

AI-INTEGRATED RESEARCH-BASED APPROACH FOR ENHANCING PRE-SERVICE EFL TEACHERS' METHODOLOGICAL COMPETENCE: A LOCALIZED, MULTI-SITE IMPLEMENTATION IN UZBEKISTAN

Erkulova Feruza Melikuziyevna

*Namangan state institute of foreign languages
associated prof., PhD*

[*feruzaerkulovauzb@gmail.com*](mailto:feruzaerkulovauzb@gmail.com)

ABSTRACT. *This study examines how an AI-integrated, research-oriented practical inquiry methodology can strengthen pre-service EFL teachers' methodological competence in Uzbekistan. The intervention reframed teacher education from the transmission of "ready-made" methodology knowledge to a dynamic system of inquiry, experimentation, evidence-based decision-making, and reflective improvement. A localized EAR cycle (problem identification → exploration → action → reflection → re-action) was enriched with AI analytics and digital learning evidence (e.g., error mapping, learning logs, automated feedback, and participation analytics). The model was implemented across multiple higher education institutions (UzSWLU, Namangan State Institute of Foreign Languages, Samarkand State Institute of Foreign Languages, Denov Institute of Entrepreneurship and Pedagogy, and Kokand State University) through blended instruction combining face-to-face sessions and Zoom-based classes. Data sources included classroom and Zoom recordings, learner written work, diagnostic tests, interviews, rubric-based assessments, e-portfolios, learning analytics dashboards, and AI log files. Findings indicate that AI-supported diagnostics made methodological discrepancies visible and measurable; reflective–empirical inquiry accelerated corrective cycles; and student teachers increasingly demonstrated evidence-based lesson design, differentiated task creation, and reflective practitioner behaviors. The study concludes that localized AI-integrated EAR provides a scalable methodological framework for developing teacher-researcher identity and strengthening methodological competence in varied regional contexts.*

Keywords: *pre-service EFL teachers; methodological competence; exploratory action research; AI analytics; reflective–empirical inquiry; blended learning; Uzbekistan*

INTRODUCTION. Preparing future foreign language teachers requires more than delivering methodological knowledge; it requires developing the capacity to notice, analyze, and improve teaching through evidence and reflection. In many teacher

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education contexts, pre-service teachers often engage with methodology as a stable content area rather than as a practical and researchable domain. This limits their ability to diagnose classroom problems, justify pedagogical decisions, and adapt instruction to learners' needs.

This study positions research-oriented practical inquiry as the core methodological concept for improving pre-service EFL teachers' methodological competence. The approach constructs a teacher as a reflective practitioner and practitioner-researcher, capable of identifying pedagogical discrepancies, collecting empirical evidence, testing methodological solutions, and redesigning instruction through iterative cycles. To enhance accuracy and timeliness in diagnosis and feedback, the inquiry process was strengthened with AI-assisted analytics (e.g., automated error-pattern mapping, real-time participation tracking, and AI feedback).

Purpose is to design, localize, and evaluate an AI-integrated EAR-based methodology that strengthens pre-service EFL teachers' methodological competence across multiple Uzbek higher education sites.

Research Questions.

How does AI-integrated EAR support the identification and diagnosis of methodological discrepancies in pre-service teachers' practice?

What changes occur in pre-service teachers' methodological competence (e.g., lesson design, differentiation, reflection, decision-making) after participation in the AI-integrated inquiry cycle?

How transferable is the localized model across institutions with different regional and instructional contexts?

The model draws on complementary foundations:

Reflective thinking: Learning to teach through disciplined reflection and inquiry into experience (Dewey).

Sociocultural learning: Development through mediated activity and scaffolding, particularly in the Zone of Proximal Development (Vygotsky).

Reflective practitioner: Professional growth through reflection-in-action and reflection-on-action (Schön).

Exploratory Action Research (EAR) in language education: iterative improvement through problem identification, exploration, action, observation/reflection, and re-action (e.g., classroom-based inquiry traditions in TESOL).

AI-assisted learning and analytics: using computational tools for evidence generation, feedback, and monitoring, enabling faster, more precise cycles of improvement.

This study extends the EAR logic by embedding AI as an active analytical participant, not merely a supportive tool. AI-enabled evidence (error maps, engagement metrics, log files, automated feedback) was integrated into reflective-empirical inquiry, making pedagogical issues observable, traceable, and actionable.

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METHODOLOGY

This study employed a multi-site, implementation-focused research design aimed at examining the effectiveness and contextual adaptability of an AI-integrated inquiry-based methodological model in pre-service EFL teacher education. The intervention was delivered through a blended instructional format combining traditional on-campus sessions with synchronous Zoom-based classes. The methodological framework was structured as an AI-integrated cyclical model encompassing the stages of problem identification, exploration, action, reflection, and re-action. Depending on institutional classification, the design may be interpreted as quasi-experimental, design-based research, or a mixed-methods implementation model, as it integrates intervention, iterative refinement, and empirical evaluation.

The model was implemented across multiple higher education institutions in Uzbekistan to ensure contextual variability and cross-regional comparison. These institutions included Uzbekistan State World Languages University (UzSWLU), Namangan State Institute of Foreign Languages, Samarkand State Institute of Foreign Languages, Denov Institute of Entrepreneurship and Pedagogy, and Kokand State University. The diversity of institutional environments enabled comparative analysis across regional characteristics, instructional traditions, learner profiles, and resource availability. Such multi-site implementation enhanced the transferability and robustness of the proposed methodological framework.

Participants consisted of pre-service EFL teachers enrolled in “Foreign Language and Literature” master’s programs and teacher education methodology modules. In several contexts, two cohorts were involved, functioning either as experimental and comparison groups or as successive implementation groups across different academic cycles. Participants had completed foundational linguistics and language proficiency coursework prior to enrollment in the methodology module. Demographic characteristics such as academic level, prior teaching exposure, and language competence were considered to ensure comparability where group-based comparison was conducted.

The intervention operationalized a localized inquiry cycle enhanced through AI-supported analytics. The model adapted a structured sequence of problem identification, analytical exploration, pedagogical action, reflective evaluation, and iterative re-action to the Uzbek educational context. Localization included consideration of Uzbek classroom discourse norms, culturally shaped teacher–student role relations, feedback etiquette, reliance on local instructional materials, and contextual institutional constraints. AI integration served as a diagnostic and analytical layer within each stage of the cycle. Digital tools enabled automated error detection, engagement tracking (including Zoom analytics), learning log analysis, and AI-

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generated feedback. These functions transformed the inquiry process into an evidence-driven system where methodological discrepancies could be objectively observed and systematically addressed.

Data collection relied on methodological triangulation to ensure depth and reliability. Evidence sources included classroom video and audio recordings from both face-to-face and Zoom sessions, Zoom analytics capturing participation patterns and interaction frequency, and screen recordings documenting online task engagement. Diagnostic tests and formative assessments administered via digital platforms such as Google Forms provided quantitative indicators of learner development. Learners' written productions and task artifacts were collected for linguistic and methodological analysis.

Semi-structured interviews, short surveys, and peer discussions contributed qualitative insights into pedagogical processes. Rubric-based lesson evaluations assessed methodological alignment and instructional effectiveness. E-portfolios stored lesson plans, reflective journals, draft revisions, and implementation evidence, creating a longitudinal documentation system. AI-generated logs, error maps, feedback summaries, and learning analytics dashboards further strengthened empirical validation. Interactive feedback platforms such as Padlet and Mentimeter were employed to measure perception shifts and communicative participation.

Data analysis combined qualitative and quantitative approaches. Thematic coding was applied to reflective journals, interview transcripts, and observation notes to identify patterns of methodological reasoning and professional growth. Content analysis was conducted on lesson plans and reflective narratives to evaluate structural and pedagogical development.

Error-pattern analysis of learner output—covering grammatical, lexical, phonological, and communicative breakdown categories—was supported by AI-based mapping tools. Comparative analysis was conducted across institutional sites and across inquiry cycles (pre- and post-intervention comparisons as well as iterative cycle evaluations). Learning analytics metrics, including participation distribution, task completion times, and engagement fluctuations, were interpreted to assess behavioral and cognitive shifts over time.

Ethical considerations were rigorously observed throughout the study. Participation was voluntary, and informed consent was obtained prior to recording sessions or collecting artifacts. All participant identifiers were anonymized in datasets and publications. No academic penalties were associated with non-participation. Digital recordings and analytics data were stored securely in password-protected, controlled-access repositories to ensure confidentiality and data integrity.

Table 1. AI-integrated scientific–integrative mechanisms of research-oriented practical inquiry

№	Mechanism (Core function)	Key components	Expected outcome
1	AI-based diagnostic observation	Skills map; error detection; level tagging; gap identification	Clear baseline needs and deficiencies
2	AI-assisted problem & research question generation	scenario building; question suggestions; complexity adaptation	Individualized inquiry tasks per student teacher
3	AI-supported data capture	transcription; activity logging; reaction analysis; clustering	Systematic, evidence-rich dataset
4	AI-driven analytical processing	coding support; error clustering; cognitive load estimation; comparisons	Evidence-based justification of findings
5	AI-assisted reflective analysis	reflection prompts; evaluation of reflection depth; strengths/weaknesses mapping	Deeper, indicator-based reflection
6	Personalized development trajectory	level-based tasks; micro-modules; adaptive practice; difficulty tuning	Individualized methodological growth path
7	AI-based verification & validation	pre/post comparison; competence mapping; criteria checking	More objective validation of outcomes

Localization was not a surface translation of labels; it re-specified what counts as “problem,” “evidence,” and “appropriate methodological action” within Uzbek educational realities. Key localization features included culturally shaped classroom etiquette, feedback norms, social distance in teacher–student communication, expectations toward authority roles, and reliance on locally familiar materials and discourse templates.

Table 2. Localized EAR model for Uzbekistan

EAR stage	Localized meaning
Problem identification	Identifying learner needs and local constraints; mapping typical classroom discrepancies
Exploration	Analyzing national traditions, local resources, and school–community realities

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Action	Integrating innovations with Uzbek teaching practices and context-relevant pedagogy
Reflection	Evaluating outcomes through student/peer/parent perspectives and evidence artifacts
Re-action	Refining the lesson and strategy through integration of tradition + modern pedagogy

Table 3. Seven-Stage Implementation Mechanism (AI-Integrated)

Stage	Core activity	AI function	Pedagogical outcome
1. Identify problem	observe lessons; notice discrepancies	detects errors, passivity, breakdowns	problem is clearly formulated
2. Collect data	video/audio, student work, diagnostics	segments and classifies evidence	empirical base established
3. Empirical analysis	linguodidactic + cognitive + methodological analysis	dashboards, error maps, charts	deeper problem explanation
4. Reflective analysis	video reflection; peer review; e-portfolio	analyzes reflection indicators	reflective competence grows
5. Design solution	new exercises; multimodal tasks	generates differentiated tasks	innovative solution prepared
6. Pilot testing	trial lessons; monitoring	real-time assessment	effectiveness tested in practice
7. Correction	revise and optimize	re-diagnosis and comparison	optimized model produced

RESULTS. The findings of the study demonstrate that the integration of AI-supported inquiry mechanisms significantly enhanced the visibility, diagnosis, and resolution of methodological discrepancies in pre-service EFL teacher education. Across the participating institutions, AI analytics transformed what had previously been impressionistic classroom observations into measurable and traceable pedagogical patterns. Recurring discrepancies were consistently identified across sites. These included mismatches between task difficulty and learners’ proficiency levels, uneven participation distribution in communicative tasks—particularly during early-stage Zoom sessions—imbalanced use of multimodal resources resulting either in

cognitive overload or insufficient scaffolding, recurrent linguistic errors (grammatical, lexical, and phonological) associated with weaknesses in task design, and communication breakdowns during pair or group activities caused by unclear instructions and limited modeling.

The AI-supported diagnostic tools, including error mapping, engagement analytics, and log-based tracking, enabled systematic categorization of these discrepancies. Instead of relying solely on subjective interpretation, pre-service teachers were able to examine concrete data reflecting learner participation patterns, task completion time, frequency of repeated errors, and interaction dynamics. This evidence-based perspective significantly improved their analytical accuracy and pedagogical awareness.

Following several iterative cycles of inquiry and intervention, measurable growth was observed in evidence-based lesson design practices. Pre-service teachers increasingly justified their methodological decisions using empirical indicators such as AI-generated error maps, rubric-based evaluations, and participation analytics. Lesson planning evolved from intuition-driven structuring to data-informed sequencing. In particular, task progression began to follow a clearer scaffolded trajectory aligned with Zone of Proximal Development (ZPD) principles, moving from guided support to freer communicative production. Grammar instruction blocks were redesigned on the basis of identified error clusters rather than generalized assumptions about learner needs. Furthermore, AI-supported task generation enabled differentiation for mixed-level learners, allowing instructional adaptation without compromising communicative goals.

A notable transformation was observed in the development of reflective practitioner competence. Reflective journals and video-reflection artifacts demonstrated increasing analytical depth across cycles. Initially, reflections were largely descriptive, focusing on recounting classroom events. Over time, however, reflections became interpretive, identifying underlying causes of observed issues. Ultimately, they evolved into action-oriented analyses, specifying concrete changes, testing strategies, and criteria for evaluating effectiveness in subsequent cycles. Peer-review processes further strengthened methodological discourse, feedback precision, and collaborative inquiry norms among participants.

Cross-site implementation confirmed the adaptability and transferability of the model. Although the nature and frequency of methodological discrepancies varied depending on institutional context, resource availability, learner characteristics, and communication norms, the underlying AI-integrated inquiry logic remained stable. The cyclical process of diagnosing, testing, reflecting, and refining functioned effectively across diverse educational settings. This demonstrates that while pedagogical

manifestations are context-sensitive, structured AI-supported inquiry offers a consistent framework for methodological development.

DISCUSSION

The findings reinforce the theoretical premise that methodological competence is most effectively developed through iterative, inquiry-based practice rather than through lecture-centered transmission of pedagogical theory. The AI integration did not replace reflective pedagogy but significantly strengthened its precision and efficiency. Three interrelated processes were notably accelerated.

First, diagnostic accuracy improved. Automated error detection, engagement metrics, and participation tracking reduced reliance on subjective interpretation and enabled rapid identification of instructional weaknesses. Second, reflective processes became more structured and evidence-linked. Indicator-based prompts and AI-supported visualization tools encouraged deeper interpretation rather than superficial description. Third, pedagogical decision-making became increasingly data-driven. Lesson redesign, task modification, and scaffolding adjustments were grounded in measurable discrepancies rather than intuition alone.

Localization played a critical role in strengthening practical relevance. By embedding the inquiry cycle within Uzbek classroom discourse norms, culturally shaped teacher–student interaction patterns, and institutional realities, the model ensured contextual alignment. This enhanced feasibility, acceptance, and sustainability of methodological innovations. In blended learning formats, additional layers of analytics—particularly Zoom engagement statistics and screen recordings—provided nuanced insight into interaction dynamics and communicative distribution patterns, allowing targeted corrective interventions.

Overall, the integration of AI into the inquiry cycle fostered a shift in professional identity. Pre-service teachers increasingly positioned themselves not merely as implementers of methodological prescriptions but as reflective practitioners and practitioner-researchers capable of systematic pedagogical improvement.

CONCLUSION AND IMPLICATIONS

This study proposes an AI-integrated, localized inquiry-based methodology as a scalable framework for strengthening pre-service EFL teachers' methodological competence in Uzbekistan. By combining cyclical pedagogical inquiry with AI-supported diagnostics and analytics, the model enabled systematic identification of methodological discrepancies, evidence-based lesson redesign, and sustained reflective growth. The intervention facilitated the development of teacher-researcher identity, reinforced data-informed decision-making, and enhanced adaptive instructional competence across diverse institutional contexts.

The practical implications are substantial. Teacher education programs should integrate structured inquiry cycles into methodology modules, institutionalize e-

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portfolio systems and peer-observation routines, and employ AI analytics ethically for formative diagnostic purposes. Furthermore, multi-site collaboration among teacher education institutions can facilitate comparative analysis of context-specific discrepancies and promote shared methodological innovation.

LIMITATIONS AND FUTURE RESEARCH

Despite its strengths, the study presents certain limitations. Variability in institutional infrastructure, differences in instructor facilitation styles, and inconsistent familiarity with AI tools across sites may have influenced implementation outcomes. Additionally, while qualitative and analytic indicators demonstrated substantial growth, future research should incorporate validated quantitative instruments to measure gains in methodological competence more precisely. Controlled comparative studies examining AI-integrated inquiry against conventional methodology instruction would provide stronger causal evidence. Further investigation is also needed to refine ethical frameworks for managing AI-generated log data and classroom recordings. Longitudinal research tracking participants into teaching practicum and early-career phases would offer valuable insight into the durability of inquiry-based methodological competence.

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