Educators' AI Journey: Developing AI Competencies in a Professional Development Program

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Abstract. As artificial intelligence (AI) becomes increasingly pervasive in education, professional development (PD) for educators to develop AI competencies has become a necessity. Despite growing offerings in AI-focused PD programs, few studies have systematically examined how educators' AI-related understanding evolves during these programs. In this study, we investigated how educators engaged with and progressed through AI competencies across a ten-week online PD program. Drawing on the UNESCO AI Competency Framework for Teachers (AI CFT), we applied Ordered Network Analysis (ONA) to model the sequential structure of educators' discussion posts and open-ended reflections across three program phases. Results showed that educators' discourse primarily centered on foundational competencies, such as basic AI techniques and AI-assisted teaching. Additionally, comparison between teachers and administrators revealed distinct developmental trajectories early in the program, but these differences converged over time through shared learning experiences. This study demonstrates the utility of ONA for tracing conceptual development in PD contexts and highlights the need for intentional program design to guide educators toward developing advanced AI competencies.

Keywords: Artificial Intelligence, AI Competency, Teacher Education, Professional Development, Ordered Network Analysis.

1. Introduction

As artificial intelligence (AI) technologies become increasingly embedded in educational systems, the need to support educators in understanding and applying these tools is more urgent than ever [21]. AI holds potential for teaching and learning—from personalized feedback and adaptive content delivery to administrative efficiency and pedagogical innovation [1, 11]. This transformation presents complex challenges, particularly for educators who are expected to integrate AI in ways that are both pedagogically meaningful and ethically responsible [12, 13].

A growing body of research has identified critical gaps in teachers' AI competency, including limited technical knowledge, uncertainty about pedagogical integration, and concerns about AI's ethical and societal implications in classrooms [2, 18]. In response, various professional development (PD) programs have emerged to help teachers build foundational AI knowledge and gain confidence in using AI-driven tools [7, 14]. Teacher PD is broadly defined as the process by which educators expand their instructional knowledge, refine teaching practices, and adapt to changing educational contexts [16]. High-quality PD is widely recognized as central to supporting teacher growth and sustaining innovation [3]. With AI's growing presence in education [5, 9], there is increasing demand for PD that goes beyond technical skill acquisition to help teachers critically examine AI's role, guide students' AI use, and support ethical, human-centered practices [6, 8, 11].

Recent studies have explored PD designs that introduce AI tools, develop technical fluency, and influence teachers' beliefs and confidence. For instance, Sun et al. [17] examined TPACK-based PD to support teachers in developing AI lesson plan ability, while Ding [4] used case-based methods to promote AI literacy and integration strategies. Other research has focused on shifting attitudes, such as building trust in AI systems [12] or improving self-efficacy for AI-based instruction [22]. However, while these initiatives contribute to teachers' AI teaching skills and attitudes, they often focus on discrete outcomes and do not systematically investigate how teachers' AI-related understanding develops over time.

To address this limitation, it is necessary to examine teachers' AI competencies through a structured and developmental lens. AI competency extends beyond tool use to include ethical reasoning, pedagogical integration, and a human-centered and responsible mindset. The UNESCO AI Competency Framework for Teachers (AI CFT) provides a comprehensive structure for this purpose. It outlines five core aspects of AI competency: *Human-Centered Mindset*, *Ethics of AI*, *AI Foundations and Applications*, *AI Pedagogy*, *and AI for Professional Development.* These are organized into three developmental levels: *Acquire*, *Deepen*, and *Create*. At the *Acquire* level, teachers are expected to demonstrate foundational competencies such as recognizing AI's potential opportunities and risks and considering human rights and social justice while applying AI in practice. The *Deepen* reflects intermediate competencies level, in which educators engage in critical thinking about AI's implications and apply these tools responsibly and effectively within pedagogical contexts. The *Create* level represents advanced competencies, where educators contribute to shaping ethical standards and institutional strategies for AI, participate in policy discussions, and promote lifelong professional learning with AI. The framework offers a two-dimensional view of AI competence—what teachers need to know and be able to do, and how their capacity can evolve from foundational to transformative engagement with AI [20].

Despite its conceptual richness, empirical studies that trace how educators engage with and progress through these competencies during PD remain limited. In response, this study draws on the AI CFT to investigate how teachers' AI competencies evolve during a ten-week online PD program. We apply Ordered Network Analysis (ONA), a method that models the sequential and directional structure of discourse [19]. ONA enables us to analyze how AI competency elements emerge and shift over time both within and across program phases. To further explore how professional roles may influence learning, we also examine how AI competency development patterns differ between educators with different professional identities, specifically comparing teachers and administrators. Our research questions ask: (1) How do educators' AI competencies evolve across three phases of the program? and (2) How do AI competency development patterns differ between teachers and administrators?

2. Methods

We employed Ordered Network Analysis (ONA) to investigate how educators' AI-related competencies developed throughout the professional learning program. Unlike traditional Epistemic Network Analysis (ENA), which captures co-occurrence [15], ONA reveals how the relationships between codes evolve over time and how connections between these shifts in response to learning experiences [19]. In this study, ONA enables us to trace not only the temporal progression of educators' reasoning within each program phase but also the directional transitions across dimensions and codes, both within individual phases and across the entire PD sequence. This is particularly valuable for analyzing movement across the three progression levels of the UNESCO AI CFT and for identifying how specific competencies emerge and shift throughout the phases of the program.

2.1 Participants and Context

This study draws on data collected from a ten-week online professional development (PD) program focused on the integration of AI in education. The program was developed and facilitated by a university-based center for professional learning and was intentionally designed to support educators across a spectrum of formal and informal learning environments. The standard track required an enrollment fee, and participants received a credit-bearing certificate after completing the program. The cohort comprised 48 participants who self-enrolled through the program's webpage. Participants came from a broad range of contexts, including K–12 public, charter, and independent schools, higher education institutions, and education consulting organizations. Their professional roles included classroom teachers, curriculum directors, university faculty, instructional designers, and school leaders. This diversity enriched the discursive and reflective nature of the learning environment, fostering varied perspectives on the affordances and challenges of AI in education.

The PD program was hosted on the Canvas learning management system and integrated both asynchronous and synchronous components. Although the analysis in this study draws on the AI CFT, the program itself was designed independently of the framework. It was structured into three sequential phases: *Explore*, *Envision*, and *Enact* (see Table 1 for an overview of program content and structure). Each was designed to progressively deepen participants' conceptual and practical engagement with AI. The *Explore* phase introduced foundational concepts through curated resources (e.g., readings, podcasts) and invited individual reflection on current teaching practices. The *Envision* phase invited participants to engage in five faculty-led workshops and dialogue with AI experts and peers. The *Enact* phase scaffolded the application of learned ideas to participants' local educational settings. Participants collaboratively developed and iteratively refined context-sensitive projects, guided by peer feedback and small-group consultation organized by professional roles.

Table 1. Program content and format.

Part	Objective	Task
Part 1: Explore (Asynchronous work on Canvas)	Engage with resources to explore AI in education—its opportunities, challenges, and key questions. Reflect on your learning and prepare for upcoming workshops.	· AI-Integrated Classroom · Review Canvas materials (articles, videos, podcasts) to build understanding and prep for workshops. Take notes. · Choose and respond to one discussion prompt after reading.
Part 2: Envision (Live virtual sessions)	Engage with live virtual workshops to dive deeper into the benefits and challenges of using AI in education. Spark ideas for designing learning activities, policies, and structures to implement in your professional context.	· Writing with AI: Implications for Educators · Intro to AI: What foundation models can do in education · Critical Lens: Risks of AI and fostering thoughtful student use · Integrating AI: Supporting student thinking and collaboration · Design Workshop
Part 3: Enact (Synchronous team virtual meetings)	Design and implement a project in your professional context. Join live virtual sessions with small teams to collaborate, reflect, and share experiences.	· Project Plan · Implement in Context · Join Team Meetings · Post-Implementation Reflection

2.2 Data Collection and Preprocessing

The dataset includes 117 participant-generated discussion posts and 245 open-ended reflections embedded in post-session surveys, submitted in response to structured prompts embedded throughout three phases (see Table 2 for scaffolding prompts). These prompts were designed to encourage reflection and conceptual engagement. Initial discussion posts were required for program completion, while course reflections and open-ended reflections were voluntary and thus completed inconsistently across participants. The contents of a participant's discussion post or open-ended reflection were treated as the unit of analysis for model building to preserve the integrity of participants' ideas and avoid over-segmentation. On average, discussion posts contained 14 sentences, and open-ended reflections contained 2 sentences. This level of granularity allowed us to capture the evolving perspectives and sense-making processes of educators engaging with AI in education across varied contexts. A summary of the data distribution by activity type is provided in Table 3 (See Table 3).

A three-step data cleaning process was conducted to prepare the dataset for coding and subsequent analysis using the ENA Web Tool. First, all entries were reviewed to remove blank or non-textual format responses. Second, all personally identifying information was removed and replaced with pseudonymized participant codes to ensure confidentiality. Third, the cleaned dataset was formatted into a matrix structure suitable for binary coding, with each line representing a single unit of analysis.

Table 2. Scaffolding prompts for discussion posts and open-ended reflections.

Submission	Scaffolding Prompt
Discussion 1	Imagine a classroom or school that is really integrated with AI. 1. What does it look like? How do students engage with AI, with each other, with their teacher(s), with assignments? How does the teacher(s) use AI? For what purposes? You may not be able to imagine a classroom that is really integrated with AI - that's okay! Talk about why it's so hard to imagine. 2. How do you feel about this classroom that's really integrated with AI? Is it a good thing, a bad thing? A little of both? Why?
Discussion 2	Based on the readings and your experience with AI, choose one of the following prompts to respond to on the discussion post below. 1. What is one recommendation, policy suggestion, idea, etc. from the readings that intrigued you? How might you incorporate it into your own school/classroom context? What do you imagine will be the benefits and limitations of doing so? What questions does it raise for you? 2. What recommendation, policy suggestion, idea, etc. from the readings you disagreed with? What questions or concerns did it raise for you?
Open-ended reflection	What insights, feelings, next steps, and/or questions are you taking away from this session?
Reflection	Please share a brief update on your project's progress. Include the following: 1. What has been going well? 2. What obstacles have you faced? 3. What next steps are you planning to take in implementation?

Table 3. Overview of data collected across program phases

Phase	Activity	Type	Count	Participation
Explore	Discussion 1	Post	43	Required
	Discussion 2	Post	43	Required
Envision	Faculty-led workshop - Session 1	Survey	33	Voluntary
	Faculty-led workshop - Session 2	Survey	37	Voluntary
	Faculty-led workshop - Session 3	Survey	33	Voluntary
	Faculty-led workshop - Session 4	Survey	31	Voluntary
	Faculty-led workshop - Session 5	Survey	30	Voluntary
Enact	Group meeting - Meeting 1	Survey	26	Voluntary
	Group meeting - Meeting 2	Survey	27	Voluntary
	Group meeting - Meeting 3	Survey	28	Voluntary
	Reflection	Post	31	Voluntary
Total			362	

2.3 Codes and Codebook

The coding scheme for this study was primarily deductive, grounded in UNESCO AI CFT [20], which outlines the knowledge, skills, and ethical understandings educators need to integrate AI effectively into their practice. As a globally recognized framework, it provides a structured, theory-informed basis for examining teacher learning in AI. Moreover, the framework's three developmental levels, *Acquire, Deepen,* and *Create*, closely align with the PD program's structure, allowing us to examine participants' conceptual growth over time. AI CFT also outlines five domains: *Human-Centered Mindset, Ethics of AI, AI Foundations and Applications, AI Pedagogy, and AI for Professional Development*, from which 15 child codes were derived. These served as the coding categories for our analysis. While the codes were informed from the pre-existing framework, the codebook was iteratively refined through close readings of participants' responses. Sample sentences and excerpts from discussion posts and survey responses were used to contextualize and clarify code definitions, ensuring alignment between theoretical constructs and participants' language. The 15 codes and their coding schemes are defined and exemplified in Table 4.

The first and second authors conducted the coding of all discussion data at the sentence level based on this framework. To ensure consistency, 30% of the dataset across all three phases was double-coded. Inter-rater reliability was calculated using Cohen's Kappa and resulted in $\kappa \geq 0.84$ for all constructs, indicating strong agreement between coders [10]. In total, 362 discourse units were analyzed in this study.

Table 4. Codes, descriptions, and example sentences for each code.

Aspects	Codes	Description
Human-centered mindset	H1_Agency	· Human Agency Teachers understand that AI is human-led and that human agency is vital when evaluating and using AI tools.
	H2_Account	· Human Accountability. Teachers show a strong grasp of human responsibility in using AI and critically assess both its role in decision-making.
	H3_SR	· Social Responsibility. Teachers show a strong grasp of human responsibility in using AI and critically assess both its role in decision-making.
Ethics of AI	E1_Prin	· Ethical Principles. Teachers understand the basic ethical issues of AI and the principles needed for responsible human.
	E2_Safe	· Safe and Responsible use. Teachers internalize key ethical rules for using AI—like respecting privacy, IP rights, and laws.
	E3_CoCR	· Co-creating Ethical Rules. Teachers advocate for AI ethics by leading discussions, addressing key concerns, and helping shape ethical practices.

(continued)

Table 4. (*Continued*)

AI foundations and applications	AI1_Basic	· Basic AI Techniques and Applications. Teachers gain basic AI knowledge—its definition, types of AI, and how to assess and use suitable AI tools in education.
	AI2_App	· Application Skills. Teachers should skillfully use AI tools in education and apply data and algorithm knowledge ethically in teaching.
	AI3_Creat	· Creating AI. Teachers can effectively adapt AI tools using advanced knowledge and skills to foster inclusive learning and tackle educational challenges.
AI pedagogy	P1_AI.Assisted	· AI-assisted Teaching. Teachers are expected to be able to identify and leverage the pedagogical benefits of AI tools to facilitate subject-specific lesson planning, teaching and assessment.
	P2_AI.Integrated	· AI-pedagogy Integration. Teachers skillfully use AI to support student-centered learning, boosting engagement, personalized support, and so on.
	P3_AI.Enhanced	· AI-enhanced Pedagogical Transformation. Teachers critically assess AI's impact on teaching and learning and design AI-driven learning experiences.
AI for professional development	PD1_AI.PL	· AI Enables Lifelong Professional Learning. Teachers explore AI tools to enhance professional development, assess learning needs, and personalize their growth in a changing education landscape.
	PD2_AI.Org	· AI to Enhance Organizing Learning. Teachers confidently use AI tools in collaborative learning communities to share resources and contribute to adaptation.
	PD3_AI.PT	· AI to Support Professional Transformation. Teachers customize AI tools to improve their professional development.

2.4 Method of analysis

We employed ONA to examine shifts in participants' conceptual engagement with AI across the three phases of the professional development program: *Explore*, *Envision*, and *Enact*. We used ONA because it can capture not only the connections between AI competency elements but also the order in which these elements appear in educators' discourse. It allowed us to trace how participants moved between competencies within and across program phases, identify which competencies acted as entry points or recurring anchors, and compare trajectories between different professional roles. The primary unit variable was defined by program phase, with each unit representing a participant's coded textual responses within a given phase. Non-textual submissions (e.g., videos, audio) were excluded to ensure consistency in text-based coding. Missing responses were also omitted. While this exclusion may slightly limit the representativeness of participant engagement, the included data reflect the majority of submitted content and support clearer representations of participants' conceptual patterns. An anonymized participant code served as a secondary unit variable, enabling individual-level analysis while maintaining confidentiality. Conversation variables were defined at the prompt level, grouping all responses to a specific discussion or survey question. We applied a moving stanza window aligned with program phases, window size was 1, treating each participant's coded responses within each phase as a single stanza. This approach enabled analysis of evolving patterns in pedagogical reasoning and AI integration across the scaffolded structure of the program. To explore changes in participants' engagement with AI competencies, we visualized ordered networks for each phase. Edges with a weight below 0.04 were hidden to highlight the most meaningful transitions in participants' discourse.

3. Results

3.1 How did participants' AI competencies develop in three phases?

To evaluate the fit of the ordered network model, we examined Spearman correlation between the observed and expected code transition coordinates. The model demonstrated strong alignment, with Spearman values of 0.93 (X-axis) and 0.88 (Y-axis). Along the X-axis (SVD1), participants in Phase 1 (P1) differed significantly from those in Phase 2 (P2) ($U = 1963.00, p < .01, r = .86$). However, the difference between Phase 2 (P2) and Phase 3 (P3) was not statistically significant ($U = 1023.00, p = .01, r = .37$). Along the Y-axis (SVD2), P1 vs. P2 did not show significant differences ($U = 901.00, p = .23, r = 0.15$); and P2 vs. P3 showed significant differences ($U = 1106.50, p < .01, r = .48$). These results suggest meaningful shifts in the ordering of AI competency codes between phases of the professional learning program.

Phase 1: Entering through practical experience (Explore/Acquire)
In Phase 1 (see Fig. 1a), the dominant trajectory from *AI-Assisted Teaching* to *Basic AI Techniques and Applications* (line weight, lw = 0.23) , and then to *Application Skills* (lw = 0.12) reflects an initial focus on practical uses of AI, such as tutoring, generating assignments, and instructional support. These early discussions were grounded in broad, experience-based understandings of AI in educational settings. Ethical considerations appeared alongside technical talk, with strong links to *Human Agency* (lw = 0.14) and *Safe and Responsible Use* (lw = 0.12). Several participants expressed concern about students' overreliance on generative AI, particularly regarding academic integrity and learner autonomy. As one teacher noted, it is essential to "guide students to make decisions rather than fully relying on answers provided by AI," expressing a desire to preserve student agency in AI-mediated learning environments. This phase corresponds to the *Explore* stage of the program and the *Acquire* level of the UNESCO AI CFT, in which participants build initial awareness of AI's possibilities and potential risks.

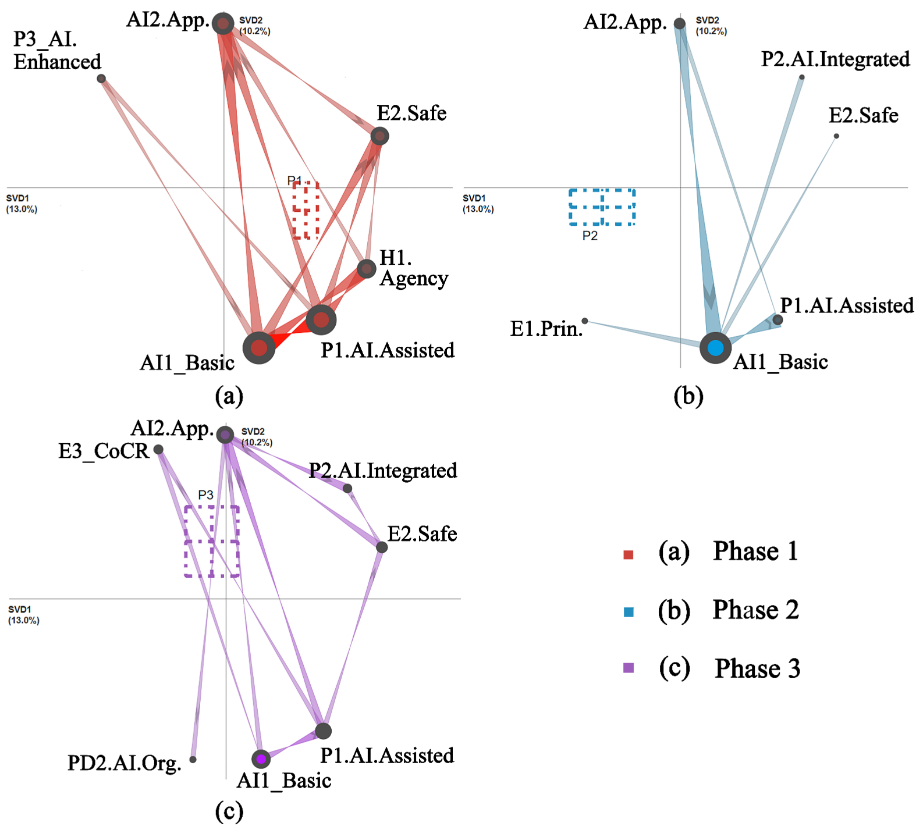

Fig. 1. The Ordered Networks of Three Phases: Phase 1 (red), Phase 2 (blue), and Phase 3 (purple).

Phase 2: Consolidating technical knowledge and embedding ethics (Envision/Acquire to Deepen)

In Phase 2 (see Fig. 1b), the network reveals a shift in trajectory, with *Application skills* connecting back to *Basic AI Techniques and Applications* (lw = 0.15)*,* which then bridged to *AI-Assisted Teaching* (lw = 0.15) and *AI-Pedagogical Integration* (lw = 0.05). This suggests that participants were consolidating their technical knowledge and applying it to instructional contexts. Concurrently, strong ties between *Basic AI Techniques and Applications* and ethical codes (*Ethical Principles* and *Safe and Responsible Use*) indicate an increased focus on responsible implementation. This emphasis likely stems from the five faculty-led workshops held during this phase, which addressed topics such as prompt engineering, lesson planning, and responsible use of AI. Participants' reflections illustrate this evolving stance, with one noting, "We need to discuss ethics even if we don't have time for it" and "Finding more ways to incorporate AI into my instruction in a meaningful but safe way." In terms of AI CFT, many participants remained at the *Acquire* level, but some began to touch the *Deepen* level by designing lessons with ethical principles.

Phase 3: Strategic and systematic integration (Enact)

In Phase 3 (see Fig. 1c) shows a relatively sparse network due to the optional nature of data collection, but reflects a more selective and intentional set of connections. Strong transitions persisted from *Basic AI Techniques and Applications* to *AI-Assisted Teaching* (lw = 0.10) and transition from *Application skills* to *AI-Pedagogical Integration* (lw = 0.08). These patterns reflect participants' project-based reflections as they revisited foundational concepts while applying them to their own educational settings. In addition, connections to *Safe Use*, *Co-creation of Ethical Rules*, and *AI for Organizing Learning* point to a nascent move toward the *Create* level in the AI CFT. For instance, one participant noted: "I also need to consider the policy implications going forward into next year… I may need to create some documentation around how to create and use the resource for other teachers and admin." These reflections indicate the beginnings of strategic planning and professional transformation, though such shifts were limited overall.

Cross-phase patterns: Limited progression beyond Acquire

To further investigate how participants' engagement with AI competencies developed throughout the program, we conducted a comparative analysis of structural changes across phases using subtracted ordered networks. Figure 2a displays the contrasts between Phase 1 and Phase 2; Figure 2b displays Phase 2 and Phase 3. Across all three phases of the program, *Basic AI Techniques and Applications*, *Application Skills*, and *AI-Assisted Teaching* remained central hubs. This pattern suggests that while participants could identify and apply AI tools in classroom settings, movement toward advanced competencies was limited. The dominance of Acquire-level codes indicates both the strength of the program in fostering foundational understanding, and the need for more attention to the *Deepen* and *Create* levels, where innovation, leadership, and systematic transformation are central.

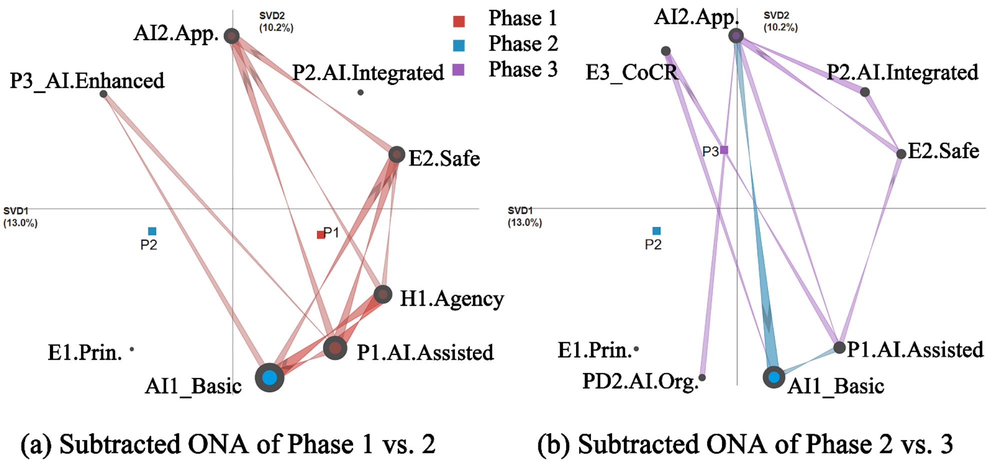

Fig. 2. The Comparison of Ordered Networks across Three Phases: Phase 1 (red), Phase 2 (blue), and Phase 3 (purple).

3.2 How did AI competency development patterns differ between teachers and administrators?

To explore whether role-specific responsibilities and experiences shaped engagement with AI competencies differently throughout the program, we compared participants' discourse patterns across roles using ONA. Forty-eight Participants were grouped into two categories: 32 teachers (including K-12 educators, professors, and instructors) and 16 administrators (curriculum directors, principals, and department chairs).

Phase 1: Distinct entry points shaped by professional identity
In Phase 1 (see Fig. 3a), teachers primarily engaged with concepts from *Application Skills* to *AI-Assisted Teaching* ($lw_{Teacher}$ = 0.12, lw_{Admin} = 0.08, the difference in line weights, lw_{Diff} = 0.04), reflecting their concern with building foundational knowledge and considering implications for classroom practice, particularly in student-centered learning. For example, one teacher remarked that "AI should be positioned as a tool—not a replacement for teachers." Given that this phase began with prompts imagining future classrooms, many teachers reflected on how AI might reshape instructional approaches.

In contrast, administrators had sustained discussions about *Co-creating Ethical Rules* ($lw_{Teacher}$ = 0.00, lw_{Admin} = 0.05, lw_{Diff} = 0.05), reflecting a systemic view of AI integration, with one administrator proposing, "We can collaborate to develop an internal policy—using resources such as those provided by ISTE—that reflects our shared values." This orientation aligns with leadership responsibilities that prioritize institutional policy, governance, and ethical frameworks.

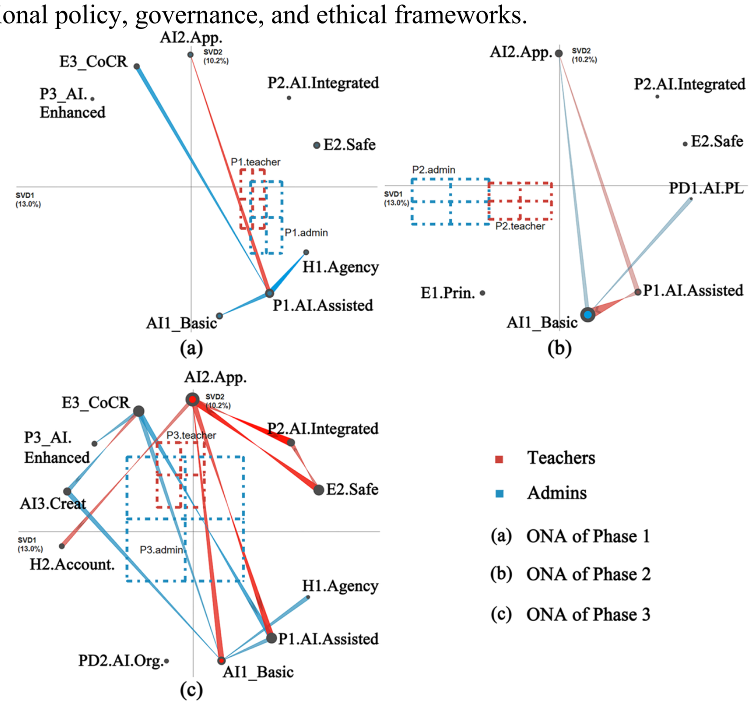

Fig. 3. Subtractors of (a) Phase 1, (b) Phase 2, and (c) Phase 3: Phase 1 (red), Phase 2 (blue), and Phase 3 (purple).

Phase 2: Expanding perspectives through cross-role engagement
In Phase 2 (see Fig. 3b), teachers increasingly discussed *AI-Assisted Teaching* ($lw_{Teacher} = 0.06$, $lw_{Admin} = 0.00$, $lw_{Diff} = 0.06$) and *Application Skills* ($lw_{Teacher} = 0.04$, $lw_{Admin} = 0.02$, $lw_{Diff} = 0.02$), indicating continued interest in pedagogical applications and integration strategies. Administrators, however, shifted toward *Basic AI Techniques and Applications* ($lw_{Teacher} = 0.00$, $lw_{Admin} = 0.60$, $lw_{Diff} = 0.60$), suggesting that workshops and peer engagement broaden their focus beyond policy and ethics to include more technical dimensions of AI. helped diversify participants' focus. This shift may indicate that the PD experience broadened participants' conceptual lenses and allowed them to adopt perspectives outside their traditional roles.

Phase 3: Convergence on applied and ethical considerations
Phase 3 (see Fig. 3c) was more diffuse due to the open-ended nature of reflection prompts and voluntary survey completion. Nevertheless, key role-based differences emerged. Administrators, for the first time, engaged with *Creating AI*, suggesting an interest in exploring generative or design-oriented competencies that could inform institutional innovation. Teachers increasingly discussed *AI-Pedagogical Integration*, illustrating an applied orientation toward using AI to support students' critical thinking and learning. As one teacher shared: "By integrating AI early in the course, I aim to enhance students' critical thinking skills and equip them with the ability to analyze the ethical and societal implications of AI technologies."

Cross-role patterns: From divergence to shared understanding
Across the three phases, teachers and administrators began with distinct focal points—classroom-level application for teachers and systematic governance for administrators. However, both of them expanded their engagement to encompass overlapping competencies by the end of the program. These findings suggest that well-structured PD can bridge perspectives and foster shared understanding across roles.

4. Discussion and conclusion

In this study, we employed Ordered Network Analysis (ONA) to explore how educators' AI competencies evolved across the three designed phases of a professional learning program. Grounded in the UNESCO AI Competency Framework for Teachers (AI CFT), our analysis uncovered meaningful patterns in how participants engaged with AI-related competencies over time, and how learning trajectories differed between teachers and administrators.

Across the program, participants' engagement evolved from broad exploration to more focused application. In the initial phase, discussions encompassed competences from all AI CFT levels—*Basic AI Techniques and Applications* (*Acquire*), *Application Skills* (*Deepen*), and *AI-Enhanced Pedagogy* (*Create*)—indicating early curiosity and wide-ranging interests. However, by later phases, most discussions were concentrated within a small set of frequently used codes—particularly foundational technical and pedagogical aspects of AI. Fewer references were made to competencies like lifelong learning, adaptive tool design, or self-directed professional transformation, highlighting more scaffolding is needed to help participants reach Create-level innovation, leadership, and systemic transformation.

Role-based analysis revealed distinct entry points but eventual convergence. Teachers initially focused on *Application Skills* and *AI-Assisted Teaching*, while administrators emphasized *Co-Creation of Ethical Rules* and systems-level planning and policy. These differences align with professional responsibilities: teachers centering on instructional integration, administrators on governance. By the program's end, role-based boundaries began to blur, and both groups explored a wider range of AI topics, suggesting that PD can narrow initial gaps in perspective, enabling more holistic engagement with AI across professional identities.

Participants' varied prior experiences with AI further point to the need for differentiated PD. Some educators reported integrating tools like ChatGPT or MagicSchool into their workflows, while others expressed hesitation, limited exposure, or even resistance. For instance, one participant shared, "I have largely avoided the most accessible forms of AI (such as ChatGPT) due to personal concerns about environmental impacts." These variations underscore a key challenge in designing effective PD: a one-size-fits-all approach may not sufficiently meet the diverse needs of educators. We suggest incorporating an initial AI self-assessment and optional intake interviews to better understand participants' starting points. Tailoring content and pacing based on these inputs could help differentiate learning experiences and support both novice and more experienced users in engaging meaningfully with AI.

Overall, this analysis shows that AI-focused PD can shift participants from exploratory engagement toward applied and ethically aware integration, while also narrowing role-based differences. However, moving participants beyond the *Acquire* and *Deepen* levels will require deliberate design that scaffolds progression, broadens competencies, and adapts to diverse starting points. For PD designers, these findings highlight the value of phased, role-responsive structures, explicit focus on advanced competences, and differentiated pathways to prepare educators for the complex demands of AI-enhanced teaching and leadership.

5. Limitations and future directions

This study is exploratory in nature and based on data from a single 10-week online PD program. As such, the findings may not be generalizable across contexts. Additionally, because some activities were optional, uneven participation may have influenced the observed discourse patterns. Moreover, participants self-enrolled in the program, which introduces the possibility of self-selection bias; those more inclined to engage with or open to AI may have been more likely to participate. This could limit the generalizability of our findings to broader educator populations with varying levels of interest or experience with AI. Future work should incorporate multiple PD programs across varied contexts and extend the duration of data collection to better capture long-term shifts in teacher learning trajectories. Further research could also investigate how different instructional designs affect the depth and diversity of AI-related competencies developed. Understanding how educators move from foundational awareness to critical, context-sensitive application is essential as AI becomes more embedded in educational systems worldwide.

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