Service Teachers' AI Training

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## Background

- Targeted training helps pre-service teachers develop a nuanced understanding and critical perspective about AI (Guan et al., 2025; Karataş & Yüce, 2024; Uwosomah & Dooly, 2025)
- Programs vary widely in what they aim to develop and how they teach it — building comprehensive knowledge (Younis, 2024), subject-specific skills (Abdulayeva et al., 2025), and a critical outlook on AI's societal impact (Dilek et al., 2025)
- No coherent way to make sense of this diversity exists, making it difficult for designers and researchers to build on what the field is already doing

## Purpose

To develop a model that maps the landscape of pre-service teachers' AI literacy training by identifying goals, instructional approaches, and the relationships between them.

## Methods

- Review of ten empirical studies on AI literacy training for pre-service teachers published from 2024 to July 2025
- Searches in ERIC and Scopus using keyword combinations of 'AI literacy,' 'pre-service,' and 'training' or 'intervention.'
  - Ten studies were included that provided details on goals and instructional approaches and reported positive outcomes.
  - Deductive coding of AI literacy goals, pedagogical approaches, and activities; inductive coding to identify overarching domains and the connections between them
  - Synthesized, interpreted, and consolidated into a conceptual model to understand current training approaches and suggest design considerations

## AN OVERVIEW OF THE STUDIES

Studies conducted across diverse contexts (e.g., the US, Hong Kong, Kazakhstan, China, and Palestine) and involved pre-service teachers from a range of subject areas, including English language teaching, physics, mathematics, and general education. Intervention varied from short workshops (Younis, 2024) to semester-long courses (Kohnke et al., 2025; Moorhouse et al., 2024), and from fully online asynchronous designs (Bae et al., 2024) to blended formats (Abdulayeva et al., 2025; MacDowell et al., 2024) and in-person modes (Moorhouse et al., 2024)

Primary training goals ranged from building AI knowledge and subject-specific teaching skills (Abdulayeva et al., 2025; Kohnke et al., 2025; Moorhouse et al., 2024) to fostering critical engagement with AI (Dilek et al., 2025) to integrating AI into authentic professional teaching tasks (Erdem Coşgun, 2025; MacDowell et al., 2024).

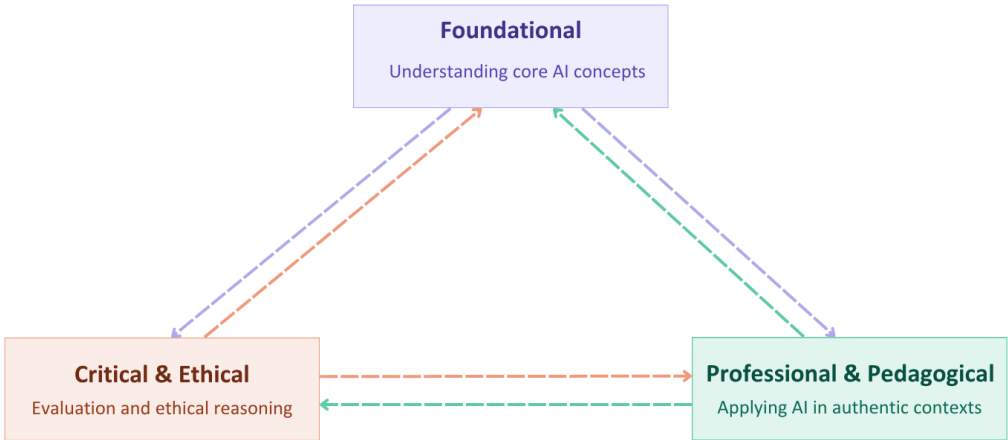
All studies reported positive outcomes in their primary goals. However, some identified gaps in other goals, such as in translating gained confidence into AI use intentions (Abdulayeva et al., 2025), engaging with deeper sociopolitical dimensions of AI (Dilek et al., 2025), and supporting their own future students for GenAI (Moorhouse et al., 2024).

## THE THREE KEY AI LITERACY TRAINING DOMAINS

| Foundational                                                                                                                                                   | Critical & Ethical                                                                                                                                                            | Professional & Pedagogical                                                                                                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Training to develop a fundamental understanding of AI — its core concepts, capabilities, and limitations. Framed as:<br>Know and understand AI (Younis, 2024), | Training to move beyond basic knowledge and passive use toward evaluation, ethical reasoning, and critical consciousness about AI's role in education and society. Framed as: | Training on integrating AI into authentic professional contexts, such as subject-specific teaching tasks. Framed as:<br>Use and apply AI (Younis, 2024)<br>Practical Skills in Assessment Design (Erdem Coşgun, 2025) |

| Foundational                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Critical & Ethical                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Professional & Pedagogical                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
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| <p>Fundamental AI concepts (Dilek et al., 2025)<br/>GenAI technological proficiency (Moorhouse et al., 2024).</p> <p><b>EXAMPLE INSTRUCTIONAL APPROACHES</b></p> <p>Direct instruction (Erdem Coşgun, 2025; Moorhouse et al., 2024; Younis, 2024)<br/>Microlearning (Kohnke et al., 2025)<br/>Experiential learning (Dilek et al., 2025)</p> <p><b>EXAMPLE ACTIVITIES</b></p> <p>Instructor-led chatbot demos (Younis, 2024)<br/>Short and long videos tutorials (Bae et al., 2024; Kohnke et al., 2025)<br/>Training a simple ML model (Dilek et al., 2025)</p> | <p>Ethical awareness and reflection, empowerment for advocacy, societal implications (Dilek et al., 2025)<br/>Critical and practical reflection (Bae et al., 2024)<br/>Apply AI ethics (Younis, 2024)<br/>Critical thinking about pedagogy (Karataş &amp; Yüce, 2024)</p> <p><b>EXAMPLE INSTRUCTIONAL APPROACHES</b></p> <p>Critical Co-discovery (Dilek et al., 2025)<br/>Experiential learning with narrative inquiry (Karataş &amp; Yüce, 2024)<br/>Structured discussion and reflection (Bae et al., 2024; Younis, 2024)</p> <p><b>EXAMPLE ACTIVITIES</b></p> <p>Asynchronous discussion with prompts (Bae et al., 2024)<br/>Analyzing AI-generated bias, polarity mapping of pro- and anti-AI stances (Dilek et al., 2025),<br/>Reflection paper on hands-on AI use (Karataş &amp; Yüce, 2024)</p> | <p>Professional GenAI competence (Moorhouse et al., 2024)<br/>AI TPACK (Kohnke et al., 2025)</p> <p><b>EXAMPLE INSTRUCTIONAL APPROACHES</b></p> <p>Task-based learning (Erdem Coşgun, 2025)<br/>Project-based learning (MacDowell et al., 2024)<br/>AI-embedded course with flipped classroom (Moorhouse et al., 2024)</p> <p><b>EXAMPLE ACTIVITIES</b></p> <p>Designing language exams with AI (Erdem Coşgun, 2025)<br/>Revising lesson plans with AI (Moorhouse et al., 2024)<br/>Mentoring an AI tool through mathematics problems (He et al., 2025)<br/>Co-authoring a textbook chapter with AI (MacDowell et al., 2024)</p> |

### HOW THE TRAINING DOMAINS INTERACT



#### Foundational training → Critical and Professional training

- Foundational training domain provides the grounding for the critique and professional training domains
- Most programs started with foundational training emphasis before introducing the other two domains

#### Critical and Ethical training→ Foundational and Professional training

- Training on critique and ethics informs foundational knowledge and informs training on evaluation and application of AI in professional contexts
- Critical evaluation of AI outputs assisted the development of foundational understanding of AI’s capabilities and limitations (e.g., biases) (Dilek et al., 2025; Moorhouse et al., 2024; Younis, 2024) as well as training on responsible AI integration.

### The Professional & Pedagogical training → the Foundational and Critical & Ethical Training

- Authentic professional tasks appeared to create conditions for foundational and critical training to emerge organically
- In Erdem Coşgun's (2025), the task of developing language assessment with AI simultaneously addressed the training on understanding AI's potentials and limitations and a critical evaluation of its potential
- In Moorhouse et al.'s (2024), hands-on exploration of using ChatGPT to provide feedback and discussion on ethical issues in AI grading embedded critical engagement with primarily professional training experiences

## PRACTICAL IMPLICATIONS

- Audit your program: which domains are you addressing, and are any underrepresented? What could be some instructional approaches to foster the underrepresented ones?
- When designing new training, consider facilitating all domains in integrated ways. Even when your primary goal is one or two domains, ask how the design can be leveraged to activate the others

### Example Integrated Design Approaches/Activities

#### Goal is to foster all domains

Example learning environment: A week-long asynchronous module that aims to develop comprehensive literacy about the technology, ethics, and application of AI in K-12 education.

- Activate foundational and critical domains: open with short direct instructions on AI's capabilities and limitations, followed by experiential activities such as training a simple ML model and evaluating the model's workings
- Activate professional and critical domains: hands-on exploration, evaluation, and think-aloud reflections of AI tools' use for developing differentiated instructional materials for different grade levels
- Activate critical, foundational, and professional domains: weave structured discussion prompts on ethical tensions after hands-on exploration. Allow for reflection on knowledge and application of AI.

#### Goal is to foster two domains: Foundational and Professional

Example learning environment: An hour-long in-person session on AI's use for language testing

- Activate the foundational and critical domains with a flipped classroom approach by providing materials on AI in language learning and asking students to find potential challenges from external resources before class.
- Activate professional domain with an in-class exploration of an AI tool for developing different types of practice test questions
- Activate critical and foundational domains with whole class discussion on its benefits, limitations, and ethical challenges based on materials and hands-on exploration

#### Goal is to foster one domain more: Critical

An eLearning module on AI ethics in education

- Activate foundational and critical domains through bite-sized videos discussing what aspects of AI cause ethical challenges
- Activate professional, critical, and foundational domains by making students generate educational materials with given prompts to identify biases, and answer questions on the possibilities of biases in AI tools
- Activate professional and critical domains by asking questions on AI ethical challenge scenarios in teaching contexts

(Abdulayeva et al., 2025; Bae et al., 2024; Dilek et al., 2025; Erdem Coşgun, 2025; He et al., 2025; Karatş & Yüe, 2024; Kohnke et al., 2025; MacDowell et al., 2024; Moorhouse et al., 2024; Younis, 2024)

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