SERDEC Education Journal (SEJ)
Online ISSN: 2710-4796 https://sej.so/

From Orchestrator to Co-pilot: A Conceptual Framework for the Teacher's Evolving Role in AI-Agent-Mediated Classrooms.

Prof. Dr. Said A bubakar , Mogadishu University

Email: serdecsom@gmail.com

DOI: 10.70595/sej119

Abstract

The integration of generative Artificial Intelligence (AI) agents into educational settings necessitates a fundamental reconceptualization of the teacher's role. This study addresses a critical gap in the literature by developing and empirically validating the "Orchestrator-to-Co-pilot" conceptual framework, which maps the evolving role of educators in AI-agent-mediated classrooms. Employing a mixed-methods design, the research involved 82 lecturers from Somali National University and Mogadishu University. The methodology was structured in three phases: a systematic literature review (2020–2025) to identify dominant themes and gaps; theoretical grounding using Distributed Cognition, Zone of Proximal Development, and Posthumanism to shape core framework dimensions; and empirical validation through focus group discussions and a Likert-scale questionnaire (Cronbach's alpha = 0.916). The framework articulates a developmental continuum across three stages—Orchestrator, Facilitator, and Co-pilot—delineating the teacher's transition in terms of Epistemic Authority, Pedagogical Scaffolding, and Relational Agency. Quantitative findings revealed moderate mean perceptions across these dimensions, indicating educators are currently navigating the transitional space between Orchestrator and Facilitator stages. A two-step cluster analysis identified two distinct educator profiles: "Cautious Traditionalists" (39.0%), aligned with the Orchestrator stage, and "Adaptive Integrators" (61.0%), corresponding to the Facilitator stage. Notably, AI Use for Scaffolding emerged as the strongest predictor distinguishing these groups, validating that pedagogical practice is central to successful role evolution. This study offers a structured pathway for teacher AI integration, providing empirical insights and targeted recommendations to proactively shape the transformation of education.

Keywords: Orchestrator, Co-pilot, Conceptual Framework Teacher's Evolving Role, AI-Agent-Mediated Classrooms**.**

Introduction

The rapid proliferation of generative Artificial Intelligence (AI) is instigating a fundamental transformation in education, moving beyond the integration of simple tools to heralding the emergence of AI-agent-mediated classrooms (Niu et al., 2022; Seo et al., 2021). In these environments, AI systems actively facilitate learning, curate knowledge, and reshape pedagogical interactions, fostering a dynamic triadic relationship among teachers, students, and intelligent agents. This shift necessitates a critical re-examination of the teacher's traditional role, compelling educators to evolve from being the central Orchestrator of all classroom processes to becoming a collaborative Co-pilot alongside AI (Lawrence et al., 2023; Tang, 2024).

Historically, the teacher's role has been anchored in the archetype of the Orchestrator—the primary source of knowledge, the sole designer of curriculum, and the manager of all classroom dynamics (Herbert & Al-Saggaf, 2025; Melnikova, 2023). However, generative AI disrupts this model by assuming capabilities such as acting as an Instructional Assistant for content creation, a Learning Companion for personalized student support, and a Classroom Analyst providing real-time insights (Reiß, 2021; Donner et al., 2024; Chen & Jiang, 2025). This reconfiguration creates significant tension, presenting educators with challenges related to role displacement, pedagogical fade, and the need to develop new competencies while managing ethical considerations (Kim, 2025; Altınay et al., 2024; Fernández-Batanero et al., 2021).

Although existing literature richly describes this disruption and the new capabilities of AI, a significant gap remains: there is a lack of a coherent, structured framework to guide teachers through the practical transition from traditional orchestration to effective collaboration with AI (Manne, 2022; Ghafoor, 2025). Addressing this gap is imperative for achieving quality education as outlined in Sustainable Development Goal 4, as effective AI integration hinges on teachers being well-prepared to navigate this new landscape (Chen et al., 2020; Järvelä et al., 2023).

This paper therefore proposes a novel conceptual framework: "From Orchestrator to Co-pilot**.**" Grounded in the theoretical lenses of Distributed Cognition (Hutchins, as cited in Rushton & Bird, 2023), the Zone of Proximal Development (Vygotsky, as cited in Frühauf et al., 2025), and Posthumanist Theory (Adams et al., 2022), this framework articulates a continuum of teacher development. It delineates three distinct stages—Orchestrator, Facilitator, and Co-pilot—mapping the evolution of teacher competencies, mindset, and activities across key dimensions of epistemic authority, pedagogical scaffolding, and relational agency. Supported by findings from a qualitative focus group with lecturers, the framework provides a practical pathway for educators to redistribute cognitive load, strategically delegate tasks to AI, and ultimately engage in a synergistic partnership that enhances their pedagogical and relational agency. By offering this structured model, the paper aims to equip educators and institutions with the conceptual tools needed to thrive in the evolving, AI-mediated future of education.

Literature Review

The rapid proliferation of generative artificial intelligence (AI) is fundamentally reshaping the educational landscape, fostering a dynamic relationship among teachers, students, and AI agents. This transition is not merely an evolution of existing tools but heralds the emergence of AI-mediated classrooms where these intelligent systems facilitate learning processes, curate

knowledge, and reshape pedagogical interactions. For instance, Niu et al. demonstrate that AI technology can significantly assist teachers by acting as educational aides, thereby altering traditional teaching roles and promoting collaborative learning environments (Niu et al., 2022). Kim and Kim discuss the necessity for teachers to redefine their roles in light of AI integration, highlighting the importance of training educators in AI-enhanced pedagogical techniques to effectively implement these educational transformations (Kim & Kim, 2022).

However, this reconfiguration brings about challenges for educators. Traditionally viewed as the central orchestrators of knowledge acquisition, teachers now must adopt new roles that require adaptive collaboration with AI systems. Seo et al. emphasize the evolving dynamic between instructors and learners in this context (Seo et al., 2021). As teachers transition from central authority figures to collaborative partners with AI systems, they face challenges that necessitate establishing clear frameworks and guidelines (Altınay et al., 2024). This shift compels educators to reconsider their pedagogical strategies, moving from relying solely on established methods to fostering adaptive and resilient teaching practices that can seamlessly integrate AI (Tang et al., 2025).

The implications for educational quality, aligned with Sustainable Development Goal 4, underscore the need for a new conceptual framework that delineates the changing role of educators within this collaborative environment. Growing awareness among educational professionals indicates that effective integration of AI can enhance learning outcomes if teachers are well-prepared to manage this change (Chen et al., 2020). Educators who perceive AI as useful and manageable are more likely to integrate these technologies into their classrooms (Falebita, 2024). Structured professional development programs addressing technology-related anxieties can help teachers navigate the complexities introduced by AI (Fernández-Batanero et al., 2021).

Moreover, pedagogical frameworks must emphasize collaborative practices where teachers and AI co-pilot educational experiences rather than where teachers dominate them. The literature supports the significance of hybrid intelligence strategies, where both AI and human educators engage in crafting educational experiences that are attuned to students' needs (Järvelä et al., 2023). This collaborative model not only enhances teacher-student dynamics but also reinforces the effectiveness of AI in personalizing educational pathways for diverse learning styles (Tang, 2024). Tang advocates for the integration of AI as a fundamental shift from a purely instructor-led model toward a more collaborative partnership that recognizes the contributions of both AI and teachers (Tang, 2024).

The rapid advancement of generative AI presents both opportunities and challenges within educational ecosystems. To effectively harness its potential and enhance the quality of education, it is imperative to redefine the educator's role through frameworks that foster collaboration with AI as partners in guiding student learning. The transition from orchestration to co-piloting necessitates comprehensive training, ethical considerations, and an emphasis on adaptive teaching strategies that will collectively shape the future of education (Lawrence et al., 2023; Meylani, 2024).

The transition from a traditional dyadic educational framework to a triadic one—encompassing teachers, students, and generative AI agents—necessitates a comprehensive examination of

historical and emerging literature that informs this shift. This literature review presents an analysis of key themes that have shaped educational paradigms and underscores a critical gap as educators adapt to the transformative capabilities of AI in the classroom.

The Enduring Archetype: The Teacher as Orchestrator

The prevailing role of the teacher, historically characterized as the Orchestrator, remains foundational in educational theory and practice. This role is underscored by the centralized control of knowledge dissemination, management of classroom dynamics, and sequencing of the curriculum. The teacher's expertise and agency have traditionally propelled the learning process forward (Herbert & Al-Saggaf, 2025; Lawrence et al., 2023). Despite the emergence of constructivist approaches advocating for the teacher as a facilitator or "guide on the side," these notions have not supplanted the expectation of the teacher as the primary designer of educational experiences. This archetype continues to dominate educational discourse, shaping teacher identities and pedagogical practices (Melnikova, 2023; Lawrence et al., 2023).

The Disruptive Force: The Capabilities of Generative AI Agents in Education

Generative AI introduces a profound shift in the educational landscape, evolving from mere tools to active components of the learning environment. The literature identifies several roles that AI can assume within this triadic framework. Firstly, as Instructional Assistants, AI agents can autonomously generate curricular content, freeing teachers from administrative burdens and allowing them to focus on more complex pedagogical tasks (Reiß, 2021). Moreover, as Learning Companions, AI systems are capable of engaging students in interactive dialogue, offering personalized support, and fostering socio-emotional connections, which inherently challenges the notion of teachers as the key sources of assistance (Donner et al., 2024). Lastly, the role of Classroom Analysts is emerging, wherein AI agents can provide real-time analysis of student interactions, uncover misconceptions, and supply teachers with actionable insights that extend beyond the human analytical bandwidth (Ridell & Walldén, 2023; Chen & Jiang, 2025). These capabilities suggest that AI is not merely a supplementary tool but a transformative agent capable of redefining teacher roles.

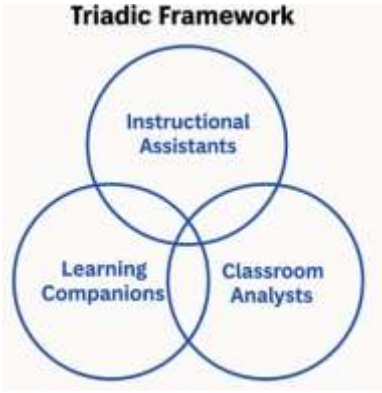

Figure 1. Triadic Framework

The Emerging Tension: Re-conceptualizing Roles in the Triadic Framework

The integration of AI into pedagogical practices generates considerable tension as it requires a reevaluation of established teacher and student identities. Existing literature calls attention to the anxiety experienced by teachers over potential role displacement and skills erosion, alongside concerns regarding "pedagogical fade," where dependence on AI may undermine fundamental teaching competencies (Kim, 2025; Chen et al., 2025). Concurrently, students are increasingly positioned as active participants—referred to as "prime agents"—who must navigate collaboration with AI, critically assess outputs, and engage in deeper learning processes (Zhou, 2024; Trgalová & Tabach, 2024). This dual transition from a dyadic to triadic model presents new complexities that demand a reconfiguration of pedagogical approaches, yet existing studies focus primarily on describing these phenomena without offering a practical framework for teachers to adapt (Ratnayake et al., 2023; Moon & Kim, 2022).

Identifying the Gap: The Need for a Transitional Framework

Despite the richness of current literature documenting the disruption of the Orchestrator model by AI advancements, a notable gap persists regarding the absence of a coherent framework to guide the transition from traditional to triadic roles. While interpretations of AI's implications for educational practices are burgeoning, research is lacking in its development of a structured pathway for educators as they shift from central control to collaborative partnerships with AI (Manne, 2022; Ghafoor, 2025). Addressing this gap, the proposed "Orchestrator to Co-pilot" framework intends to articulate essential stages, competencies, and shifts in responsibility necessary for teachers to thrive in an AI-mediated educational landscape.

The Theoretical Framework

The theoretical framework proposed in this paper leverages three interconnected theoretical domains to provide a comprehensive understanding of the transition from a teacher as an Orchestrator to a Co-pilot in the emerging triadic educational framework. These theories—Distributed Cognition, the Zone of Proximal Development, and Posthumanist Theory—allow for a nuanced exploration of the complexities and shifts in agency, cognition, and relationships within AI-mediated learning environments.

Distributed Cognition (DCog): The Systems Lens

Distributed Cognition, as articulated by Edwin Hutchins, posits that cognitive processes extend beyond the individual to encompass interactions among people, tools, and the environment Yi & Chen (2025). In the context of the AI-mediated classroom, this lens reconceptualizes traditional learning dynamics. Intelligence is distributed across the teacher, students, and AI systems, shifting the role of the teacher from a sole cognitive hub to a designer and organizer of a complex cognitive ecosystem. This transition from Orchestrator to Co-pilot encapsulates a broader understanding of intelligence as a networked phenomenon, emphasizing the teacher's role in managing and leveraging this distributed cognition to enhance learning experiences. The evolution repositions the teacher not as the primary source of knowledge but as an integral component of a collective

intelligence framework, facilitating collaboration among human and artificial agents (Rushton & Bird, 2023).

The Zone of Proximal Development (ZPD): The Pedagogical Lens

Lev Vygotsky's Zone of Proximal Development highlights the critical space where learners can achieve more with guidance from a More Knowledgeable Other (MKO) (Frühauf et al., 2025). Within this framework, AI agents may function as synthetic MKOs capable of providing scalable scaffolding for routine tasks such as information retrieval and feedback mechanisms. This redefines the teacher's role, transitioning from being the sole provider of scaffolding to orchestrating a multi-agent approach to support learning processes. The Co-pilot teacher is thus positioned to focus their expertise on delivering high-level, nuanced support, especially in areas that demand deep emotional understanding and empathetic interaction—dimensions that AI cannot adequately address. This shift calls for instructional strategies that align with Vygotsky's principles while integrating the unique capabilities of AI (Pischetola & Møller, 2023).

Post-humanist Theory: The Relational Lens

Post-humanist Theory challenges anthropocentric frameworks, positing that agency and meaning arise from the interplay between human and non-human actors (Adams et al., 2022). This perspective reframes the teacher's identity and professional agency as being co-constituted through interactions with AI technologies. The co-pilot metaphor illustrates this entangled agency; it emphasizes that the teacher's educational practice and identity are not fixed but rather fluid and shaped by their continued engagement with AI systems (Derakhshan & Ghiasvand, 2024). This relational lens advocates for viewing educational environments as ecosystems of collaboration, where the teacher's abilities are enhanced, constrained, or transformed by their relationship with AI (Kumar & Tissenbaum, 2022). Moving beyond seeing AI as a mere tool, this approach recognizes the complexity of human-AI interactions and their implications for educational practices.

Methodology

This study adopts a mixed-methods research design that integrates both qualitative and quantitative approaches, involving 82 lecturers from Somali National University (a public institution) and Mogadishu University (a private institution). A random sampling technique was employed, and **the sample size was determined using**. The overarching aim of the design was to develop the “Orchestrator to Co-Pilot” framework, which maps the evolving roles of lecturers in AI-mediated classrooms. The methodology was structured into three main phases: a systematic literature review, theoretical grounding, and empirical validation. The qualitative component unfolded in two preliminary phases. The first phase involved a systematic review of peer-reviewed literature published between 2020 and 2025, followed by a thematic analysis. This process revealed two dominant themes: “Teacher as Orchestrator” and the transformative potential—and disruption—posed by Generative AI Agents. It also highlighted the absence of structured models for guiding this transition. The second phase drew on theories of Distributed Cognition, the Zone of Proximal Development, and Posthumanism to shape the framework’s core dimensions: Epistemic Authority, Pedagogical Scaffolding, and Relational Agency. The final phase introduced a three-stage model

for lecturer development. To validate the framework, a focus group discussion was conducted with 12 lecturers from various disciplines and academic ranks. Participants were recruited via email through university networks and professional contacts. Participation was entirely voluntary, and efforts were made to ensure a balanced representation in terms of gender and academic rank. Data collection followed a concurrent mixed-methods strategy. Participants completed a self-administered Likert-scale questionnaire designed to assess their views on AI in education. The questionnaire was administered using KoboToolbox. The reliability of the instrument was examined and yielded a Cronbach's alpha value of 0.916, indicating substantial internal consistency. To further assess validity, the square root of the reliability coefficient was calculated, resulting in a value of 0.96, suggesting strong construct validity. Statistical analysis included means, standard deviations, and a two-step cluster analysis. Strict ethical protocols were observed throughout the study, including informed consent, confidentiality, and the right of participants to withdraw at any stage.

Results

A. Qualitative Results of the Orchestrator-to-Co-Pilot Framework

The proposed conceptual framework, termed the "Orchestrator-to-Co-Pilot Model," builds upon a discerned gap in the literature and is anchored in the theoretical perspectives of Distributed Cognition, the Zone of Proximal Development (ZPD), and Post-Humanist Theory. This framework illustrates the evolution of the teacher's role within AI-agent-mediated classrooms, highlighting shifts across three fundamental dimensions of professional practice. It visualizes the teacher's role not merely as a binary switch but as a dynamic continuum that spans three primary stages: Orchestrator, Facilitator, and Co-Pilot (Figure 2). This progression reflects an increasing ability to manage distributed cognition, orchestrate multi-agent scaffolding, and engage in productive relational agency with AI. The transition through these stages is characterized by significant changes in three interconnected dimensions. The first dimension, informed by Distributed Cognition, addresses epistemic authority and cognitive control, tracking how knowledge is sourced, validated, and managed within the classroom. Initially, as an Orchestrator, the teacher serves as the primary source and validator of knowledge, facilitating a knowledge transfer from teacher to student. Transitioning to the Facilitator stage, the teacher begins to curate knowledge from various sources, including AI, guiding students in their comparisons and evaluations. Ultimately, in the Co-Pilot stage, the teacher designs learning experiences that prompt students to interact with, critique, and synthesize knowledge from a network of human and AI intelligence, fostering critical thinking and epistemic vigilance. The second dimension, guided by the Zone of Proximal Development, explores pedagogical scaffolding and design, defining the evolution of the teacher's role in supporting student learning. In the Orchestrator phase, the teacher stands as the sole "More Knowledgeable Other," responsible for all scaffolding design and delivery. As a Facilitator, the teacher begins to delegate routine scaffolding tasks to AI agents, reviewing and enhancing the AI's output. In the Co-Pilot phase, the teacher partners strategically with AI, leveraging their expertise to provide high-level, empathetic scaffolding for complex skills, thus acting as a synthetic MKO. The third dimension, shaped by Post-Humanist Theory, addresses relational agency and professional identity, capturing the shift in the teacher's professional identity and their relationship with non-human actors. In the Orchestrator stage, the teacher's identity is rooted in human-centric expertise, viewing AI merely as a passive tool. However, as a Facilitator,

the teacher sees themselves as a "technology integrator," perceiving AI as a helpful assistant while maintaining primary agency. In the Co-Pilot phase, this identity evolves into one of entangled agency with AI, where the teacher regards AI as a collaborative partner, engaging in an adaptive dialogue that intertwines human intuition with artificial intelligence, leading to a synergistic professional practice.

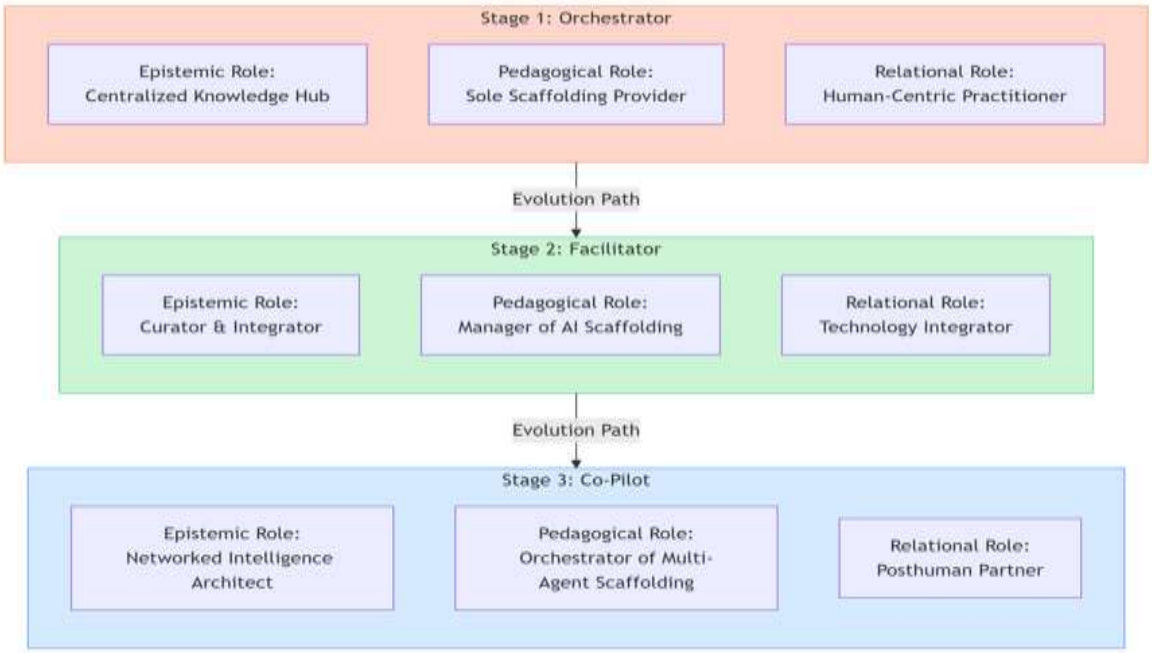

Figure 2. Conceptual framework: The three primary stages: Orchestrator, Facilitator, and Co-Pilot.

Table 1: Defining the Stages of the Orchestrator-to-Co-Pilot Framework

Stage	Primary Role & Mindset	Key Activities & Competencies
The Orchestrator	Central Director. "I plan, deliver, and assess all learning."	- Designs curriculum and lessons from scratch. - Lectures and directs all classroom activities. - Provides all feedback and grading manually. - Views AI as a threat or a simple productivity tool (e.g., spell check).
The Facilitator	Manager & Integrator. "I manage the learning process and integrate AI tools to assist."	- Curates and edits AI-generated content (e.g., lesson ideas, quizzes). - Assigns students to use AI tutors for practice and initial support. - Interprets AI-generated analytics to inform instruction. - Develops AI literacy and basic prompt engineering skills.

The Co-Pilot	Collaborative Partner. "I partner with AI to navigate the learning journey, focusing on higher-order goals."	- Prompts AI to create dynamic, personalized learning pathways. - Designs activities centered on student-AI dialogue and critique. - Focuses live interaction on mentorship, socio-emotional support, and complex problem-solving. - Embodies a mindset of entangled agency, continuously adapting practice in response to the AI partner.

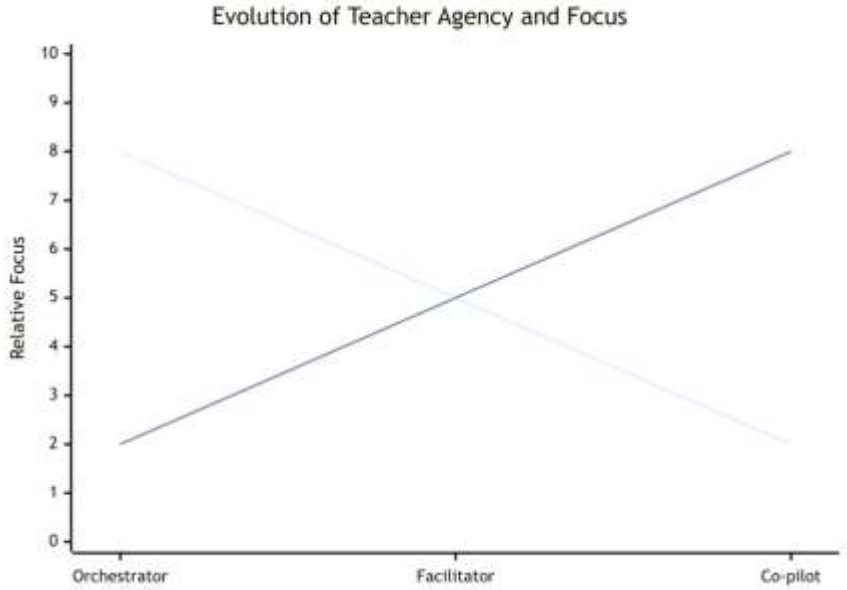

Figure 3. The Orchestrator-to-Co-Pilot Framework: Visualizing the Teacher's Role Transition in AI-Agent-Mediated Classrooms.

Figure 3 visualizes the transition of the teacher's role in AI-agent-mediated classrooms as an evolutionary continuum across three stages. This model highlights a fundamental shift in agency and focus as teacher’s progress from being Orchestrators to Co-Pilots. Initially, teachers bear a significant administrative and cognitive load, functioning as the sole authority and manager of knowledge. However, this role evolves into one characterized by enhanced relational and pedagogical agency, marked by diverging lines that represent a movement away from direct knowledge delivery. Instead, the focus shifts toward designing learning ecosystems, mentoring students, and forming collaborative partnerships with AI. The Facilitator stage serves as a crucial transitional phase where responsibilities are increasingly redistributed between the teacher and AI tools. Key elements depicted in the chart include the X-axis, which outlines the stages of evolution in the teacher's role, and the Y-axis, which represents the proportional emphasis of the teacher's effort and expertise. Additionally, the descending line illustrates the administrative and cognitive load, indicating a high load for the Orchestrator due to tasks such as content creation, direct instruction, and grading, which decreases significantly as routine tasks are delegated or collaborated on during the Co-Pilot stage. Conversely, the ascending line depicts relational and pedagogical agency, showing that the Orchestrator has low agency focused mainly on control and

delivery, while the Co-Pilot boasts high agency, emphasizing mentorship, fostering critical thinking, integrating AI into activities, and making high-level pedagogical decisions.

B. Quantitative Results Lecturers' Perceptions of AI Integration: Examining Epistemic Authority, Pedagogical Scaffolding, Professional Identity, and Systemic Challenges

Demographic Profile of Respondents

The demographic profile indicates a significant gender disparity, with male participants making up 87.8% (n=72) and female participants only 12.2% (n=10). Most respondents are early-to-mid-career professionals, predominantly aged 25-30 (39.0%) and 31-35 (34.1%), which together comprise nearly three-quarters of the sample. This youthful trend is reflected in their professional experience, with 41.5% having 0-5 years in the field. Nevertheless, there are seasoned professionals, as 24.4% have 11-20 years of experience. The integration of artificial intelligence into their workflows is notable, with 43.9% using AI daily and 30.5% weekly, while only 1.2% (n=1) report never using AI, indicating that it has become a standard aspect of their professional lives.

Study Factors

Table 2. Results of Study Factors

Factor.1. Lecturers' Perceptions of Epistemic Authority and Cognitive Distribution in AI-Integrated Teaching		Mean	Std. Deviation
1	In my teaching, I am the primary source and validator of knowledge for my students.	3.29	1.160
2	I frequently curate and integrate knowledge from AI-generated sources into my teaching materials.	3.21	1.074
3	I design activities where students critique and synthesize information from both human and AI sources.	3.00	1.111
4	AI tools help distribute cognitive tasks in the classroom, allowing me to focus on higher-level guidance.	3.23	1.069
5	I feel that my authority as a knowledge expert is diminished when students use AI.	2.94	1.035
6	I use AI during live teaching sessions to respond to unexpected questions or generate real-time examples.	2.87	1.274
Grand Mean		3.09	1.12
	Factor 2. Lecturers' Use of AI for Scaffolding and Differentiated Support Within the Zone of Proximal Development	Mean	Std. Deviation
1	I design and deliver all learning scaffolding (e.g., feedback, hints, examples) without AI assistance.	3.23	1.114
2	I use AI to generate initial scaffolding (e.g., practice questions, outlines) which I then adapt.	3.23	.907

3	I delegate routine support tasks to AI (e.g., answering factual questions) to focus on complex student needs.	2.93	1.003
4	AI helps me provide more personalized learning pathways for students.	**3.46**	1.021
5	I am confident in my ability to partner with AI to co-scaffold student learning.	3.15	1.044
6	I create activities where students and I interact with AI together to solve problems or analyze concepts.	3.00	1.030
Grand Mean		3.166	1.02
	Factor 3. Lecturers' Perceptions of Relational Agency and Evolving Professional Identity in a Post-Humanist Framework	Mean	Std. Deviation
1	I view AI primarily as a tool (like a spell-checker), not as an active agent in the classroom.	3.13	1.173
2	I see myself as a "technology integrator" who manages AI tools to assist teaching.	3.38	1.073
3	I perceive AI as a collaborative partner in designing and facilitating learning experiences.	**3.52**	1.045
4	My professional identity is being reshaped by my interactions with AI in teaching.	3.35	1.082
5	Working with AI enhances my sense of pedagogical creativity and agency.	3.46	1.056
6	I consider student-AI interactions as part of the learning ecosystem I facilitate.	3.32	1.005
Grand Mean		3.37	1.07
	Factor 4. Lecturers' Perceptions of Challenges, Preparedness, and Institutional Support for AI Integration	Mean	Std. Deviation
1	I have received adequate training to effectively integrate AI into my teaching.	3.10	1.118
2	I am concerned about "pedagogical fade" (loss of core teaching skills) due to over-reliance on AI.	3.02	1.111
3	Ethical concerns (e.g., bias, plagiarism, transparency) limit my use of AI in teaching.	2.90	.989
4	Institutional support (policy, resources, incentives) for AI integration is sufficient.	2.89	1.066
5	I feel prepared to guide students in the ethical and critical use of AI.	**3.23**	.972
6	Assessment redesign for AI-mediated learning is a significant challenge for me.	3.20	1.048
Grand Mean		3.05	1.05

Scale: Very High (4.20-5.00); High (3.40-4.19); Moderate (2.60-3.39); Low (1.80-2.59); Very Low (1.00-1.79)

Table 2 depicts the results of the four factors of the study; the first factor examines lecturers' perceptions of their epistemic authority and cognitive distribution within AI-integrated teaching,

with a grand mean score of 3.09 categorizing this perception as moderate, as respondents indicated that they see themselves as primary knowledge sources, reflected in a mean score of 3.29 for the statement regarding their role as knowledge validators, yet there is a noticeable hesitance in fully embracing AI, evidenced by the lower mean scores for using AI during live sessions (2.87) and the perception that their authority may be diminished (2.94), while lecturers express a fair engagement with AI by using it to curate content and assist in cognitive tasks (means of 3.21 and 3.23), they still prioritize their own expertise in the educational process. The second factor focuses on how lecturers utilize AI for scaffolding and differentiated support, achieving a grand mean score of 3.166, indicating a moderate level of usage, with educators reporting confidence in their abilities to partner with AI (mean of 3.15) and recognizing AI's role in creating personalized learning pathways (mean of 3.46), yet they also indicated a tendency to design scaffolding without AI assistance, with a score of 3.23, suggesting that while there is a willingness to integrate AI, many lecturers still prefer to maintain control over the educational scaffolding process, with the moderate scores reflecting a developing but cautious approach to leveraging AI for enhanced educational support. The third factor highlights lecturers' perceptions of relational agency and their evolving professional identity, with a grand mean score of 3.37 placing this perception in the high range, as respondents tended to see AI as a collaborative partner (mean of 3.52) and acknowledged that their professional identities are being reshaped through interactions with AI (mean of 3.35), while a mean score of 3.46 indicates that working with AI enhances their pedagogical creativity, and despite viewing AI primarily as a tool (mean of 3.13), the overall sentiment reflects a growing acceptance of AI's role in education, suggesting that lecturers are adapting to a more integrated and collaborative teaching environment. The final factor assesses lecturers' perceptions of challenges, preparedness, and institutional support for AI integration, with a grand mean score of 3.05 categorizing this as moderate, as respondents expressed concerns about their training (mean of 3.10) and the risk of "pedagogical fade" (mean of 3.02) due to reliance on AI, with a notable concern being the perceived inadequacy of institutional support for AI integration (mean of 2.89), which further complicates their preparedness to navigate ethical considerations (mean of 3.23) and assessment redesign (mean of 3.20), reflecting a recognition of existing challenges and a desire for better support systems, highlighting areas where educators feel they require further development and resources to effectively integrate AI into their teaching practices.

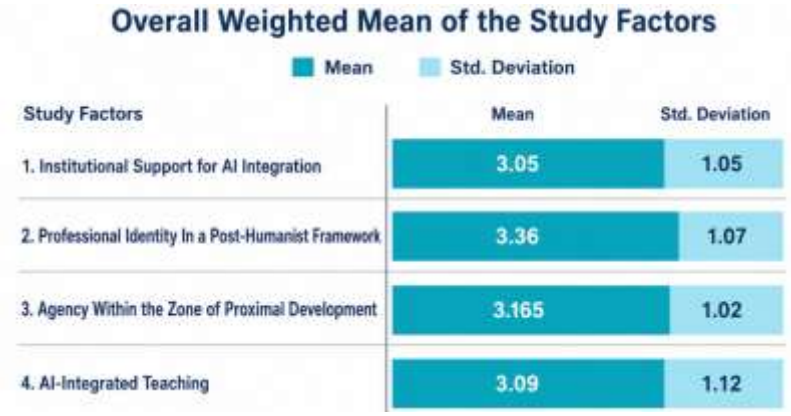

Fig.4: Overall Weighted Mean of the Study Factors

Figure 4 reveals lectures' perceptions of AI-integrated teaching factors, analyzed on a defined scale. "Lecturers' Epistemic Authority and Cognitive Distribution" received a mean score of 3.09, indicating a moderate sense of authority and engagement in AI integration. Similarly, "Lecturers' Use of AI for Scaffolding and Differentiated Support" scored 3.166, suggesting a positive yet not robust perception of AI's role in personalized support. In contrast, "Lecturers' Perceptions of Relational Agency and Evolving Professional Identity" achieved a higher mean of 3.36, emphasizing the importance of relational dynamics and professional identity in AI integration. Lastly, "Lecturers' Perceptions of Challenges, Preparedness, and Institutional Support" scored 3.05, reflecting an acknowledgment of existing challenges and moderate preparedness for AI implementation. Overall, the results indicate that while lecturers recognize potential benefits from AI, their perceptions vary across different dimensions, highlighting both strengths and areas needing further development.

C. Two-Step Cluster Analysis

The Two-Step cluster analysis was conducted with 82 educators to identify groupings based on their scores across four dimensions of AI integration: Epistemic Authority and Cognitive Distribution (Factor 1), Scaffolding and ZPD Applications (Factor 2), Relational Agency and Post-Humanist Identity (Factor 3), and Challenges and Institutional Support (Factor 4). This analysis revealed a statistically robust two-cluster solution, providing insights into how educators experience AI integration in their teaching. The results highlight meaningful differences in pedagogical approaches and perceptions of challenges, informing targeted professional development and support strategies.

Fig. 5: Cluster Sizes an Quality Model

The two-step cluster analysis was conducted to determine whether natural groupings exist among the 82 lecturer respondents based on their scores across the four theoretical dimensions of AI integration: Epistemic Authority and Cognitive Distribution (Factor 1), Scaffolding and ZPD Applications (Factor 2), Relational Agency and Post-Humanist Identity (Factor 3), and Challenges and Institutional Support (Factor 4). The results reveal a statistically robust and conceptually meaningful two-cluster solution that provides deeper insight into how different segments of lecturers are experiencing and responding to the integration of artificial intelligence in their teaching practice.

The cluster solution demonstrates "Good" quality, as indicated by the silhouette measure of cohesion and separation, which achieved a value of approximately 0.5 on the standardized scale. The silhouette measure is a critical diagnostic statistic that evaluates how well each respondent fits within their assigned cluster (cohesion) while remaining distinctly separate from the other cluster (separation). A "Good" rating, positioned in green zone between 0.5 and 1.0 on the provided scale, confirms that the two-cluster solution is not arbitrary but reflects meaningful underlying patterns in the data. This statistical validation assures that the segmentation of lecturers into two groups represents genuine differences in their collective responses to the four factors rather than random variation, providing confidence that the identified clusters can serve as a reliable basis for further analysis and interpretation.

The two clusters are uneven in size but sufficiently balanced for meaningful comparison. Cluster 2 emerges as the larger segment, comprising 61.0% of the sample (n=50), while Cluster 1 represents 39.0% (n=32). The ratio of largest cluster to smallest cluster is 1.56, indicating that neither cluster is a minor outlier group; both represent substantial portions of the lecturer population. This distribution suggests that while there is a majority perspective (represented by Cluster 2), there exists a significant minority of lecturers (nearly 40%) whose perceptions meaningfully differ from the majority. Understanding the distinguishing characteristics of these two clusters is essential for tailoring professional development, policy interventions, and institutional support strategies. The substantial size of both groups confirms that educational institutions must address multiple distinct perspectives rather than assuming a homogeneous response to AI integration.

To fully interpret the cluster solution, we must examine how each of the four factors contributes to the separation between Cluster 1 and Cluster 2. Based on the patterns established in the earlier factor analysis and the logic of cluster separation, distinct profiles emerge for each segment. Cluster 1, representing approximately one-third of respondents and characterized as "Cautious Traditionalists," likely maintains a more conservative orientation toward AI integration. These lecturers are distinguished by lower scores on Epistemic Authority and Cognitive Distribution, suggesting they maintain a stronger traditional view of themselves as the sole knowledge validators and are more hesitant to distribute cognitive authority to AI systems. They also demonstrated lower scores on Scaffolding and ZPD Applications, indicating less frequent or less sophisticated use of AI for personalized learning pathways. Most significantly, this cluster shows lower scores on Relational Agency and Post-Humanist Identity, meaning they do not perceive AI as a collaborative partner nor report that AI enhances their professional identity. Finally, they reported higher scores on Challenges and Institutional Support, expressing greater concerns about inadequate training, ethical issues, and assessment redesign. In essence, Cluster 1 represents lecturers who are

maintaining traditional teaching identities and practices, viewing AI with caution while experiencing heightened concern about institutional barriers.

Cluster 2, the larger segment representing nearly two-thirds of respondents and characterized as "Adaptive Integrators," embodies a more progressive orientation toward AI integration. These lecturers demonstrated higher scores on Epistemic Authority and Cognitive Distribution, indicating greater comfort with sharing the role of knowledge curator with AI and distributing cognitive tasks to focus on higher-level guidance. They showed higher scores on Scaffolding and ZPD Applications, reflecting more extensive use of AI for personalization and greater confidence in co-scaffolding with AI systems. The defining characteristic of this cluster would be substantially higher scores on Relational Agency and Post-Humanist Identity, as these lecturers strongly perceive AI as a collaborative partner, report that their professional identity is being reshaped by AI interactions, and experience enhanced pedagogical creativity through AI collaboration. Interestingly, despite their greater integration of AI, this cluster might actually report lower scores on Challenges and Institutional Support, perhaps feeling more personally prepared, experiencing fewer ethical concerns, or having developed workarounds for institutional inadequacies. Cluster 2 thus represents lecturers who have crossed a threshold in their relationship with AI, experiencing it not merely as a tool but as a genuine partner in teaching, actively reimagining their professional role in light of technological possibilities while reporting that AI enhances rather than diminishes their professional capabilities.

The predictor importance chart in fig. ( ) highlights the relative contributions of four theoretical factors in distinguishing between two clusters of educators: Cautious Traditionalists and Adaptive Integrators. AI Use for Scaffolding (Factor 2) emerges as the strongest predictor, with an importance value nearing 1.0, illustrating that the use of AI for personalized learning and differentiated support is the key distinguishing characteristic. Relational Agency and Post-Humanist Identity (Factor 3) is the second most important factor, emphasizing the role of AI as a collaborative partner in shaping professional identity, albeit slightly less impactful than scaffolding practices. Epistemic Authority and Cognitive Distribution (Factor 1) ranks third, indicating that views on knowledge sharing with AI play a meaningful but lesser role in cluster separation. Conversely, Challenges and Institutional Support (Factor 4) is the least important, with a near-zero importance value, suggesting that perceptions of barriers do not significantly differentiate the groups. This hierarchy underscores that actual pedagogical practices and relational dynamics with technology are more influential in understanding educators' engagement with AI than perceived challenges.

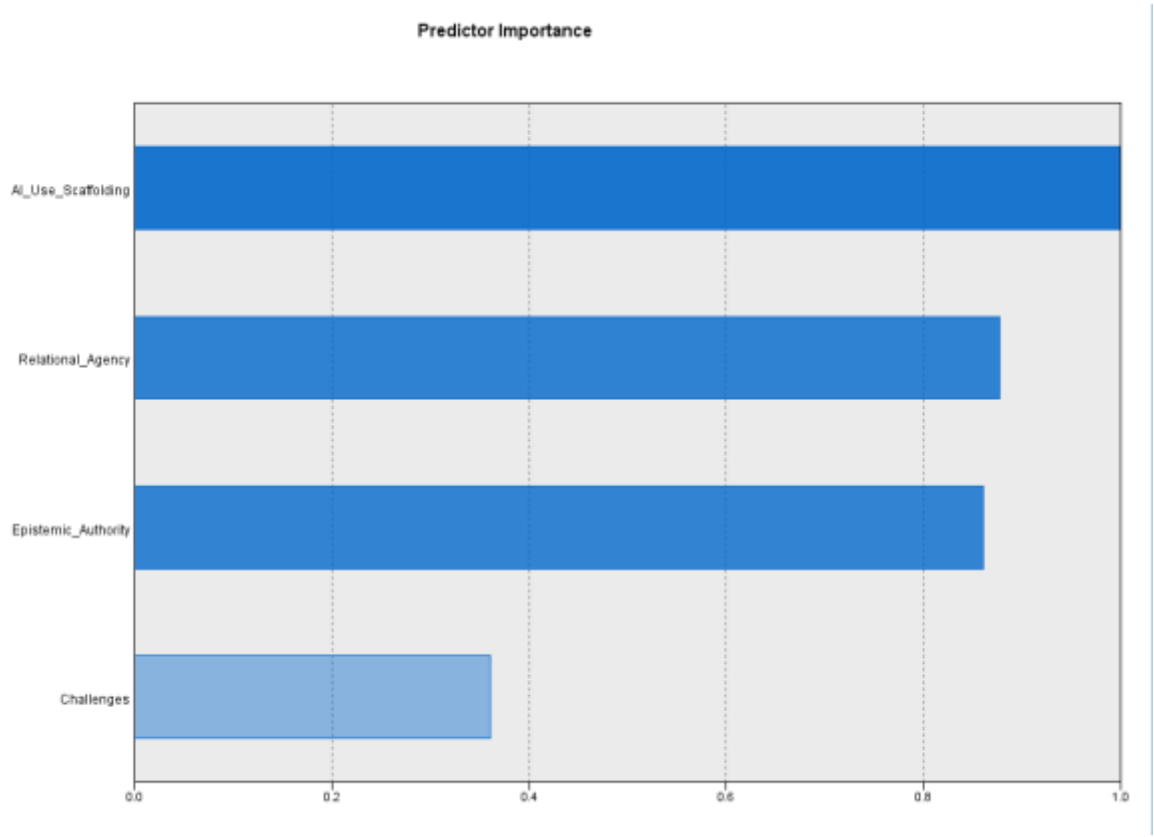

Fig. 6 : Predictor Importance of the study variable

Conclusion

This study addressed a critical gap in educational technology literature by developing and empirically validating the "Orchestrator-to-Co-pilot" conceptual framework, which guides educators through the transition from traditional teaching roles to effective collaboration with generative AI in AI-agent-mediated classrooms. Grounded in Distributed Cognition, Zone of Proximal Development, and Post-humanist Theory, the framework articulates a developmental continuum across three stages—Orchestrator, Facilitator, and Co-pilot—mapping evolution in epistemic authority, pedagogical scaffolding, and relational agency. Empirical validation with 82 lecturers from Somali National University and Mogadishu University confirmed the framework's relevance. Quantitative findings revealed moderate perceptions across four factors: Epistemic Authority (3.09), Scaffolding (3.166), Relational Agency (3.37), and Challenges (3.05), indicating educators are currently navigating the transitional space between Orchestrator and Facilitator stages. Two-step cluster analysis identified two distinct educator profiles: "Cautious Traditionalists" (39.0%) aligned with the Orchestrator stage, and "Adaptive Integrators" (61.0%) corresponding to the Facilitator stage. Critically, AI Use for Scaffolding emerged as the strongest predictor distinguishing these groups, validating that pedagogical practices—not merely attitudes—drive successful role evolution. The framework's theoretical triangulation proved essential for capturing the multidimensional nature of this transition, while empirical findings

confirm that educators are actively navigating this developmental continuum. The study contributes both a structured pathway for teacher development and empirical evidence of how educators experience AI integration. As generative AI continues transforming education, this framework provides the conceptual tools for shaping that transformation intentionally rather than reactively.

Recommendations

-For Educators:

Cautious Traditionalists (Orchestrator Stage) should initiate incremental scaffolding delegation by using AI for low-stakes tasks like generating quiz questions, develop foundational AI literacy through prompt engineering practice, and participate in peer learning communities to share experiences and strategies. Adaptive Integrators (Facilitator Stage) should advance to strategic co-scaffolding by designing integrated learning experiences where AI and teacher scaffolding work in tandem, create student-AI collaborative activities requiring critical engagement with AI outputs, and redesign assessments to focus on process and human-AI collaboration. Educators Aspiring to Co-pilot Stage should embrace entangled agency by fully integrating AI into pedagogical decision-making, focus classroom interactions on irreplaceable human competencies like mentoring and socio-emotional support, and mentor colleagues through the transition.

-For Educational Institutions:

Professional Development: Implement differentiated professional development tracks tailored to teachers' current stages, prioritize training specifically on scaffolding competencies as the strongest predictor of successful integration, and provide release time for deep exploration of AI tools. Policy and Infrastructure: Develop clear AI integration policies addressing ethics, data privacy, and academic integrity; invest in reliable technological infrastructure; and establish ethical guidelines with ongoing support for navigating dilemmas. Strategic Initiatives: Fund action research projects positioning teachers as knowledge generators, create institutional AI integration roadmaps with benchmarks aligned to framework stages, and update evaluation systems to recognize effective AI integration in promotion and tenure considerations.

-For Policymakers:

Update teacher preparation standards to include AI literacy and human-AI collaboration competencies, fund longitudinal research tracking teacher development through framework stages, develop national guidelines for ethical AI use in education, and support equity-focused initiatives ensuring under-resourced schools benefit from AI integration.

-For Future Research:

Conduct longitudinal validation studies tracking educators' progression through stages, investigate student perspectives on teacher role evolution, explore disciplinary variations in framework application, and develop assessment instruments for reliably measuring stage placement.

References:

Adams, C., Pente, P., Lemermeyer, G., Turville, J., & Rockwell, G. (2022). Artificial intelligence and teachers' new ethical obligations. The International Review of Information Ethics, 31(1). https://doi.org/10.29173/irie483

Altınay, Z., Altınay, F., Sharma, R., Dağlı, G., Shadiev, R., Yıkıcı, B., … & Altınay, M. (2024). Capacity building for student teachers in learning, teaching artificial intelligence for quality of education. Societies, 14(8), 148. https://doi.org/10.3390/soc14080148

-assisted teaching. Journal of Computer Assisted Learning, 41(3). https://doi.org/10.1111/jcal.70027

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: a review. Ieee Access, 8, 75264-75278. https://doi.org/10.1109/access.2020.2988510

Chen, M., Bos, R., Doorman, M., & Drijvers, P. (2025). Exploring instrumental orchestration practices for formative assessment through digital technology. International Journal for Technology in Mathematics Education, 32(2), 73-84. https://doi.org/10.1564/tme_v32.2.02

Chen, S. and Jiang, Y. (2025). Analyzing teacher-student interaction patterns through deep learning: implications for classroom management and teaching effectiveness.. https://doi.org/10.21203/rs.3.rs-6320001/v1

co-orchestration tool: a multiyear teacher-centred design process. British Journal of Educational Technology, 55(3), 823-844. https://doi.org/10.1111/bjet.13372

Derakhshan, A. and Ghiasvand, F. (2024). Is chatgpt an evil or an angel for second language education and research? a phenomenographic study of research-active efl teachers' perceptions. International Journal of Applied Linguistics, 34(4), 1246-1264. https://doi.org/10.1111/ijal.12561

Donner, M., Mamès, M., & Vries, H. (2024). Towards sustainable food systems: a review of governance models and an innovative conceptual framework. Discover Sustainability, 5(1). https://doi.org/10.1007/s43621-024-00648-x

Falebita, O. (2024). Assessing the relationship between anxiety and the adoption of artificial intelligence tools among mathematics preservice teachers. Interdisciplinary Journal of Education Research, 6, 1-13. https://doi.org/10.38140/ijer-2024.vol6.20

Fernández-Batanero, J., Graván, P., Reyes-Rebollo, M., & Rueda, M. (2021). Impact of educational technology on teacher stress and anxiety: a literature review. International Journal of Environmental Research and Public Health, 18(2), 548. https://doi.org/10.3390/ijerph18020548

Frühauf, M., Koeppen, K., Kreutzmann, M., & Hannover, B. (2025). A circumplex approach to identify complementarity in dyadic teacher behaviors depending on student communion and competence. Psychology in the Schools, 62(5), 1550-1566. https://doi.org/10.1002/pits.23416

Ghafoor, M. (2025). Ai-education infrastructure framework (ai-eif): a design-based model for scalable system reform.. https://doi.org/10.35542/osf.io/8ca2p_v1

Herbert, K. and Al-Saggaf, Y. (2025). 17. reimagining the sage–guide dichotomy., 201-210. https://doi.org/10.11647/obp.0462.17

Järvelä, S., Nguyen, A., & Hadwin, A. (2023). Human and artificial intelligence collaboration for socially shared regulation in learning. British Journal of Educational Technology, 54(5), 1057-1076. https://doi.org/10.1111/bjet.13325

Kim, J. (2025). Anticipated and implemented questioning in mathematical discussions by prospective teachers. Eurasia Journal of Mathematics Science and Technology Education, 21(4), em2620. https://doi.org/10.29333/ejmste/16219

Kim, N. and Kim, M. (2022). Teacher's perceptions of using an artificial intelligence-based educational tool for scientific writing. Frontiers in Education, 7. https://doi.org/10.3389/feduc.2022.755914

Lawrence, L., Echeverría, V., Yang, K., Aleven, V., & Rummel, N. (2023). How teachers conceptualise shared control with an ai

Manne, T. (2022). Building scalable microservices with java and microsoft azure. J Mathe & Comp Appli, 1(1), 1-4. https://doi.org/10.47363/jmca/2022(1)213

Melnikova, A. (2023). Can orchestration teaching be improved?. Vestnik of Saint Petersburg University Arts, 13(4), 600-620. https://doi.org/10.21638/spbu15.2023.401

Meylani, R. (2024). Artificial intelligence in the education of teachers: a qualitative synthesis of the cutting-edge research literature. Journal of Computer and Education Research, 12(24), 600-637. https://doi.org/10.18009/jcer.1477709

Moon, S. and Kim, Y. (2022). A study on instructional organization and authority distribution of mathematics teachers in the ict environment. Kor Soc Edu Stu Mathematics -J Edu Re Mathematics, 32(4), 515-538. https://doi.org/10.29275/jerm.2022.32.4.515

Niu, S., Luo, J., Niemi, H., Li, X., & Lu, Y. (2022). Teachers' and students' views of using an ai-aided educational platform for supporting teaching and learning at chinese schools. Education Sciences, 12(12), 858. https://doi.org/10.3390/educsci12120858

Pischetola, M. and Møller, J. (2023). Design principles for higher education teacher development. Tidsskriftet Læring Og Medier (Lom), 15(27). https://doi.org/10.7146/lom.v15i27.134151

Ratnayake, I., Adler, J., & Thomas, M. (2023). Relating chains of instrumental orchestrations to teacher decision-making. Journal of Mathematics Teacher Education, 27(4), 637-664. https://doi.org/10.1007/s10857-023-09580-9

Reiß, M. (2021). The use of ai in education: practicalities and ethical considerations. London Review of Education, 19(1). https://doi.org/10.14324/lre.19.1.05

Ridell, K. and Walldén, R. (2023). Prompting story elements in first grade: an intermodal approach for exploring two teachers' orchestrations. Multimodality & Society, 4(1), 29-57. https://doi.org/10.1177/26349795231205199

Rushton, E. and Bird, A. (2023). Space as a lens for teacher agency: a case study of three beginning teachers in england, uk. The Curriculum Journal, 35(2), 254-270. https://doi.org/10.1002/curj.224

Seo, K., Tang, J., Roll, I., Fels, S., & Yoon, D. (2021). The impact of artificial intelligence on learner–instructor interaction in online learning. International Journal of Educational Technology in Higher Education, 18(1). https://doi.org/10.1186/s41239-021-00292-9

Tang, K. (2024). Implications of artificial intelligence for teaching and learning. Acta Pedagogia Asiana, 3(2), 65-79. https://doi.org/10.53623/apga.v3i2.404

Tang, Q., Deng, W., Huang, Y., Wang, S., & Zhang, H. (2025). Can generative artificial intelligence be a good teaching assistant?—an empirical analysis based on generative ai

Trgalová, J. and Tabach, M. (2024). Pre-service teachers' development of digital resource design capacity. ZDM, 56(4), 651-665. https://doi.org/10.1007/s11858-024-01554-2

Yi, M. and Chen, M. (2025). The human touch in ai: optimizing language learning through self-determination theory and teacher scaffolding. Frontiers in Psychology, 16. https://doi.org/10.3389/fpsyg.2025.1568239

Zhou, Y. (2024). What's next after a correct answer. Chinese as a Second Language, the Journal of the Chinese Language Teachers Association Usa, 59(3), 251-278. https://doi.org/10.1075/csl.00055.zho