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Designing an In-Service Training Model for Teachers in the Iranian Education System

ABSTRACT

This study aimed to design a comprehensive in-service teacher training model for the Iranian education system to identify the key dimensions, components, and operational pathways for effective professional development. This qualitative research employed a grounded theory approach. Data were collected through 21 semi-structured interviews with teachers, school administrators, and educational experts, as well as an analysis of in-service training program documents. The data were analyzed using open, axial, and selective coding to extract major categories and design the theoretical model. Findings: The results indicated that the in-service teacher training model functions as an integrated, five-dimensional system: causal/antecedent conditions (intelligent professional needs assessment), contextual/background conditions (learner-oriented organizational support and educational digital inclusion), intervening conditions (smart digital learning and educational artificial intelligence literacy), strategic/interactive conditions (advanced pedagogical design and innovative intelligent methods), and consequential conditions (sustainable professional development, intelligent educational evaluation, and networked professional participation). The central axis of the model, “Intelligent Management of In-Service Training,” integrates all dimensions into a coherent and interactive framework, enhancing training effectiveness, teacher engagement, and organizational learning. The findings confirmed the central role of “Intelligent Management of In-Service Training” as the final conceptual framework. This five-dimensional model, tailored to the Iranian context, provides a practical, evidence-based tool for planning, implementing, and evaluating in-service training, offering scientific guidance for policymakers, administrators, and future research in teachers’ professional development.

Keywords: Design; Grounded theory; Iran; In-service teacher training; Model

Introduction

The accelerating transformation of educational systems in the twenty-first century has fundamentally reshaped expectations placed upon teachers, positioning continuous professional development as a central pillar of educational quality, innovation, and sustainability. Rapid technological advancement, shifting pedagogical paradigms, and the increasing complexity of learner needs have collectively rendered initial teacher education insufficient for sustaining professional competence throughout a

teaching career. As a result, in-service teacher training has emerged as a strategic mechanism through which educational systems attempt to maintain instructional effectiveness, support teacher well-being, and ensure alignment between classroom practices and evolving societal demands. Contemporary scholarship consistently emphasizes that teacher learning must be understood as a lifelong process rather than a discrete preparatory phase, requiring structured opportunities for reflection, skill acquisition, and professional renewal (1). Within this perspective, in-service training is no longer viewed merely as supplementary professional activity but as an essential component of systemic educational reform.

Historically, in-service teacher training programs were designed primarily to transmit new curricular guidelines or policy directives; however, modern conceptualizations emphasize transformative professional learning grounded in collaboration, reflective practice, and contextual adaptation. Studies have shown that effective programs extend beyond episodic workshops and instead promote sustained engagement, mentoring relationships, and school-embedded learning communities that facilitate continuous improvement (2). The shift toward sustained professional learning ecosystems reflects growing recognition that teaching expertise evolves through iterative cycles of practice, feedback, and professional dialogue. Transformative pedagogical initiatives such as school-based in-service training models have demonstrated the capacity to reshape instructional practices and improve learning outcomes by integrating professional development directly into classroom realities (3). Consequently, the success of educational reform increasingly depends on the quality and responsiveness of in-service training systems.

Despite widespread acknowledgment of their importance, many in-service training programs continue to face persistent challenges related to effectiveness, relevance, and teacher engagement. Teachers frequently report that training sessions are disconnected from practical classroom needs, overly theoretical, or insufficiently responsive to contextual constraints. Research exploring teachers' lived experiences highlights feelings of frustration arising from standardized training models that overlook local educational realities and individual professional trajectories (4). Phenomenological investigations further reveal structural challenges such as limited follow-up support, inadequate needs assessment, and lack of teacher participation in program design (5). These findings suggest that improving training outcomes requires rethinking not only program content but also governance structures, implementation processes, and evaluation frameworks.

Evaluation has therefore become a central concern in contemporary discussions of in-service teacher education. Scholars increasingly employ systematic evaluation models to assess program effectiveness and ensure alignment between intended objectives and actual outcomes. The application of comprehensive evaluation frameworks such as the Context–Input–Process–Product (CIPP) model has enabled more holistic analysis of training programs by examining environmental conditions, resource allocation, implementation quality, and learning impacts simultaneously (6). Diagnostic analyses grounded in such models reveal that many programs fail not because of inadequate resources but due to misalignment between teacher needs, institutional expectations, and pedagogical strategies (7). Consequently, evidence-based evaluation has become indispensable for designing adaptive and responsive professional development systems.

Teacher motivation represents another decisive factor influencing participation and learning outcomes in professional development initiatives. Empirical studies identify low motivation as a recurring obstacle, often linked to perceived irrelevance of training content, excessive workload, lack of incentives, and limited institutional recognition of professional learning achievements (8). When teachers view training programs as bureaucratic obligations rather than opportunities for growth, participation becomes passive and learning outcomes diminish. Conversely, programs that foster professional autonomy, collaboration, and practical applicability tend to generate stronger engagement and sustained behavioral change. Understanding motivational dynamics is therefore critical for enhancing program effectiveness and ensuring meaningful professional learning experiences.

The integration of digital technologies has further transformed the landscape of in-service teacher training. Digital competency development has become a core objective as educators increasingly operate within technology-rich learning environments. Research demonstrates that targeted in-service programs significantly enhance teachers' digital literacy and capacity to implement innovative instructional methods aligned with contemporary educational demands (9). The expansion of cloud-based training infrastructures has enabled scalable professional learning models capable of overcoming geographical and logistical barriers while facilitating collaborative knowledge sharing (10). These developments illustrate how technological innovation can reshape professional development delivery mechanisms and expand access to high-quality training opportunities.

Artificial intelligence represents the most recent frontier in teacher professional development. Emerging research highlights AI's transformative potential to personalize training pathways, provide adaptive feedback, and support data-driven instructional decision-making (11). Studies examining teachers' perceptions of AI education reveal both enthusiasm and uncertainty, underscoring the necessity of structured training programs that build technological confidence alongside pedagogical competence (12). The integration of AI into in-service training also introduces new pedagogical possibilities, including intelligent tutoring systems, automated assessment analytics, and personalized professional learning environments. However, effective implementation depends on institutional readiness and teachers' willingness to engage with emerging technologies.

Online and blended learning formats have likewise expanded opportunities for professional development, particularly in contexts where traditional face-to-face training is limited. Evaluations of online in-service training programs indicate positive outcomes in terms of teacher satisfaction, knowledge acquisition, and flexibility of participation (13). Massive Open Online Courses (MOOCs) have emerged as scalable solutions capable of delivering professional learning to large populations of educators while supporting self-paced engagement (14). These developments highlight a broader shift toward learner-centered professional development models that prioritize accessibility, personalization, and continuous engagement over centralized training structures.

Nevertheless, technological expansion alone does not guarantee effectiveness. Research examining compulsory professional development programs reveals divergent teacher attitudes, with some educators perceiving mandatory training as valuable professional investment while others regard it as inefficient or disconnected from classroom realities (15). Policy implementation studies further demonstrate that inconsistencies in administrative support and resource allocation can undermine training objectives despite well-designed program frameworks (16). These findings underscore the importance of aligning policy, institutional culture, and professional learning design to ensure meaningful outcomes.

The professional growth dimension of in-service training remains a central justification for continued investment in teacher development initiatives. Empirical evidence shows that participation in structured training programs contributes to improved pedagogical competence, instructional innovation, and reflective teaching practices (17). In addition to enhancing classroom performance, professional development initiatives contribute to teacher identity formation and career sustainability, reinforcing teachers' sense of professional efficacy. The linkage between professional growth and educational quality suggests that effective in-service training operates simultaneously at individual, institutional, and systemic levels.

Teacher well-being has recently emerged as a critical yet previously overlooked outcome of professional development programs. Contemporary research demonstrates that targeted in-service interventions, particularly those addressing classroom management and emotional resilience, can significantly enhance teachers' psychological well-being and reduce occupational stress (18). Given the increasing prevalence of teacher burnout worldwide, integrating well-being considerations into professional development design represents a significant paradigm shift. Rather than focusing exclusively on instructional competence, modern programs increasingly adopt holistic approaches that support teachers as professionals and individuals.

International comparative research reveals that contextual adaptation remains essential for successful implementation of in-service training. Cultural, institutional, and policy differences shape how professional development initiatives are perceived and enacted across educational systems. Studies conducted in diverse educational contexts demonstrate that localized program design improves relevance, ownership, and sustainability (19). Such findings highlight the importance of contextual sensitivity when transferring training models across regions or educational systems, emphasizing the need for flexible frameworks capable of responding to local conditions while maintaining global quality standards.

Theoretical developments in adult learning further inform contemporary approaches to in-service teacher education. Integrated pedagogical, andragogical, and heutagogical frameworks emphasize self-directed learning, reflective inquiry, and learner autonomy as essential components of effective professional development (20). These frameworks recognize teachers as adult learners whose professional growth depends on active participation rather than passive knowledge reception. When training programs align with adult learning principles, teachers are more likely to internalize new practices and sustain long-term professional change.

Despite decades of reform efforts, persistent structural problems continue to limit the effectiveness of many in-service training initiatives. Teachers often encounter logistical barriers, insufficient differentiation, and lack of ongoing support mechanisms that hinder learning transfer to classroom practice. Investigations into teachers' experiences as learners reveal systemic tensions between administrative expectations and authentic professional learning needs (21). Addressing these tensions requires reconceptualizing professional development as a collaborative process involving policymakers, school leaders, and teachers themselves.

The emergence of dynamic and technology-enhanced training models offers promising pathways for addressing longstanding limitations. Computer-based scaffolding systems have demonstrated the capacity to personalize learning trajectories and support sustained skill development within virtual training environments (22). Similarly, mentorship-based approaches promote continuous professional learning by embedding support structures within everyday teaching practice (2). These innovations signal a transition toward adaptive professional development ecosystems capable of responding to evolving educational challenges.

In addition to technological and structural considerations, educational researchers increasingly emphasize the importance of systemic integration between professional development initiatives and broader educational reform agendas. In-service training programs that operate in isolation from curriculum reform, assessment policies, or institutional leadership structures often fail to achieve meaningful impact. Studies highlight the necessity of aligning training objectives with organizational priorities and long-term educational strategies to ensure sustainability (17). Such alignment transforms professional development from a peripheral activity into a central driver of educational transformation.

Moreover, contemporary discussions increasingly frame in-service teacher training as a mechanism for fostering innovation, equity, and resilience within educational systems. As global education confronts challenges such as technological disruption, demographic change, and shifting labor market demands, teachers require continuous opportunities to update pedagogical knowledge and develop adaptive competencies. Digital transformation, AI integration, mentorship systems, and context-responsive program design collectively represent interconnected dimensions of modern professional development frameworks (9, 11). Understanding how these dimensions interact remains a critical research priority.

Taken together, existing literature demonstrates that in-service teacher training constitutes a multifaceted phenomenon shaped by pedagogical theory, technological innovation, organizational culture, policy frameworks, and teacher agency. While substantial progress has been achieved in designing innovative training models, persistent gaps remain regarding effectiveness

evaluation, motivational engagement, contextual adaptation, and long-term professional impact. Addressing these gaps requires comprehensive investigation integrating theoretical insight with empirical evidence drawn from diverse educational contexts.

Therefore, the aim of this study is to examine the effectiveness, challenges, and developmental dimensions of in-service teacher training programs by analyzing their structural characteristics, implementation processes, and outcomes for teachers' professional competence and well-being.

Methods and Materials

Research Type

The present study is qualitative, employing an exploratory grounded theory approach, aimed at designing and validating an in-service teacher training model for the Iranian education system. This research type allows the researcher to deeply analyze participants' experiences and perspectives, identify patterns and influential components in teachers' professional development, and propose a conceptual model aligned with the needs of the national education system (23-25).

Population and Sample

The qualitative phase involved three main groups. The first group consisted of teachers from various grades and disciplines, providing practical and realistic insights into factors affecting the effectiveness of in-service training. The second group included school administrators, whose executive and supervisory roles gave them awareness of managerial capacities and facilitating or inhibiting factors in program implementation. The third group comprised educational experts, including university faculty, researchers, and curriculum specialists, offering specialized and theoretical perspectives on designing and validating training models. Selecting these groups aimed to achieve a comprehensive and multidimensional understanding of the needs and capacities of in-service training systems.

Purposeful non-probability sampling was used, with participants selected based on professional experience and expertise. Sample size was determined according to the principle of theoretical saturation, continuing until new data no longer added information and themes reached stability (26-28). Ultimately, 21 participants were included: 7 teachers, 7 administrators, and 7 experts. Inclusion criteria required relevant experience and at least a master's degree for teachers and administrators and a doctorate for experts. Participants lacking relevant experience or providing incomplete data were excluded.

Data Collection

Data were collected through semi-structured interviews and document analysis. The interviews were designed based on theoretical foundations and literature review and included open-ended, probing, and exploratory questions to elicit participants' in-depth perspectives. Interviews were recorded and transcribed with participants' informed consent. Document analysis of in-service training program materials enriched the data and allowed for the comparison of field findings with existing documentation (25, 29, 30).

Validity and Reliability

To enhance validity and reliability, criteria of trustworthiness, transferability, dependability, and confirmability were followed, with data coded independently by two coders (31). Cohen's kappa coefficient was reported at 0.850, indicating excellent agreement and high reliability.

Data Analysis

The research procedure included designing the interview protocol, selecting purposive participants, conducting and recording interviews, researcher note-taking, analyzing documents, and coding data in three stages: open, axial, and selective coding (23, 24). Data analysis followed grounded theory methodology based on Strauss and Corbin (1996). Analysis was conducted concurrently with data collection to facilitate the identification of components and influential patterns. Steps

included reviewing interview texts and extracting initial concepts, integrating and organizing similar categories, identifying relationships and attributes in axial coding, and determining central categories to design the theoretical model of in-service teacher training (25, 32).

Findings and Results

The research data were analyzed using a grounded theory approach based on Strauss and Corbin's (1996) model. Data were collected through semi-structured interviews with 21 participants, including teachers, school administrators, and experts in the field of education. The unit of analysis was the interview texts. Theoretical sampling was employed, and the analysis was conducted in three stages: open, axial, and selective coding.

In the initial open coding stage, 90 initial concepts were extracted from the data through line-by-line examination of the interview transcripts. In the secondary (focused) open coding stage, similar concepts were grouped into 30 major categories, including teacher skill gap analysis, data-driven instructional prioritization, forecasting future professional needs, designing adult learning-based training, enhancing self-directed learning, interactive instructional structure, digital learning infrastructure, personalized learning with artificial intelligence, interactive virtual learning, blended learning implementation, educational scenario simulation, adaptive learning with artificial intelligence, teaching competency enhancement, professional reflection reinforcement, continuous professional learning, monitoring the instructional process, course effectiveness analysis, data-driven feedback, supportive educational policies, provision of learning resources, organizational learning culture, professional coaching, teacher learning networks, collaborative teaching, equitable digital access, inclusive education, reducing technological gaps, understanding AI concepts, educational application of AI, and ethical considerations in AI.

In the axial coding stage, these 30 major categories were further grouped into 10 core categories: intelligent professional needs assessment, advanced pedagogical design, smart digital learning, innovative intelligent methods, sustainable professional development, smart educational evaluation, learner-oriented organizational support, networked professional participation, digital educational inclusion, and educational AI literacy.

In the selective coding stage, the core categories were integrated into the final core category of "Intelligent Management of In-Service Teacher Training," which includes five dimensions: causal/conditional factors (intelligent professional needs assessment), contextual/background factors (learner-oriented organizational support and digital educational inclusion), intervening factors (smart digital learning and educational AI literacy), strategic/interactive factors (advanced pedagogical design and innovative intelligent methods), and consequential factors (sustainable professional development, smart educational evaluation, and networked professional participation). The reconstructed major and core categories are presented in Table 1.

Table 1. Reconstructed Major and Core Categories

No.	Major Categories	Core Categories	Category Type
1	Teacher skill gap analysis, data-driven instructional prioritization, forecasting future professional needs	Intelligent professional needs assessment	Causal / Conditional dimension
2	Designing adult learning-based training, enhancing self-directed learning, interactive instructional structure	Advanced pedagogical design	Strategic / Interactive dimension
3	Digital learning infrastructure, personalized learning with artificial intelligence, interactive virtual learning	Smart digital learning	Intervening / Conditional dimension
4	Blended learning implementation, educational scenario simulation, adaptive learning with artificial intelligence	Innovative intelligent methods	Strategic / Interactive dimension
5	Teaching competency enhancement, professional reflection reinforcement, continuous professional learning	Sustainable professional development	Consequential dimension
6	Monitoring the instructional process, course effectiveness analysis, data-driven feedback	Smart educational evaluation	Consequential dimension
7	Supportive educational policies, provision of learning resources, organizational learning culture	Learner-oriented organizational support	Contextual / Background dimension

8	Professional coaching, teacher learning networks, collaborative teaching	Networked professional participation	Consequential dimension
9	Equitable digital access, inclusive education, reducing technological gaps	Digital educational inclusion	Contextual / Background dimension
10	Understanding AI concepts, educational application of AI, ethical considerations in AI	Educational AI literacy	Intervening / Conditional dimension

Based on Table 1, the data indicate that the in-service teacher training model in Iran operates as an integrated, five-dimensional system. In the causal/antecedent conditions dimension, the core category of “Intelligent Professional Needs Assessment” serves as the primary driver of training and determines the real priorities and needs of teachers. Skill gap analysis and forecasting of future professional needs shape the design and planning of training programs and provide the basis for subsequent decision-making.

The contextual conditions dimension provides the necessary environment for the implementation of training. Categories such as “Learner Organizational Support” and “Educational Digital Inclusion,” together with supportive policies, resource provision, organizational learning culture, and equal digital access, establish the environmental and organizational conditions required for successful training implementation.

In the intervening conditions dimension, categories such as “Intelligent Digital Learning” and “Educational Artificial Intelligence Literacy” function as tools and intervening factors, facilitating training implementation and enhancing its effectiveness by providing digital infrastructure, interactive virtual learning, and technology skill development.

The strategic/interactive dimension includes the categories of “Advanced Pedagogical Design” and “Innovative Intelligent Methods,” which define the operational and strategic pathways of the training programs. Training designed based on adult learning principles, interactive structures, and real-life simulation systematically and effectively guides program implementation and teacher interactions.

Finally, the outcome dimension comprises categories such as “Sustainable Professional Development,” “Intelligent Educational Evaluation,” and “Professional Network Participation,” reflecting the long-term results and effects of in-service training. These categories present tangible and valuable outputs of the model, including enhanced teaching competence, continuous professional learning, program effectiveness analysis, and networked teacher interactions.

This five-dimensional structure demonstrates that the in-service training model functions as a coherent and continuous flow: intelligent needs assessment acts as the initial driver, the environment and technology serve as facilitators, educational strategies determine the implementation path, and the outcomes reveal the actual impact of the model on teachers’ professional development and organizational learning.

Based on comparative and integrative analyses, the final core category of the study, “Intelligent Management of In-Service Training,” was selected as the central axis of the model. It consolidates all extracted core and major categories from the data analysis into a coherent and explanatory framework, representing the integration and alignment of different dimensions of in-service training and providing a foundation for coordinated, intelligent, and effective planning, implementation, and evaluation of training programs.

From the perspective of grounded theory, the core category “Intelligent Management of In-Service Training” explains the complex relationships among causal, intervening, contextual, strategic, and outcome dimensions. Specifically, the causal dimension, including “Intelligent Professional Needs Assessment,” provides the primary basis for designing training. The intervening dimension, including “Intelligent Digital Learning” and “Educational Artificial Intelligence Literacy,” highlights the supporting tools and technologies. The contextual dimension, including “Learner Organizational Support” and “Educational Digital Inclusion,” defines the environment and organizational infrastructure necessary for effective learning.

The strategic/interactive dimension, with the core categories “Advanced Pedagogical Design” and “Innovative Intelligent Methods,” identifies practical methods and strategies to enhance interaction, participation, and learner engagement. Finally, the outcome dimension, including “Sustainable Professional Development,” “Intelligent Educational Evaluation,” and “Professional Network Participation,” reflects the results and achievements of training while providing continuous feedback for process improvement.

Figure 1 illustrates the in-service teacher training model in Iran as an intelligent, integrated system, with the final core category “Intelligent Management of In-Service Training” at its center. The causal conditions, including Intelligent Professional Needs Assessment and its related major categories, serve as the main driver of the process. Contextual and intervening conditions provide the necessary environment and tools for implementation, strategic dimensions guide the operational path of training, and the outcome dimension delivers tangible results and valuable feedback.

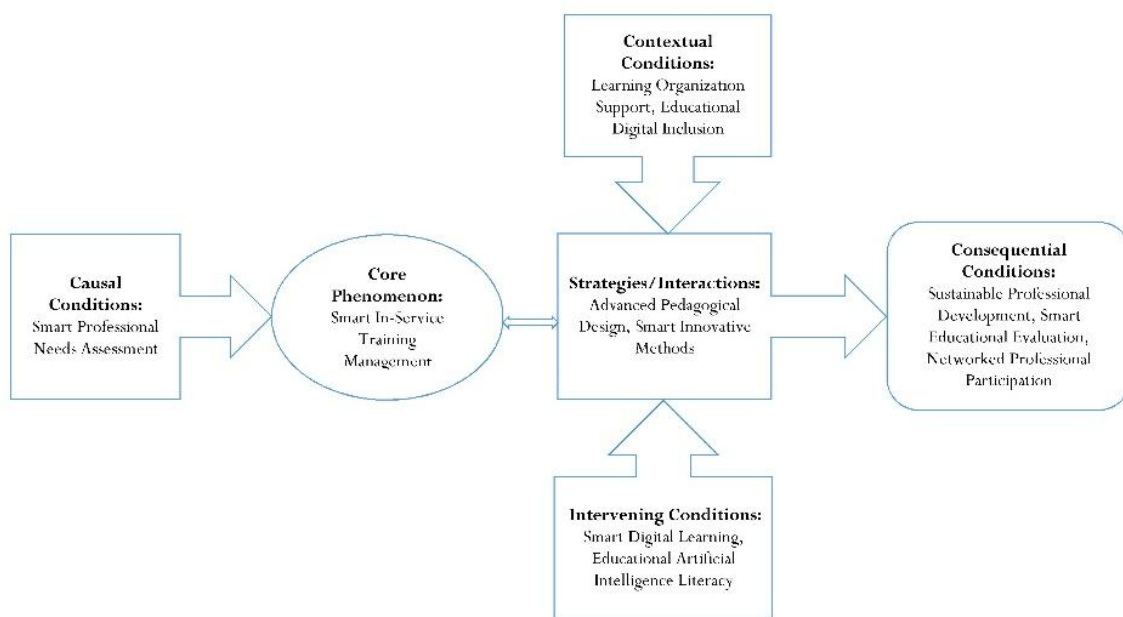


Figure 1. The In-Service Training Model for Teachers in Iran’s Education System as “Smart In-Service Training Management”

Discussion and Conclusion

The findings of the present study demonstrate that in-service teacher training programs play a multidimensional role in enhancing teachers’ professional competencies, instructional effectiveness, and psychological readiness for contemporary educational environments. The results indicated that participation in structured training initiatives significantly improved pedagogical knowledge, digital competencies, and classroom management skills among teachers. These findings align with research showing that sustained professional development strengthens teachers’ instructional performance and promotes continuous professional growth (17). The improvement observed in teaching practices suggests that well-designed in-service programs serve not merely as knowledge transmission mechanisms but as catalysts for professional transformation. Similar conclusions have been reported in studies emphasizing that continuous professional learning enhances teachers’ adaptability and enables them to respond effectively to evolving curricular and technological demands (1).

A major outcome of the study relates to the enhancement of teachers’ digital competencies following participation in training programs. Teachers demonstrated increased confidence in integrating educational technologies and digital tools into

instructional practice, confirming the growing importance of technology-oriented professional development. These results correspond with evidence indicating that in-service training focused on digital literacy significantly contributes to the development of modern teaching competencies required in technology-rich learning environments (9). Furthermore, the integration of technology-supported learning approaches reflects broader educational transitions toward digital transformation, where teachers must continuously update their competencies to remain effective facilitators of learning. The findings reinforce earlier studies emphasizing that cloud-based and digitally mediated training models expand accessibility and provide scalable opportunities for professional development (10).

Another significant finding concerns the positive relationship between in-service training participation and teacher motivation. Teachers reported higher levels of professional engagement and increased willingness to adopt innovative teaching methods after completing training programs. This result supports previous research identifying motivation as a critical determinant of professional learning outcomes. Studies examining teachers' participation behavior demonstrate that when training programs address authentic classroom needs and provide practical applicability, teachers perceive them as meaningful professional opportunities rather than administrative obligations (8). The present findings also suggest that motivational enhancement occurs when teachers experience autonomy, relevance, and recognition within training structures, consistent with evidence highlighting the importance of participatory program design and teacher involvement in professional learning processes (4).

The study further revealed that collaborative and mentorship-oriented training approaches significantly contributed to sustained professional learning. Teachers who participated in mentorship-based or school-embedded training reported stronger skill retention and greater confidence in implementing new pedagogical strategies. These results are consistent with research demonstrating that mentorship models foster continuous professional growth by embedding learning within daily teaching practice (2). Similarly, school-based training initiatives have been shown to transform teaching and learning by encouraging collaboration, peer reflection, and shared problem-solving among educators (3). The findings highlight the importance of moving beyond isolated workshops toward continuous professional learning communities.

The results also indicate that teachers' perceptions of training relevance strongly influence program effectiveness. Participants emphasized that contextual alignment between training content and classroom realities increased the likelihood of practical application. This observation aligns with phenomenological research revealing that teachers often disengage from programs perceived as disconnected from real teaching challenges (5). Moreover, context-sensitive training design has been identified as a key factor for ensuring program sustainability and professional ownership among educators (19). The present findings therefore reinforce the argument that successful professional development requires careful needs assessment and contextual adaptation.

Another notable outcome involves the impact of in-service training on teachers' well-being and professional resilience. Participants reported reduced stress levels and improved classroom confidence following training experiences that addressed classroom management and emotional competencies. These findings support research demonstrating that targeted professional development interventions contribute positively to teacher well-being and occupational satisfaction (18). By strengthening both instructional competence and emotional coping strategies, in-service training programs may serve as preventive mechanisms against teacher burnout, an increasingly significant concern within global education systems.

The effectiveness of online and blended learning formats emerged as an additional theme in the findings. Teachers highlighted flexibility, accessibility, and self-paced learning as major advantages of online professional development environments. These results corroborate studies showing that online training programs generate positive learning outcomes and high levels of participant satisfaction (13). The success of digital learning formats also corresponds with research demonstrating

the effectiveness of MOOC-based professional development models in expanding access to teacher training and supporting lifelong learning pathways (14). However, participants also emphasized the necessity of combining online learning with interactive and collaborative elements, echoing findings suggesting that technological solutions must be pedagogically grounded to achieve meaningful impact.

The study also confirmed the growing importance of artificial intelligence in shaping future teacher professional development. Participants expressed interest in AI-supported instructional tools while simultaneously identifying a need for structured guidance and training to effectively utilize such technologies. These findings align with research highlighting AI's transformative potential in teacher education, particularly through personalized learning pathways and data-driven instructional support (11). Teachers' cautious optimism regarding AI integration mirrors evidence showing that successful implementation depends on adequate preparation and confidence-building measures within training programs (12). Thus, professional development initiatives must evolve to include emerging technological competencies while addressing teachers' concerns regarding ethical and practical implications.

Despite positive outcomes, the findings revealed ongoing structural challenges affecting training effectiveness. Some participants perceived mandatory training requirements as burdensome when institutional support and incentives were insufficient. This observation corresponds with research demonstrating that obligatory professional development programs may generate resistance if teachers perceive them as time-consuming or disconnected from professional needs (15). Similarly, policy implementation studies highlight that inconsistencies in administrative coordination and resource allocation can weaken program outcomes even when policy intentions are sound (16). The findings therefore emphasize that institutional conditions play a decisive role in determining training success.

Evaluation mechanisms emerged as another critical factor influencing program effectiveness. Teachers reported that programs incorporating systematic evaluation and feedback processes produced more meaningful learning experiences. These results align with studies advocating comprehensive evaluation frameworks such as the CIPP model for diagnosing program strengths and weaknesses and ensuring continuous improvement (6). Diagnostic approaches integrating contextual analysis, implementation monitoring, and outcome assessment enable training designers to adapt programs dynamically and maintain relevance within changing educational environments (7).

The findings also highlight the importance of adult learning principles in shaping effective professional development. Training programs that encouraged self-directed learning, reflection, and experiential engagement produced stronger professional outcomes than lecture-based approaches. These results are consistent with theoretical models emphasizing pedagogical, andragogical, and heutagogical integration as foundations for optimal in-service training design (20). Teachers as adult learners require autonomy, practical relevance, and opportunities for collaborative inquiry, reinforcing the need for learner-centered training environments.

Finally, the study revealed persistent systemic barriers related to logistical constraints, insufficient follow-up support, and limited differentiation of training content. Teachers noted that uniform training models often failed to address diverse professional needs and experience levels. These findings mirror earlier research documenting challenges experienced by teachers as learners within standardized professional development structures (21). Addressing such barriers requires shifting toward flexible, adaptive, and personalized training ecosystems capable of accommodating professional diversity.

The present study is subject to several limitations that should be acknowledged when interpreting the findings. First, the research relied primarily on self-reported data, which may be influenced by participants' subjective perceptions and social desirability bias. Second, the study focused on a specific educational context, limiting the generalizability of results to other regions or educational systems with different institutional structures and policy environments. Third, the cross-sectional design

prevented examination of long-term impacts of in-service training on teaching performance and student outcomes. Additionally, variations in training program quality across institutions may have affected participant experiences, introducing uncontrolled contextual variables.

Future research should adopt longitudinal designs to investigate the sustained effects of in-service training on teacher professional growth, instructional innovation, and student achievement over extended periods. Comparative studies across different educational systems and cultural contexts would provide deeper understanding of contextual factors influencing training effectiveness. Researchers are also encouraged to explore the integration of artificial intelligence and adaptive learning technologies within professional development frameworks, particularly examining how personalized training pathways influence teacher motivation and competency development. Mixed-method approaches combining quantitative outcome measures with qualitative exploration of teacher experiences could generate richer insights into mechanisms of professional learning and organizational change.

Educational policymakers and training designers should prioritize needs-based program development grounded in systematic assessment of teachers' professional challenges. Institutions should shift from isolated workshop models toward continuous professional learning systems incorporating mentorship, collaboration, and reflective practice. Investment in digital infrastructure and AI-supported training platforms should be accompanied by pedagogical guidance and ongoing technical support to ensure effective adoption. School leaders should foster supportive organizational cultures that recognize professional development as an integral component of teaching practice rather than an administrative requirement. Finally, integrating teacher well-being, motivation, and professional autonomy into training design can enhance engagement, sustainability, and overall effectiveness of in-service teacher training initiatives.

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Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

All ethical principles were adhered in conducting and writing this article.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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