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AI-Based Interactive Content Development through Activity-Based Training Design for Kindergarten Teachers: A Systematic Literature Review

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Abstract

Background: Artificial intelligence (AI) can expand teachers' capacity to develop visual, multimodal, adaptive, and interactive learning content, but tool mastery alone does not ensure pedagogical competence. Recent reviews also indicate that teacher professional development (TPD) for AI remains less developed than research on AI applications for learners. In early childhood education (ECE), AI-supported content development must additionally address child development, safety, simplicity, and the balance between digital interaction and direct pedagogical interaction.
Aims: This study synthesizes evidence on teacher competence, professional development design, training activities, and ECE-relevant considerations to formulate an AI-based Activity-Based Training Design (ABTD-AI) framework.
Methods: Following PRISMA 2020, we searched five databases for literature published mainly from 2016 to 2026. Of 180 records, 20 duplicates were removed; 160 were screened, 60 full texts assessed, and 40 studies included in a thematic synthesis guided by four research questions and predefined criteria.
Results: The findings show that AI-based content development requires integrated technological, pedagogical, subject-specific, AI-literacy, evaluation, and child-appropriate design competencies. Effective TPD combines contextualized practice, collaboration, feedback, reflection, and ongoing mentoring, while activity-based training should produce observable outputs that transfer to classroom practice. These principles inform the seven-stage ABTD-AI framework, linking AI co-creation and verification with practical training, product development, feedback, and mentoring.
Conclusion: ABTD-AI is presented as an evidence-informed conceptual framework for designing and mentoring kindergarten teachers in AI-based interactive content development. Its effectiveness has not yet been established empirically and requires subsequent implementation research.

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INTRODUCTION

Digital transformation has changed how teachers design, present, and evaluate learning experiences. In early childhood education (ECE), digital technology should be positioned as a means of supporting play, exploration, communication, visualization, and multisensory experiences rather than replacing

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pedagogical interaction. Literature on teacher digital competence indicates that mastering devices alone is insufficient; teachers need the ability to select digital resources, design learning activities, integrate technology with pedagogy and content, and evaluate its impact. The TPACK framework emphasizes that meaningful technology integration occurs at the intersection of technological, pedagogical, and content knowledge (Fradão, 2025; Umutlu, 2022; Heine et al., 2023; Smestad et al., 2023; Saltos-Rivas et al., 2023; Yang et al., 2023).

These findings are relevant to the partner context described in the PKM proposal for Yayasan Barunawati Surabaya. The proposal identifies that playgroup and kindergarten teachers have not yet optimally utilized interactive content, although the schools have access to devices such as smartboards. The main problems include limited interactive learning resources, limited competence in developing digital content, the need for more engaging learning, and suboptimal utilization of available devices.

At the same time, generative AI expands opportunities for teachers to create text, images, stories, activity ideas, quizzes, audio, and media designs (Mai et al., 2024; Ouyang & Jiao, 2021; Roll & Wylie, 2016). However, recent reviews show that teacher AI competence involves more than tool use: teachers also need pedagogical integration skills, the ability to critically evaluate of AI outputs, ethical judgement, and the capacity to make context-sensitive design decisions (Dogan et al., 2025; Tan et al., 2025). Empirical work also links AI literacy with readiness, attitudes, self-efficacy, and responsible use (Du et al., 2024; Galindo-Domínguez et al., 2024; Yue et al., 2024).

However, existing professional development literature tends to emphasize either general digital competence, AI-oriented teacher development, or technology-training design, while ECE-focused studies more often emphasize the production of interactive materials (Trust et al., 2016; Wohlfart & Wagner, 2023). Reviews of professional learning identify active practice, collaboration, feedback, reflection, and sustained support as important design features (Amemasor et al., 2025; Garrett, 2024). ECE-oriented training studies likewise emphasize guided production of digital materials (Nuryani et al., 2025; Wahyono et al., 2022). These strands provide useful evidence, but they do not by themselves specify how AI co-creation, pedagogical verification, product development, peer review, and transfer can be organized as one activity sequence.

The research gap is therefore more specific than the general lack of studies on AI or teacher training. There is a need for an integrated, ECE-sensitive training design that connects (1) teacher AI and pedagogical competence, (2) authentic interactive-content production, (3) activity-based professional learning, and (4) sustained transfer and mentoring. Activity-Based Training Design (ABTD) provides a useful organizing principle because it treats training as a sequence of purposeful activities that produce experiences and outputs transferable to practice (Rodwell, 2017). ABTD-AI is proposed as a synthesis, not as a claim that a new training model has already been empirically validated. The novelty lies in explicitly mapping SLR evidence to seven operational stages and embedding AI verification, child development, ethics, and teacher agency throughout the sequence.

This article aims to: (1) identify the teacher competencies required to develop and integrate AI-based interactive content; (2) identify professional development design characteristics associated with teacher learning and practice; (3) identify training activities consistent with ABTD principles; and (4) synthesize these findings into an AI-based Activity-Based Training Design framework for kindergarten teachers. The article presents an evidence synthesis and a conceptual design contribution; it does not report PKM implementation outcomes or claim that ABTD-AI is effective before empirical testing.

METHOD

Research Design

The study employed a Systematic Literature Review (SLR) with thematic synthesis and was reported using the PRISMA 2020 framework (Page et al., 2021). The review connected four domains: (a)

AI/GenAI in education; (b) teacher digital competence, TPACK, and AI competence; (c) professional development/teacher training; and (d) activity-based learning or training. Kindergarten/ECE evidence was prioritized because digital content for young children has distinctive developmental, safety, interaction, and usability requirements. Studies from K–12 or general teacher professional development were included only when their design principles were transferable to ECE teacher training.

Research Questions

RQ1. What characteristics of teacher competence are required to develop and integrate AI-based interactive learning content?
RQ2. What professional development design characteristics support changes in teachers' competence, self-efficacy, attitudes, and digital practices?
RQ3. Which training activities are most consistent with the principles of Activity-Based Training Design?
RQ4. How can these findings be synthesized into an AI-based Activity-Based Training Design framework for kindergarten teachers?

Search Strategy and Eligibility

The literature search was conducted in Scopus, Web of Science, ERIC, ScienceDirect, and Google Scholar. The core Boolean search structure reported specified in the review protocol was: ("artificial intelligence" OR "generative AI" OR "AI literacy" OR "ChatGPT") AND ("teacher professional development" OR "teacher training" OR "teacher education") AND ("interactive learning content" OR "digital learning content" OR "digital competence" OR "AI competence") AND ("activity-based training" OR "active learning" OR "hands-on training" OR "learning by doing"). Database syntax was adapted to the search interface while retaining these four conceptual blocks. The primary publication period was 2016–2026, with earlier theoretical sources retained only when they provided foundational concepts for TPACK, ABTD, or PRISMA. The available manuscript records do not contain the original date-stamped search exports or database-specific hit counts; therefore, these values are not reconstructed or invented in the revised manuscript. Instead, the reproducibility table below reports the database-specific query structure and transparently flags the missing historical metadata.

Table 1. Database Search Strategy and Search Coverage

Database	Platform	Search String / Syntax	Coverage	Records Retrieved
Scopus	Scopus	TITLE-ABS-KEY(("artificial intelligence" OR "generative AI" OR "AI literacy" OR ChatGPT) AND ("teacher professional development" OR "teacher training" OR "teacher education") AND ("interactive learning content" OR "digital learning content" OR "digital competence" OR "AI competence") AND ("activity-based training" OR "active learning" OR "hands-on training" OR "learning by doing"))	2016–2026	Not retained
Web of Science	Core Collection	TS=(("artificial intelligence" OR "generative AI" OR "AI literacy" OR ChatGPT) AND ("teacher professional development" OR "teacher training" OR "teacher education") AND ("interactive learning content" OR	2016–2026	Not retained

		"digital learning content" OR "digital competence" OR "AI competence") AND ("activity-based training" OR "active learning" OR "hands-on training" OR "learning by doing"))		
ERIC	ERIC	("artificial intelligence" OR "generative AI" OR "AI literacy" OR ChatGPT) AND ("teacher professional development" OR "teacher training" OR "teacher education") AND ("interactive learning content" OR "digital learning content" OR "digital competence" OR "AI competence") AND ("activity-based training" OR "active learning" OR "hands-on training" OR "learning by doing")	2016–2026	Not retained
ScienceDirect	ScienceDirect	("artificial intelligence" OR "generative AI" OR "AI literacy" OR ChatGPT) AND ("teacher professional development" OR "teacher training" OR "teacher education") AND ("interactive learning content" OR "digital learning content" OR "digital competence" OR "AI competence") AND ("activity-based training" OR "active learning" OR "hands-on training" OR "learning by doing")	2016–2026	Not retained
Google Scholar	Google Scholar	"artificial intelligence" OR "generative AI" OR "AI literacy" OR ChatGPT + "teacher professional development" OR "teacher training" OR "teacher education" + "interactive learning content" OR "digital learning content" OR "digital competence" OR "AI competence" + "activity-based training" OR "active learning" OR "hands-on training" OR "learning by doing"	2016–2026	Not retained

Table 2. Eligibility and Quality Appraisal Criteria

Criteria	Operationalization
Inclusion	Peer-reviewed articles; relevant to teachers/teacher education; addressing AI, digital competence, interactive content, or professional development; containing findings/methods that can be extracted; published in English or Indonesian.
Exclusion	Editorials/opinion pieces without methods; studies focusing only on AI for students without implications for teachers; duplicate publications; studies without sufficient information for synthesis.
Context	Priority is given to K–12/ECE and teacher professional development, with cross-level studies included when their design principles are relevant to kindergarten teachers.

Outcomes	Digital/AI competence, self-efficacy, attitudes, technology-integration practices, digital product quality, participant engagement, transfer to practice, or sustainability of mentoring.
Quality appraisal	Methodological quality was appraised using the core criteria of the Mixed Methods Appraisal Tool (MMAT) 2018. The appraisal considered design appropriateness, data collection, analysis, interpretation, and coherence with the reported research question. Appraisal informed interpretation of evidence rather than producing a pooled effect size.

Screening and Data Extraction

Study selection involved title/abstract screening, followed by full-text assessment against the predefined eligibility criteria. According to the author-contribution record, Fajar Arianto conducted the literature search and screening. Thus, the screening was performed by one reviewer in the available workflow, and no inter-reviewer disagreement or adjudication event was recorded. At full-text stage, 20 reports were excluded because they failed at least one eligibility criterion. The source manuscript does not retain a category-level exclusion log for these 20 reports; the applicable exclusion categories were: (a) population/context not relevant to teachers or transferable ECE/K–12 professional development; (b) topic/intervention not addressing AI, digital competence, interactive content, or professional development; (c) insufficient methodological or empirical information for extraction; and (d) publication/report type not meeting the predefined criteria. Exact category counts are not reconstructed because the original screening log is not present in the manuscript file. The final working set remained 40 studies.

Reviewer-procedure note: the one-reviewer workflow is retained as a factual description of the available record. For a future update, a second independent reviewer and a documented disagreement-resolution procedure should be added to strengthen inter-rater reliability.

No formal methodological quality appraisal using in the MMAT or another formal appraisal instrument was conducted. Accordingly, the synthesis is presented as a thematic evidence synthesis based on the predefined eligibility, screening, extraction, and cross-study comparison procedures. No study-quality score is assigned.

Table 3. Study Exclusion Categories and Operational Criteria

Code	Exclusion Category	Operational Reason	No. Excluded
A	Population/context mismatch	Not focused on teachers/teacher education or not transferable to ECE/K–12 teacher training	Count not retained
B	Topic/intervention mismatch	Did not address AI, digital competence, interactive content, or professional development	Count not retained
C	Insufficient information	Methods/findings could not be extracted with sufficient detail for synthesis	Count not retained
D	Publication/report type	Editorial/opinion/duplicate/other non-eligible report type	Count not retained

PRISMA 2020 Flow of Study Selection

Figure 1. PRISMA 2020 Flow of Study Selection

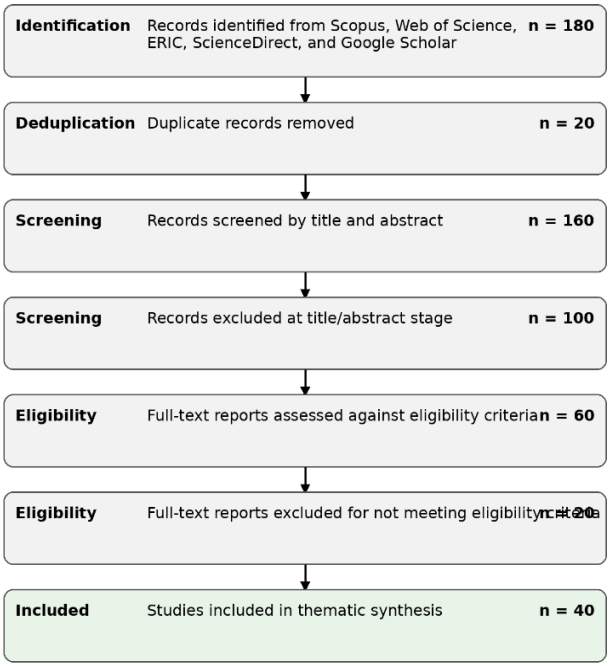


Table 4 is placed in the Results and Discussion section to make the evidence base directly traceable. It summarizes the 40 included studies by year, evidence type/context, and evidence focus.

Table 4. Synthesis of 40 studies

No	Study	Year	Evidence Type/Context	Evidence Focus
1	(Amemasor et al., 2025)	2025	Systematic review; teacher professional development	Digital instructional integration and teaching-practice outcomes
2	(Claro et al., 2024)	2024	Systematic review; in-service teachers	Dimensions and measurement of teacher digital competence
3	(Crompton & Burke, 2023)	2023	Review; higher education	AI in higher education and implications for educators
4	(Dogan et al., 2025)	2025	Systematic review; teacher AI professional development	TPACK, PD designs, tools, and teacher-learning outcomes
5	(Du et al., 2024)	2024	Empirical; teachers	AI literacy and teacher learning
6	(Fernández-Batanero et al., 2020)	2020	Systematic review; teachers	Digital competences for teacher professional development
7	(Galindo-Domínguez et al., 2024)	2024	Empirical; teachers	Digital competence and attitudes toward AI
8	(Garrett, 2024)	2024	Systematic review; teacher technology workshops	Features and outcomes of technology-focused professional learning
9	(Hrastinski, 2021)	2021	Systematic review; teachers	Digital tools supporting professional development in lesson study
10	(Kasneci et al., 2023)	2023	Review; education	Opportunities, risks, and responsible use of LLMs/ChatGPT

11	(Li Wang, P., & Chen, 2025)	2025	Systematic review; teacher PD	AI-integrated professional development designs and teacher agency
12	(Mai et al., 2024)	2024	Systematic review; teaching and learning	Uses, opportunities, and limitations of ChatGPT
13	(Nuryani et al., 2025)	2025	Community-service/training; PAUD teachers	Canva and AI for digital learning media development
14	(Ouyang & Jiao, 2021)	2021	Conceptual review; AI in education	Three paradigms of AI in education
15	(Revuelta-Domínguez et al., 2022)	2022	Systematic review; teachers	Digital teaching competence
16	(Roll & Wylie, 2016)	2016	Review; AI in education	Evolution and emerging directions of AI in education
17	(Smestad et al., 2023)	2023	Systematic review; teachers/student teachers	Dimensions of professional digital competence
18	(Tan et al., 2025)	2025	Systematic review; teachers	AI in teaching and teacher professional development
19	(Tondeur et al., 2019)	2019	Empirical/review; teacher educators	Teacher educators as gatekeepers of technology integration
20	(Trust et al., 2016)	2016	Empirical/review; teachers	Professional learning networks and teacher learning
21	(Wahyono et al., 2022)	2022	Training study; PAUD teachers	Preparation of interactive learning materials
22	(Yue et al., 2024)	2024	Empirical; 1,664 K–12 teachers	AI-TPACK readiness and attitudes toward AI education
23	(Zainal et al., 2026)	2026	Systematic review; teachers	Measurement tools for teacher AI literacy
24	(Zawacki-Richter et al., 2019)	2019	Systematic review; higher education	AI applications and the role of educators
25	(Zhang, 2024)	2024	Systematic review; K–12	ChatGPT use in K–12 education
26	(Deng et al., 2024)	2024	Quasi-experimental; pre-service teachers	Generative-AI-supported teacher training, self-efficacy, and higher-order thinking
27	(J. Yang et al., 2025)	2025	Systematic review; primary education	AI literacy content, pedagogy, tools, assessment, and outcomes
28	(Tagare et al., 2025)	2025	Systematic review; K–12 teachers	Ethical competencies for teacher AI literacy
29	(Kokoç et al., 2026)	2026	Systematic review; in-service teachers	Teacher AI literacy, professional development, and contextual conditions
30	(Chiu et al., 2025)	2025	Scale development/validation; K–12 teachers	AI knowledge, pedagogy, assessment, ethics, human-centred education, professional engagement
31	(L. Yang et al., 2023)	2023	Systematic review; K–12 teachers	Digital competence concepts, methods, and challenges
32	(Hava & Babayiğit, 2025)	2025	Empirical; teachers	AI-TPACK competence and digital proficiency
33	(Lucas et al., 2024)	2024	Empirical; K–12 teachers	Trust in AI, AI knowledge, and digital competence

34	(Ding et al., 2024)	2024	Professional-development intervention; middle-school teachers	Case-based AI PD and teacher AI literacy/integration
35	(Heine et al., 2023)	2023	Systematic review; teacher professional competence	Digital resources as a dimension of professional digital competence
36	(Wohlfart & Wagner, 2023)	2023	Umbrella review; teachers	Teacher roles in educational digitalization
37	(Saltos-Rivas et al., 2023)	2023	Systematic mapping; university teachers	Digital competency factors and constructs
38	(Zhou et al., 2025)	2025	Longitudinal mixed-method; language teachers	Exploration, sustained practice, and institutionalisation in GenAI PD
39	(Aravantinos et al., 2026)	2026	Systematic review; K–12 teachers	AI PD needs, AI literacy, ethical use, organizational support, and continuous training
40	(Borko, 2004)	2004	Conceptual review; teacher professional development	Professional development and teacher learning; conceptual foundations
41	(Desimone, 2009)	2009	Conceptual/methodological; teacher professional development	Conceptualization and measurement of professional development impact
42	(Garet et al., 2001)	2001	Empirical; teachers	Characteristics of effective professional development and teacher learning outcomes
43	(Koehler et al., 2013)	2013	Conceptual; teacher knowledge	Technological pedagogical content knowledge (TPACK)
44	(Rodwell, 2017)	2017	Book; training design	Activity-based training design and knowledge learning
45	(Selwyn, 2019)	2019	Book; AI in education	Critical perspectives on AI and the future of education
46	(Yu B. & Yu, 2025)	2025	Bibliographic information incomplete	Effects of block-based visual programming

RESULTS AND DISCUSSION

Results: Evidence Synthesis

RQ1. Teacher competencies required for AI-based interactive content

The synthesis indicates that the competencies required to develop AI-based interactive content are multidimensional. Across digital competence reviews and AI professional development studies, teachers need technological and pedagogical knowledge, content design capability, AI literacy, the ability to evaluate generated outputs, and the capacity to align technology with learning objectives (Claro et al., 2024; Dogan et al., 2025; Fernández-Batanero et al., 2020; Revuelta-Domínguez et al., 2022). For ECE, these competencies must be extended to developmental appropriateness, safety, simple navigation, multisensory design, and preservation of direct teacher–child interaction. Thus, the SLR suggests extending the conventional TPACK-oriented interpretation: AI competence is not only the ability to operate a tool but also the ability to question, verify, adapt, and pedagogically justify AI-supported outputs (Kokoç et al., 2026; Zainal et al., 2026; Tagare et al., 2025).

Evidence focused on younger learners also reinforces the need for developmental sensitivity. Recent reviews of primary-school AI literacy identify age-appropriate pedagogy, human–AI interaction, critical data literacy, and AI ethics as important dimensions, while studies of teacher AI competence identify AI knowledge, AI pedagogy, AI assessment, ethics, and human-centred education as distinct competency dimensions (Chiu et al., 2025; Hanjun et al., 2023). Although primary-school evidence is

not identical to kindergarten evidence, it provides a relevant adjacent evidence base that supports cautious transfer to ECE training design.

RQ2. Professional development design characteristics

The reviewed evidence converges on contextualized, active, collaborative, feedback-rich, and sustained professional learning. General TPD research emphasizes content focus, active learning, coherence, collaboration, and duration (Ansyari et al., 2020; Nguyen et al., 2021), while technology-oriented reviews emphasize practical activities, reflection, relevance, and structured learner support (Amemasor et al., 2025; Garrett, 2024). AI-specific reviews further emphasize teacher agency, pedagogical integration, and responsible use (Dogan et al., 2025; Li et al., 2025; Tan et al., 2025). The key implication is that the training problem is not solved by adding an AI demonstration to a conventional workshop; the learning architecture itself must require teachers to make design decisions, produce artifacts, receive feedback, and revisit those decisions.

Recent evidence further strengthens this interpretation. Studies published in 2024–2026 report that teacher AI competence extends beyond technical operation to include pedagogical compatibility, assessment, ethics, human-centred judgement, and professional engagement; empirical and review studies also emphasize sustained, case-based, and practice-oriented professional development. These findings are consistent with the proposed ABTD-AI architecture, particularly its emphasis on teacher agency, artifact production, verification, coaching, and transfer (Aravantinos et al., 2026; Chiu et al., 2025; Ding et al., 2024; Li et al., 2025; Zhou et al., 2025).

RQ3. Training activities consistent with ABTD principles

The synthesis identifies a progression from needs/context analysis to tool exploration, design/storyboarding, hands-on production, peer review and coaching, reflection/ethical checking, and classroom transfer. This sequence is consistent with ECE-oriented guided production studies (Nuryani et al., 2025; Wahyono et al., 2022) and with broader professional learning evidence emphasizing practice, reflection, and support. Importantly, activity-based learning should not be equated with activity for its own sake. (Alfiandra et al., 2022) shows that complex activities can introduce extraneous cognitive load when task demands are poorly integrated; therefore, each training activity in ABTD-AI is tied to a clear competency and a concrete artifact. This provides a stronger theoretical bridge between ABTD and instructional design.

Table 5. Table of Synthesis of Design Evidence

Research Question	Synthesis Finding	Critical Interpretation	Design Implication
RQ1	Teacher competence combines TPACK, AI literacy, evaluation/verification, content design, and ECE-specific judgement.	Existing digital-competence studies explain technology–pedagogy integration, while AI-competence reviews add critical evaluation and ethical judgement. The synthesis therefore treats AI competence as pedagogical decision-making, not tool operation alone.	Embed AI literacy, pedagogical alignment, verification, and child-appropriateness in every stage.
RQ2	TPD is strengthened by active practice, contextual relevance, collaboration, feedback, reflection, and continuity.	General TPD and AI-PD reviews converge on practice-oriented learning, but they rarely specify an ECE-specific production sequence for AI-based interactive content.	Use artifact-based activities, coaching, reflection, and post-training mentoring.

RQ3	ABTD-consistent activities progress from needs analysis to exploration, design, production, coaching, reflection, and transfer.	Activity-based learning can become cognitively demanding when tasks are not aligned with learning goals; scaffolding and artifact-focused tasks are therefore necessary.	Link each activity to one observable competency and one output.
RQ4	The seven-stage ABTD-AI sequence integrates the four evidence domains into one conceptual training architecture.	The novelty is the explicit evidence-to-stage mapping and the embedding of AI verification, teacher agency, ECE constraints, and transfer within the same sequence.	Use ABTD-AI as a conceptual basis for PKM implementation and subsequent empirical testing.

RQ4. Synthesis into the ABTD-AI framework

RQ4. Synthesis into the ABTD-AI framework: The seven stages were derived by triangulating recurring evidence rather than by adding arbitrary steps. Needs/context mapping responds to the literature on contextualized professional learning; AI and platform exploration responds to evidence on AI literacy and tool selection; storyboard design connects TPACK and content-design needs; hands-on creation operationalizes authentic practice and artifact production; coaching integrates feedback, peer learning, and mentoring; reflection embeds verification, ethics, developmental appropriateness, and teacher judgement; and transfer connects training to classroom implementation and sustained support. The resulting framework therefore represents a traceable synthesis from evidence to design stages, not an empirically validated intervention.

Discussion: From learning by doing to ABTD-AI

The SLR indicates that the proposed framework differs from three approaches that are often treated separately. First, conventional technology training may prioritize tool exposure and procedural skills; ABTD-AI instead requires teachers to justify tool use through pedagogical and ECE criteria. Second, AI-focused professional development often emphasizes AI literacy or classroom integration; ABTD-AI adds a concrete production pathway in which teachers create and revise interactive artifacts. Third, ECE interactive-content training emphasizes material production but does not necessarily integrate AI verification, ethical checking, or sustained mentoring. The novelty of ABTD-AI is therefore architectural: it connects competence, activity, artifact, feedback, reflection, and transfer within one sequence (Crompton & Burke, 2023; Zawacki-Richter et al., 2019; Zhang, 2024).

ABTD-AI transforms the training logic from "trainer explains–participants listen" into "trainer models–participants act–participants produce–participants receive feedback–participants reflect–participants transfer." Each activity is designed to generate evidence of learning, such as a needs map, prompt set, storyboard, prototype, revised product, quality checklist, or implementation plan. This logic is consistent with professional learning research emphasizing practice and transfer, while also recognizing that activity must remain instructionally purposeful rather than merely increasing participant workload.

AI is positioned as a co-creation and decision-support resource under teacher control. Teachers determine learning objectives, child characteristics, content boundaries, interaction forms, and quality criteria; AI can assist with alternative text, visuals, activity ideas, and material variations. Outputs should then undergo factual verification, developmental-appropriateness checks, safety and bias checks, copyright review, and curriculum alignment. This positioning is consistent with AI-

competence reviews that emphasize teacher judgement, critical evaluation, and responsible use (Dogan et al., 2025; Tan et al., 2025).

Table 6. Table Proposed AI-Based Activity-Based Training Design (ABTD-AI)

No	Stage	SLR-derived rationale	ABTD activity and application	Output
1	Orient	Contextualized professional learning requires alignment with teacher needs and school conditions (Amemasor et al., 2025; Li et al., 2025).	Map teacher competence, child characteristics, available devices, curriculum themes, and a real content problem.	Needs map + product target
2	Explore	AI-PD and AI-competence reviews emphasize AI literacy, tool selection, critical evaluation, and responsible use (Dogan et al., 2025; Tan et al., 2025).	Demonstrate AI and interactive platforms; compare outputs; identify appropriate tools and verification criteria.	Tool-selection criteria + initial prompts
3	Design	TPACK and digital-competence research indicates that technology should be connected to pedagogy and content (Revuelta-Domínguez et al., 2022).	Select a learning problem and create a storyboard/content flow before production.	Interactive content storyboard
4	Create	ECE training studies and TPD reviews support guided, hands-on production of authentic learning artifacts (Nuryani et al., 2025; Wahyono et al., 2022).	Produce text, visuals, audio, quizzes, or interactive elements using AI and digital platforms.	Prototype / initial product
5	Coach	Professional learning evidence emphasizes collaboration, feedback, mentoring, and peer interaction (Tondeur et al., 2019).	Trial the product, conduct peer critique, receive facilitator coaching, and revise.	Revised version + feedback notes
6	Reflect	AI education literature emphasizes verification, ethics, bias, safety, and teacher agency; activity-based learning also requires reflection and guidance (Kasneci et al., 2023).	Reflect on the process and complete factual, developmental, ethical, safety, copyright, and curriculum checks.	Quality and ethics checklist
7	Transfer	Sustained professional learning requires implementation support, relevance to practice, and continuity beyond the workshop (Amemasor et al., 2025; Li et al., 2025).	Plan classroom use, adaptation, monitoring, revision, and post-training mentoring.	Action plan + sustainability indicators

Implications

The ABTD-AI framework has practical implications for the community engagement program (PKM). Training time should be allocated primarily to activities that produce observable outputs rather than extended lectures about AI. Each activity should be linked to a competency objective and an artifact that can be reviewed. Post-workshop mentoring should be built into the design rather than treated as optional. Evaluation should examine participant reaction, knowledge/skill development, product

quality, and transfer to practice. Products should be developed from real school contexts so that teachers can immediately adapt them to classroom needs.

The framework also makes the Barunawati PKM targets more operational. Instead of measuring training success only through the number of teachers trained or media produced, the program can document: (1) storyboard quality; (2) prompt construction and AI-output verification; (3) interactive-content quality; (4) pedagogical justification for selected features; (5) evidence of peer-review revision; and (6) classroom implementation and subsequent revision. These indicators are proposed for future PKM evaluation and should be empirically validated rather than treated as established outcome measures.

Research Contribution

The contribution of this article is a synthesis and operationalization of three literature strands that are commonly treated separately: AI for teacher professional development, interactive-content development for ECE, and Activity-Based Training Design. The theoretical contribution is not a claim of a new standalone learning theory; rather, ABTD-AI functions as a bridging conceptual architecture that makes explicit how teacher competence, authentic activity, artifact production, feedback, reflection, responsible AI use, and transfer can be connected. Its methodological contribution is the evidence-to-stage mapping that links each of the seven proposed stages to recurring findings in the reviewed literature. This framework can guide the design of implementation studies, evaluation instruments, and subsequent design-based research.

Limitations

This review has several limitations. First, AI literature is developing rapidly, so the evidence base may change quickly. Second, evidence specifically concerning kindergarten/ECE teachers is smaller than evidence concerning K–12 teachers more generally, which means some design principles were transferred cautiously from broader teacher professional development literature. Third, ABTD is not yet a widely standardized educational research term; some ABTD principles therefore had to be interpreted alongside active learning, experiential learning, and professional development literature. Fourth, the review uses thematic synthesis rather than meta-analysis, so it does not estimate pooled effects. Finally, the PRISMA counts reported here reflect the final screening set used in this manuscript; study-level screening and appraisal records should be retained as supplementary documentation. A further limitation is that no formal methodological quality appraisal instrument was applied; therefore, the synthesis should not be interpreted as weighting studies according to methodological quality.

Suggestions

Future research should evaluate ABTD-AI empirically through design-based research, pilot implementation, or quasi-experimental designs. Such studies should examine changes in teacher AI/digital competence, product quality, self-efficacy, classroom transfer, and sustained use, while also documenting implementation fidelity. In ECE contexts, evaluation should additionally examine developmental appropriateness, cognitive load, data and privacy safety, bias in AI outputs, and teacher–parent engagement. Because the present article is conceptual and evidence-synthetic, no claim of ABTD-AI effectiveness is made before such empirical testing.

CONCLUSION

The Systematic Literature Review indicates that developing AI-based interactive content for kindergarten teachers requires more than introducing applications. The reviewed evidence points to integrated competencies in technological, pedagogical, and content knowledge; AI literacy; critical evaluation of AI outputs; ethical judgement; and ECE-sensitive content design. Professional development evidence further emphasizes contextual relevance, active practice, collaboration, feedback, reflection, and sustained mentoring.

On the basis of these findings, the article formulates the ABTD-AI conceptual framework with seven stages: orientation and needs mapping; AI and platform exploration; storyboard design; hands-on production; coaching and peer review; reflection and ethical checking; and classroom transfer. The framework differs from tool-centered training by connecting AI co-creation with pedagogical decision-making, artifact production, verification, feedback, and transfer within one sequence. ABTD-AI should therefore be understood as an evidence-informed conceptual design for future PKM implementation, not as an empirically validated model. Its effectiveness, feasibility, and sustainability remain questions for subsequent empirical research.

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AUTHOR CONTRIBUTION STATEMENT

Fajar Arianto developed the study concept, conducted the literature search and screening, analyzed and synthesized the findings, and drafted the manuscript. Bachtiar Sjaiful Bachri, Nur Ainiyah, Anugrah Dwicahyandi Oktavian, Yuda Sakti, and Rico Eko Andrianto contributed to the conceptualization, interpretation of findings, critical review, and revision of the manuscript. All authors reviewed and approved the final version of the manuscript.

AI DISCLOSURE STATEMENT

During the preparation of this manuscript, the authors used AI-based tools solely to assist with language editing and manuscript preparation. All content, interpretations, analysis, and conclusions were reviewed and verified by the authors. The authors take full responsibility for the accuracy and integrity of the published work.

CONFLICTS OF INTEREST

The authors declare that there are no financial, institutional, or personal conflicts of interest that could influence the conduct of this study, the analysis of data, the preparation of the manuscript, or its publication.

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