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DESIGNING AI-SUPPORTED FLIPPED PROFESSIONAL DEVELOPMENT FOR TEACHERS

Ghina Albadawi and Sahar Chaer

INTRODUCTION

Teacher professional development has increasingly evolved toward digitally mediated, learner-centered models that emphasise flexibility, collaboration, reflective practice, and sustained engagement. Advances in educational technology, combined with changing conceptions of adult learning, have challenged traditional transmission-oriented approaches to professional learning and encouraged the development of more interactive and participatory models (Darling-Hammond et al., 2017). More recently, AI-supported learning environments have expanded opportunities for personalised, flexible, and continuous professional development, enabling teachers to engage in self-paced learning, collaborative inquiry, and reflective practice across diverse educational contexts (Holmes et al., 2019). Contemporary research further suggests that effective technology-enhanced professional learning environments are characterised by coherence, active participation, and ongoing reflective engagement rather than isolated training events (Bond et al., 2021).

Problem statement and study aim

The rapid evolution of digital technologies has transformed professional learning, particularly teacher development. Traditional professional development, often characterised by passive knowledge transmission and limited interaction, has been challenged for its limited impact on instructional practice (Desimone & Garet, 2015). In response, there has been a shift toward dynamic, adult learner-centered approaches emphasising engagement, reflection, and practical application in contemporary educational contexts worldwide (Darling-Hammond et al., 2017).

Within this context, flipped learning has emerged as a promising pedagogical model. By relocating engagement with course content to asynchronous environments and dedicating synchronous sessions to interactive, application-oriented activities, flipped learning supports active participation and deeper learning (Bergmann & Sams, 2012). Flipped learning has been widely adopted in student learning contexts, while its application in teacher professional development has gained traction more recently (Han & Røkenes, 2020).

Simultaneously, artificial intelligence (AI) technologies have begun to influence educational design in meaningful ways. AI tools support personalised learning, provide adaptive feedback, and facilitate structured reflection, thereby enhancing the learning experience (Luckin et al., 2016). Despite increasing interest in AI, empirical research examining its integration into teacher professional learning within structured flipped learning models remains limited (Copur-Gencturk et al., 2024).

Taken together, these developments highlight a gap: although flipped learning and AI-supported education have demonstrated potential in enhancing learning experiences, limited empirical research has examined their integration within structured teacher professional development frameworks (Tammets & Ley, 2023). This study addresses this gap by examining the design and implementation of an AI-supported flipped professional development model for teachers. Rather than focusing solely on evaluating the effectiveness of the training, the study adopts a learning design perspective, exploring how pedagogical structuring, AI integration, and reflective processes interact to shape the adult learning experience.

Research questions

To investigate the pedagogical and experiential dimensions of the AI-supported flipped professional development model, the study addresses the following research questions:

RQ1: How does an AI-supported flipped learning design influence teachers' engagement in professional development activities?

RQ2: How do teachers perceive the role of AI-assisted learning activities within the different phases of a flipped professional development model?

LITERATURE REVIEW

This literature review explores research on flipped professional development and AI-supported teacher learning to establish the rationale for investigating how AI can be intentionally integrated within flipped models of teacher professional development. Flipped learning has been widely adopted as a pedagogical model that shifts direct instruction outside formal learning sessions and reallocates synchronous time for active learning, collaboration, and application (Kapur et al., 2022). In the context of teacher professional development, this model has gained interest as it aligns with adult learning principles that emphasise self-direction, relevance, and experiential engagement (Knowles, 1984).

Empirical research indicates that flipped professional development enhances teacher engagement and ownership of learning by allowing their flexible access to preparatory materials and enabling deeper interaction during face-to-face or synchronous sessions (Fidan, 2023; Sointu et al., 2022). Teachers in flipped professional development environments often demonstrate higher levels of participation in collaborative activities and report increased relevance of training content to classroom practice (González-Zamar & Abad-Segura, 2022).

However, several limitations remain. These include inconsistent completion of pre-session tasks, variability in teachers' digital literacy, and limited institutional structures to support sustained engagement (Sointu et al., 2022). Additionally, most flipped professional development models rely on static instructional materials, with limited integration of adaptive or intelligent systems that respond to individual teacher needs (Schmid et al., 2023).

AI is increasingly reshaping professional learning ecosystems by enabling adaptive feedback, personalised scaffolding, and reflective dialogue. In education, AI applications have been used to support lesson planning, formative feedback, and data-driven instructional decision-making (Holmes et al., 2019). Generative AI systems have introduced new possibilities for teacher professional learning by acting as interactive cognitive partners rather than passive tools.

These systems can prompt reflection, suggest alternative pedagogical strategies, and support metacognitive awareness by making instructional reasoning explicit (Kasneci et al., 2023), thereby positioning AI as a co-constructive learning agent rather than a content-delivery tool.

Nevertheless, AI-in-education research continues to be dominated by applications focused on student learning, adaptive tutoring systems, and classroom-level personalisation, with comparatively limited attention to structured teacher professional development (Erhardt et al., 2026).

Existing literature reveals three key gaps. First, limited research has examined the integration of AI-supported scaffolding within flipped professional development, where models still rely largely on static pre-learning materials. Second, AI-in-education research remains predominantly student-centered, with limited attention to teacher professional learning (Erhardt et al., 2026). Third, empirical studies on AI-supported professional development remain limited in resource-constrained contexts such as Lebanon, where infrastructural and institutional constraints affect implementation. Accordingly, this study investigates an AI-supported flipped professional development model implemented across multiple teacher groups and learning phases.

THEORETICAL FRAMEWORK

This study is grounded in Kolb's (1984) experiential learning theory, which conceptualises learning as a four-stage cyclical process involving: concrete experience or feeling, reflective observation or watching, abstract conceptualisation or thinking, and active experimentation or doing. This framework is particularly relevant to professional learning, where meaningful development occurs through the integration of theory and practice.

The flipped learning model structure aligns closely with this experiential cycle. The asynchronous pre-learning phase supports abstract conceptualisation by introducing participants to core concepts before live interaction. Synchronous sessions provide opportunities for concrete experience and active experimentation through discussion and collaborative problem-solving. The reflective phase promotes reflective observation by encouraging participants to analyse their experiences and connect them to theoretical frameworks.

The study also draws on learning design principles that highlight intentional sequencing, coherence across learning phases, alignment between activities and pedagogical goals, and integration of reflection as a central component of learning (Goodyear, 2015).

Within this framework, AI is conceptualised as a scaffold that supports cognitive and metacognitive processes. AI-generated prompts are used to guide participants' engagement with content, stimulate critical thinking, and structure reflective practices. This approach aligns with constructivist perspectives, which emphasise the role of guided interaction in knowledge construction (Vygotsky, 1934/1978).

AI-SUPPORTED FLIPPED TRAINING DESIGN FRAMEWORK

The AI-supported flipped training design framework examined in this study was developed by the Education Resource Center (ERC) at a Lebanese educational institution. The framework was designed to sustain professional learning during periods when in-person training became difficult because of the ongoing war in Lebanon. The AI component of the framework consisted of

generative artificial intelligence (GenAI) tools, specifically Microsoft Copilot and ChatGPT, which were integrated as pedagogical scaffolds to support cognitive engagement, reflective practice, and professional dialogue. These tools were not used as autonomous instructional systems or adaptive learning platforms; rather, they were intentionally incorporated by trainers to enhance participants' interaction with learning content and reflective activities.

The model integrated flipped learning with GenAI-supported cognitive and reflective scaffolding across asynchronous, synchronous, and reflective phases. Microsoft Copilot and ChatGPT were used to generate prompts, reflective questions, and discussion supports that encouraged participants' questioning, analysis, and metacognitive engagement throughout the learning cycle.

The framework was implemented across five professional development courses conducted between February and July 2025. It consisted of three interconnected phases: pre-learning, interactive learning, and reflective learning. Each phase served a distinct pedagogical purpose while contributing to an integrated professional learning cycle.

Pre-learning phase

The pre-learning phase represented the foundational stage of the framework. Before attending live sessions, participants engaged with asynchronous materials including videos, readings, guided tasks, and GenAI-supported prompts developed through Microsoft Copilot and ChatGPT focusing on key concepts and questions. This phase aimed to activate prior knowledge, encourage self-paced engagement, and prepare participants for collaborative interaction during synchronous sessions. Microsoft OneNote functioned as the primary platform for hosting resources, assignments, and preparatory materials. While OneNote served as the organisational and content delivery platform, Microsoft Copilot and ChatGPT were incorporated within selected activities to provide GenAI-supported prompts and reflective questions. Thus, OneNote functioned as the learning environment, whereas GenAI tools served as cognitive scaffolds embedded within the instructional design. Trainers shared instructional content in advance to allow participants sufficient time to engage with concepts before attending live discussions. The framework emphasised clarity of expectations, structured sequencing of content, and alignment between asynchronous tasks and synchronous activities. GenAI-generated prompts were integrated to scaffold participants' engagement with content by encouraging questioning, analysis, and conceptual exploration. These prompts supported cognitive preparation and helped participants arrive at live sessions with preliminary ideas and reflections already formed.

Interactive learning phase

The interactive phase consisted of synchronous sessions conducted through Microsoft Teams. Live sessions emphasised collaborative discussion, practical application, problem-solving, and shared reflection rather than direct content transmission. Trainers facilitated interactive activities that connected asynchronous learning with authentic professional contexts, monitored engagement, supported participants with low attendance or participation, and maintained ongoing communication throughout the course implementation process.

Communication channels such as WhatsApp groups supported continuity between sessions through reminders, clarifications, provision of additional resources, and follow-up interaction. Microsoft Copilot- and ChatGPT-supported questioning strategies and reflective prompts were used selectively to deepen dialogue, encourage analysis, and sustain engagement during

collaborative activities. These tools supported discussion and reflection but did not replace trainer facilitation or function as automated instructional agents.

Reflective learning phase

The reflective phase extended learning beyond synchronous participation. Reflection was an intentionally designed process rather than an incidental outcome of training experiences. Participants engaged in reflective assignments, feedback cycles, and GenAI-supported reflective activities using Microsoft Copilot and ChatGPT to promote deeper examination of instructional practices and professional learning experiences.

Microsoft Copilot- and ChatGPT-generated reflective prompts and case-based scenarios were integrated to guide participants' analysis of classroom applications, instructional decisions, and learning outcomes. These prompts encouraged metacognitive engagement by helping participants connect theoretical concepts to authentic educational contexts and examine the implications of newly acquired strategies for practice.

The framework also emphasised continuous feedback and individualised support. Trainers provided constructive feedback on assignments and reflective tasks while encouraging participants to apply feedback progressively throughout the course. This iterative process contributed to sustained professional growth and reinforced the integration of reflection within the broader learning design.

Structural and organisational components of the framework

The framework included organisational structures to ensure consistency, engagement, and accountability. Microsoft Teams channels centralised resources, assignments, and communication, while standardised assignment systems maintained coherence across courses. Clear expectations were set for participation, preparation, confidentiality, and professional interaction, including active engagement, independent work, pre-session preparation, and application of learning in practice. Within this integrated professional learning ecosystem, GenAI tools (Microsoft Copilot and ChatGPT) represented one component of the instructional design, supporting cognitive processing and reflection alongside trainer guidance, collaborative interaction, and digital learning platforms. Overall, these elements created an integrated professional learning ecosystem combining technology, structured pedagogy, communication, and reflection.

Alignment with experiential learning theory

The framework aligns with Kolb's (1984) experiential learning theory by organising learning into interconnected phases: pre-learning supports conceptual understanding, interactive sessions promote active experience and experimentation, and reflective activities encourage critical reflection and professional application. The integration of Microsoft Copilot and ChatGPT within this cycle reflects the use of GenAI as a cognitive and reflective scaffold that supports participants' engagement with experience and meaning-making processes. Integrated within a digitally supported flipped professional development environment, the framework also uses AI to enhance engagement and reflective practice. This model guided the design and implementation of the professional development courses examined in the study, as shown in Figure 1.

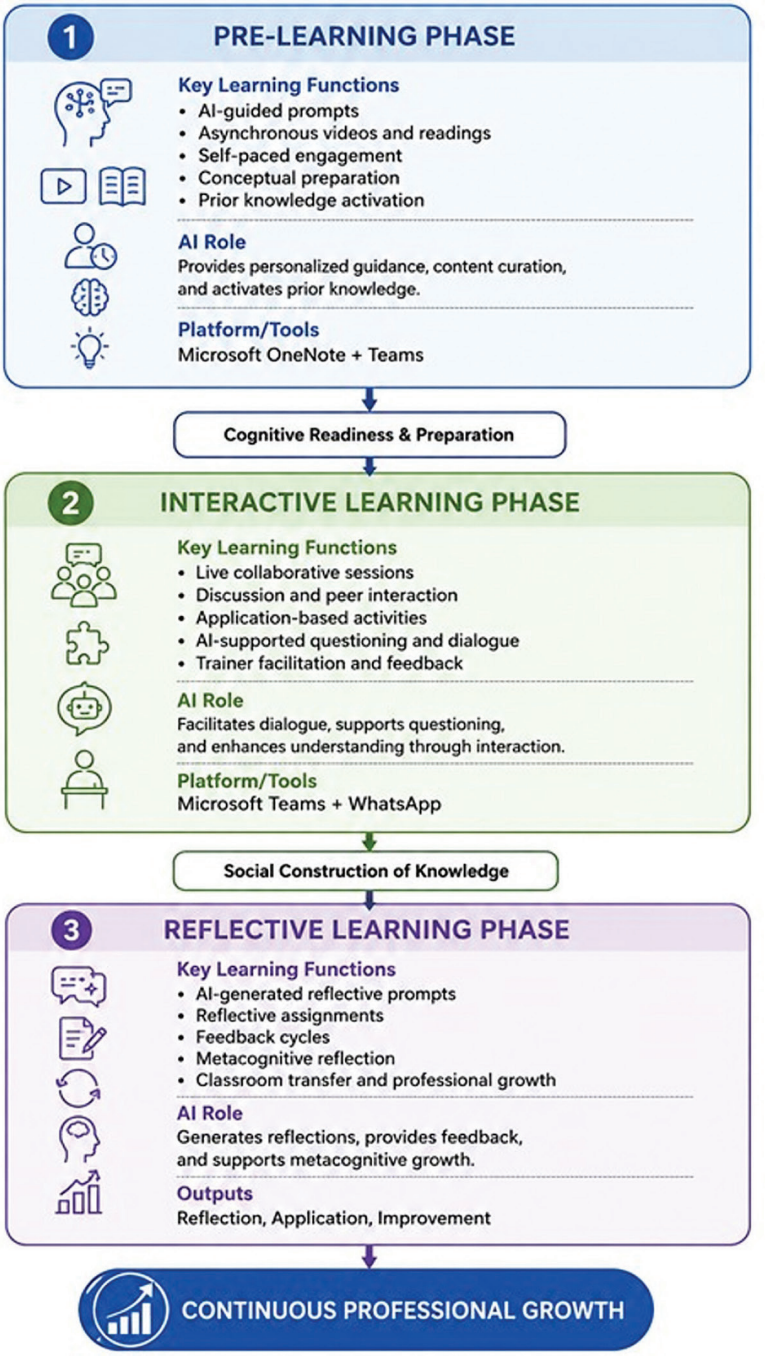


Figure 1. AI-supported flipped professional development process model.

METHODOLOGY

Research design

This study employed a qualitative case study design to examine the implementation of a generative AI (GenAI)-supported flipped professional development framework within a real-world educational context (Yin, 2018). The framework integrated Microsoft digital learning platforms, including Microsoft OneNote for organising learning resources, assignments, and asynchronous activities, and Microsoft Teams for synchronous sessions, communication, and collaborative engagement. The GenAI component involved the use of Microsoft Copilot and ChatGPT, which were incorporated as pedagogical scaffolds to support participants' cognitive engagement, questioning, reflection, and professional learning activities.

The framework was developed and coordinated centrally by the Education Resource Center (ERC), which ensured consistency in the selection of digital platforms, AI tools, learning activities, and implementation procedures across all professional development courses. All participants engaged with the same designated platforms and GenAI tools through trainer-guided activities and structured prompts. Therefore, AI use was embedded within a controlled professional development design rather than representing unrestricted individual use of different AI applications.

Descriptive quantitative data from participant questionnaires were incorporated to support and triangulate qualitative findings rather than for inferential analysis (Creswell & Plano Clark, 2018).

Participants

The study included 63 participants enrolled in five flipped professional development courses conducted between February and July 2025. Participants comprised 52 teachers, 6 coordinators, and 5 educational leaders drawn from seven schools affiliated with the host educational institution.

The flipped training programme was conceptualised and coordinated by two learning designers from the ERC, one of the operational units within the host educational institution. Five instructors also contributed to the design and facilitation of the training sessions. The instructional team included professionals occupying diverse educational roles, including subject coordinators, researchers, and school leaders (principal, vice principal, and head of cycle). Collectively, these contributors provided perspectives on both the design and implementation of the learning model.

Data collection

Data was collected from three primary, complementary sources. Participant questionnaires, consisting of five-point Likert-scale items ranging from 1 = strongly disagree to 5 = strongly agree, were administered via Microsoft Forms to capture participants' perceptions of engagement, interaction, and course effectiveness. Response frequencies and descriptive statistics were examined to summarise participants' perceptions and were used to complement and contextualise the qualitative findings. The questionnaire data were interpreted descriptively and were not used to establish causal relationships or measure learning gains. Trainer evaluation reports documented participant engagement, interaction patterns, and observable learning behaviors throughout course implementation, serving as continuous observational records of the learning process. Reflective assignments were evaluated using the ERC trainer-developed evaluation rubric. The rubric assessed four dimensions: understanding of material (40 percent), critical thinking and application of theory to practice (30 percent), clarity and organisation (20 percent), and timeliness (10 percent). Scores were used descriptively to examine engagement with reflective activities.

Semi-structured interviews were conducted with learning designers and instructors to explore design rationale, AI integration, instructional sequencing, and perceived effectiveness of the model, providing in-depth insights into decision-making and implementation experiences.

Data analysis

Qualitative data from interviews and trainer evaluation reports were analysed thematically using inductive coding to identify recurring patterns related to engagement, instructional design, and AI integration in the flipped professional development model. Questionnaire data were analysed descriptively using frequencies and means to support and contextualise the qualitative findings, without conducting hypothesis testing. Findings from all sources were then integrated through triangulation to compare and synthesise results, thereby enhancing the depth and credibility of the overall interpretation. Trustworthiness was strengthened through multiple strategies apart from methodological and data source triangulation. Peer debriefing with the instructional team helped refine interpretations and reduce potential researcher bias. In addition, descriptive quantitative data were integrated to complement qualitative findings and enhance convergence of evidence across data sources.

Ethical considerations

Prior to data collection, approval to conduct the study was obtained from the Director General of Education of the private educational association with which all participating school staff were affiliated. All participants were informed about the purpose of the study, participation was voluntary, informed consent was obtained from all participants, and all data were anonymised and treated confidentially throughout the research process.

FINDINGS

RQ1: Influence of AI-supported flipped design on teacher engagement

The findings indicate that the participants experienced positive levels of engagement across preparation, participation, interaction, and reflection. Participants reported high levels of overall satisfaction with the courses. Of the 63 participants, 28 participants (44.4 percent) rated the courses as excellent, while 35 participants (55.6 percent) rated them as very good. All 63 participants indicated that they would recommend the courses to others.

Engagement was especially evident during synchronous sessions. Participants described live discussions and collaborative activities as highly interactive and meaningful. Ratings of interaction with trainers were similarly positive, with 42 participants (66.7 percent) reporting excellent interaction and 21 participants (33.3 percent) reporting very good interaction. Trainer reports supported these findings and documented high levels of participation and motivation during live sessions. Because the study did not include a comparison group or pre-intervention data from previous professional development offerings without AI-supported components, changes in satisfaction or engagement attributable specifically to AI integration cannot be determined. The findings therefore represent participants' perceptions of the implemented AI-supported flipped professional development framework rather than evidence of causal improvement compared with previous models.

A major factor contributing to engagement was the effectiveness of the pre-learning phase. Participants entered live sessions with prior exposure to content, which increased confidence

and readiness for discussion. Trainers consistently observed that participants arrived with ideas already formed and demonstrated stronger willingness to participate. The flipped structure also supported learner autonomy. Participants appreciated the ability to review materials independently, engage at their own pace, and revisit content before live sessions. Communication systems further strengthened engagement. Trainers emphasised that WhatsApp groups and structured follow-up mechanisms maintained continuity and encouraged participation throughout the learning process.

Overall, the findings suggest that the integration of GenAI-supported activities within a flipped professional development structure contributed to a learning environment characterised by cognitive readiness, active participation, and sustained interaction. Participants' accounts indicate that AI-supported prompts and reflective activities complemented the existing affordances of flipped professional development by supporting preparation, engagement with content, and reflection. However, given the case study design, these findings do not establish that the AI-supported approach was more engaging than flipped professional development without AI integration.

RQ2: Perceptions of AI-supported learning activities

The second research question explored teachers' perceptions of AI-assisted learning activities across the phases of the flipped professional development model, organised into pre-learning, synchronous learning, and reflective learning.

Theme 1: GenAI-supported pre-learning phase (Preparation and cognitive readiness)

Participants expressed positive perceptions of GenAI-supported asynchronous learning activities, particularly regarding preparation and cognitive structuring. Survey data showed that 52 participants (83 percent) strongly agreed that asynchronous materials supported their learning effectively, while 11 participants (17 percent) agreed.

Participants reported that GenAI-supported prompts helped them focus on key concepts, think critically, and prepare better for live sessions. These perceptions suggest that GenAI-supported preparation was experienced by participants as a useful support for cognitive readiness and engagement during synchronous learning. For example, Participant 15 noted that the AI-supported activities helped them "think about the topic before coming to the session."

Theme 2: AI-enhanced synchronous learning phase (Engagement and interaction)

Synchronous sessions were perceived as highly engaging, with 52 participants (83 percent) strongly agreeing and 11 participants (17 percent) agreeing that live sessions were effective. Participants perceived that prior preparation through AI-supported activities contributed to their confidence during synchronous discussions and collaborative tasks. One participant described this experience: "I felt better prepared, participated more actively and confidently because of these activities" (Participant 35).

Trainer observations also indicated positive levels of participation, motivation, and interaction during synchronous sessions. However, because the study did not include a comparison group or previous implementation of the same courses without AI integration, these findings cannot determine whether GenAI-supported activities resulted in higher engagement compared with traditional or non-AI flipped professional development approaches.

Theme 3: AI-supported reflective learning phase (Metacognition and practice integration)

The reflective phase was identified as a strong component of the model. Participants reported that GenAI-supported reflection prompts encouraged deeper examination of practice and suported connections between theory and classroom application. As one participant explained: "The reflective prompts encouraged me to look at my teaching practices from a different perspective. They helped me connect the ideas that we discussed in the course with situations I experience in my own classroom" (Participant 60).

Trainer observations indicated sustained engagement with reflective activities. In one course, reflective assignments achieved an average score of 14.23/20. These assignments were evaluated using the ERC evaluation rubric, which assessed understanding of material (40 percent; 8 marks), critical thinking and connection between theory and practice (30 percent; 6 marks), clarity and organisation (20 percent; 4 marks), and timeliness (10 percent; 2 marks). The average score indicates that participants demonstrated satisfactory performance across these criteria, particularly in engaging with course materials and connecting concepts to professional practice. This score is reported descriptively as an indicator of assignment performance and engagement with reflective activities rather than as a measure of learning gains or the effectiveness of AI integration. Learning designers also noted that GenAI-supported prompts contributed to coherence across phases by maintaining a structured reflective process throughout the professional development cycle.

Given the absence of a comparative condition, these findings are interpreted as evidence of participants' experiences and perceptions of the implemented GenAI-supported framework rather than evidence that AI produced improvements over non-AI approaches.

Cross-phase challenges and implementation constraints

Despite overall positive perceptions, several challenges emerged, including internet connectivity issues, adjustment to self-directed learning, and varying levels of digital readiness. Participants also reported initial difficulties with platforms such as Microsoft OneNote and GenAI-supported tools. Suggested improvements included shorter videos, more interactive tasks, clearer instructions, and gamified activities.

Overall, teachers perceived AI as a facilitative tool that enhanced preparation, engagement, and reflection across all phases, while also introducing variability due to contextual and technical constraints. Notably, AI was viewed as augmenting rather than replacing instructional and human interaction in professional development.

DISCUSSION

This discussion interprets RQ1 and RQ2 findings across three phases of the AI-supported flipped professional development model: pre-learning, synchronous engagement, and reflective learning. Overall, findings suggest that participants experienced the GenAI-supported flipped professional development framework as a coherent learning design in which AI-mediated scaffolding was integrated across interconnected phases. The findings highlight how GenAI tools may support preparation, interaction, and reflection when intentionally embedded within a flipped professional development structure.

Engagement as a phase-dependent construct

Engagement is reconceptualised as distributed and phase-dependent rather than limited to visible participation in training sessions. Participants perceived GenAI-supported pre-learning activities as contributing to conceptual access, focus, and readiness before synchronous sessions. This aligns with research showing that generative AI can strengthen preparation and self-regulated learning (Kasneci et al., 2023; Miao & Holmes, 2023).

The findings contribute to discussions of engagement by illustrating how participants experienced engagement as distributed across phases, with pre-learning activities supporting preparation before synchronous interaction. This also aligns with Kolb's (1984) experiential learning cycle by showing that transitions from conceptualisation to experimentation are deliberately enabled through AI-mediated pre-learning scaffolds.

AI as embedded cognitive scaffolding in learning design

AI is reconceptualised as embedded cognitive scaffolding rather than an external instructional tool. Across phases, AI prompts guided attention, structured thinking, and supported deeper analysis. This aligns with research on generative AI as a cognitive and metacognitive support when integrated into pedagogy (Kasneci et al., 2023). The study contributes to this discussion by illustrating how GenAI-supported scaffolding can be embedded across multiple phases of a professional learning cycle rather than being limited to isolated feedback interactions. Theoretically, this aligns with Vygotsky's (1978) mediated learning, extended into digitally supported mediation distributed across different stages of the learning process.

Coherence as a mechanism of learning effectiveness

A key finding is that participants perceived coherence across phases as an important characteristic of the learning design. The pre-learning, synchronous, and reflective stages functioned as an integrated system, with each phase reinforcing the next. AI-supported prompts acted as continuity mechanisms that sustained conceptual threads across the learning cycle. This aligns with literature emphasising integrated digital learning ecosystems (Bond et al., 2020; Holmes et al., 2019). Coherence in this model is both structural and cognitive, supporting opportunities for iterative meaning-making and continued engagement across phases.

Reflection as a designed, not emergent, cognitive process

The findings highlight the value of intentionally designing reflection opportunities within professional learning experiences. Reflection was significantly strengthened through structured AI-supported prompts, enabling participants' reported analytical engagement. These findings are supported by research indicating that structured prompting enhances metacognitive depth (Kasneci et al., 2023) and that reflection is a designed cognitive process rather than an automatic outcome (Uittenhove et al., 2025). Within Kolb's cycle, reflection is reframed here as an intentionally engineered phase scaffolded by AI rather than a spontaneous stage.

Contextual constraints and design adaptation

Implementation was shaped by contextual constraints, including internet connectivity, digital readiness, and adaptation to self-directed learning. This aligns with literature emphasising that successful integration of GenAI-supported professional learning requires attention to socio-

technical readiness, infrastructure, and institutional capacity (Miao & Holmes, 2023; Williamson & Eynon, 2020). Thus, AI-supported flipped learning is best understood as a situated, adaptive design process rather than a universal solution.

Toward an integrated AI-supported flipped learning model

The findings suggest an integrated design framework in which AI functions as a phased cognitive scaffold across learning stages. The pre-learning phase supports conceptual preparation, the synchronous phase enables collaborative knowledge construction, and the reflective phase strengthens metacognitive synthesis through AI-supported prompts. The model's main contribution lies in integration rather than addition: AI is embedded as a learning design layer supporting continuity, coherence, and sustained engagement as perceived by participants.

CONCLUSION

This study demonstrates that AI-supported flipped professional development functions as an integrated learning system in which engagement, interaction, and reflection are distributed across interconnected professional learning stages. The findings indicate that participants perceived AI-supported pre-learning activities as supporting cognitive readiness, which was associated with positive experiences during synchronous engagement and reflective activities. Rather than operating as isolated instructional components, these phases formed a coherent learning continuum in which AI scaffolding supported continuity, progression, and depth of professional learning. The findings further suggest that the contribution of the framework lies in the intentional integration of GenAI-supported activities within a structured flipped professional development design.

The study contributes to AI-in-education research by framing AI as an embedded pedagogical scaffold supporting preparation, interaction, and reflection. It contributes to discussions of flipped learning and experiential learning by illustrating how GenAI-mediated support can be incorporated across different learning phases and strengthen cognitive progression. From a socio-constructivist perspective, it highlights AI's role in facilitating collaborative meaning-making and sustained engagement. The study provides contextual insights into the implementation of this framework within a resource-constrained educational setting.

The findings suggest that professional development programmes may consider integrating GenAI-supported activities across different stages of learning to support coherence, engagement, and reflection. The model is particularly relevant for contexts with limited time, facilitation capacity, and growing demands for flexible professional learning, where AI-supported scaffolding can enhance continuity and learner preparedness.

Limitations

The study is limited by its case study design and small sample size, which restrict generalisability. It relies primarily on self-reported perceptions and descriptive data, which may not fully capture behavioral change or instructional impact. In addition, it does not examine long-term effects or classroom-level transfer, limiting conclusions about sustained professional learning outcomes.

Although participants included teachers, coordinators, and educational leaders, the study did not conduct subgroup comparisons due to the exploratory nature and sample size. Furthermore, the

study did not include a comparison group or baseline data from previous professional development implementations without GenAI integration. Therefore, conclusions regarding the added value of GenAI compared with non-AI approaches remain limited.

Future research directions

Future research should explore longitudinal impacts of AI-supported flipped professional development on classroom practice, as well as comparative studies examining AI-supported and non-AI professional development models to determine whether GenAI integration contributes additional benefits beyond established flipped professional development approaches. It could also examine whether perceptions of GenAI-supported professional learning differ across professional roles. Experimental and quasi-experimental designs could provide stronger causal evidence, while further research is also needed on AI personalisation and its effects on instructional practice and student outcomes.

AI statement

AI tools were used to support language refinement, organisational structuring, and preliminary editing during manuscript preparation. All conceptual development, interpretation, and final writing decisions were completed by the authors.

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