Innovative training management models for advancing teacher competence: A research-based framework for pedagogical development

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Abstract: The competence of teachers plays a vital role in improving the quality of education in the 21st century. This study explores the development and validation of an innovative training management model aimed at strengthening the pedagogical skills of elementary school teachers. Using the Plomp development model as a framework, the research involved 114 participants selected through purposive sampling. Data collection combined qualitative and quantitative methods, including normality tests, paired sample t-tests, and normalized gain (N-Gain) analysis. The findings indicate that the model is highly feasible, with expert validation scores exceeding 90% and positive feedback from users. Implementation of the model led to significant improvements in teachers' abilities to plan instruction, conduct educational activities, and integrate technology into learning. The N-Gain results categorized the training as highly effective. These outcomes suggest that the model provides a practical and sustainable approach to professional development. Further research is recommended to explore broader application and long-term impacts.

Keywords: Educational technology integration, Pedagogical development, Professional development, Teacher competence, Training management model.

1. Introduction

The quality of education is fundamentally shaped by the competence of teachers, who serve as key agents in curriculum implementation and pedagogical innovation [1-3]. As education systems evolve to meet the demands of the 21st century, the effectiveness of teacher training programs in enhancing pedagogical skills has become a focal point of educational research and policy discussions. Many countries have introduced comprehensive curriculum reforms to improve student outcomes, yet challenges persist in ensuring that teachers are adequately prepared to implement these changes effectively [4, 5]. Despite ongoing professional development initiatives, research indicates that teacher preparedness remains inadequate, with persistent difficulties in adapting to modern pedagogical approaches, integrating digital tools, and fostering critical thinking skills among students.

The successful implementation of educational reforms is contingent upon multiple interrelated factors, including school leadership, teacher innovation, student engagement, resource availability, and community involvement [6]. Among these, teacher competence plays a particularly crucial role, necessitating continuous professional development through structured and contextually relevant training programs. Effective training equips educators with the requisite skills to design, implement, and assess curriculum delivery, fostering improved student learning outcomes [7]. Furthermore, well-designed professional development initiatives enhance teachers' capacity to integrate technological advancements, address diverse student learning needs, and adapt to dynamic educational paradigms [8].

Despite the acknowledged benefits of teacher training, prevailing professional development models frequently fail to meet teachers' contextual needs. Many existing initiatives are characterized by top-

down approaches that prioritize policy dissemination over practical skill development [9]. This often results in training content that is misaligned with classroom realities, limiting its impact on teacher competence and long-term instructional effectiveness. Empirical evidence suggests that traditional training programs frequently lack participant engagement in the development of applicable pedagogical strategies, instead focusing on passive knowledge transfer without fostering meaningful learning experiences [10]. Consequently, many teachers struggle to translate theoretical training into practical, student-centered instructional methodologies.

The limitations of existing teacher training programs are further reflected in national and international teacher competency assessments. In many countries, evaluation metrics indicate that a substantial proportion of educators continue to perform below proficiency benchmarks, underscoring significant gaps in pedagogical competence. Research highlights that teachers often encounter challenges in curriculum implementation due to inadequate professional development support, further emphasizing the urgent need for training programs that effectively address pedagogical deficiencies and equip teachers with practical competencies aligned with contemporary educational demands [11].

One of the critical challenges in teacher training management is the ineffective planning, execution, and evaluation of professional development initiatives. Studies indicate that training schedules and resource allocations are often inconsistent with pedagogical priorities, leading to suboptimal training outcomes. While formal training agendas may be structured, their execution frequently deviates from intended objectives due to logistical constraints, administrative inefficiencies, and inadequate financial support [12]. Additionally, the absence of sustained engagement mechanisms, such as mentorship programs, peer collaboration networks, and iterative feedback loops, diminishes the long-term effectiveness of teacher training, leading to skill regression over time [13].

Addressing these challenges necessitates the development of innovative training management models that prioritize contextual learning, experiential pedagogy, and sustained professional development. Research suggests that inductive training paradigms, which emphasize experiential learning and collaborative problem-solving, offer a promising alternative to conventional deductive models that rely heavily on knowledge dissemination. By aligning training content with teachers' specific classroom challenges, these models foster deeper engagement, practical skill application, and enhanced pedagogical competence [14].

Furthermore, the integration of technology within professional development programs has emerged as a critical component in modern teacher training strategies. Digital platforms, interactive learning environments, and adaptive educational technologies have been shown to enhance teacher engagement and instructional effectiveness when implemented within well-structured training frameworks [15]. However, mere exposure to digital tools is insufficient—training programs must also incorporate strategies for improving teachers' digital literacy and provide continuous support to ensure effective technological integration in instructional practice.

Beyond individual teacher development, effective training programs contribute to broader institutional and systemic improvements. Research highlights their positive impact on school productivity, decision-making efficacy, instructional innovation, and overall educational quality [16]. Moreover, well-structured professional development initiatives enhance teacher motivation, resilience, and collaborative learning, fostering a culture of continuous improvement within educational institutions [17]. However, despite these potential benefits, many conventional training programs continue to exhibit structural deficiencies that hinder their long-term sustainability and practical applicability.

Therefore, this study aims to undertake a comprehensive analysis of existing teacher training models, examining their effectiveness in equipping educators with relevant pedagogical competencies. Additionally, it seeks to explore alternative training management frameworks that integrate contextual, experiential, and technology-enhanced learning approaches to address the limitations of conventional professional development initiatives. By identifying key factors influencing teacher training efficacy, this

study contributes to the ongoing discourse on optimizing professional development strategies to enhance educational quality on a global scale.

The findings of this research will provide valuable insights for policymakers, education practitioners, and institutional leaders in designing and implementing evidence-based teacher training programs that align with contemporary pedagogical demands. As education systems continue to evolve, ensuring that teachers receive high-quality, contextually relevant professional development will be crucial in shaping the future of learning and fostering sustainable educational advancement worldwide.

2. Literature Review

2.1. Training Management for Teacher Competence Development

Effective training management ensures that professional development programs are strategically planned, implemented, and evaluated to enhance teacher competence. Within educational institutions, structured training management fosters pedagogical innovation, strengthens instructional quality, and promotes adaptability in dynamic learning environments [6]. Research highlights that well-designed training programs improve teacher motivation, leadership capacity, and instructional effectiveness, contributing to overall school performance [7]. Teacher training is guided by four key management principles: planning, organizing, leading, and evaluating. Planning aligns training objectives with curriculum standards and professional needs [8]. Organizing ensures efficient resource allocation, including digital tools and instructional materials, fostering a productive learning environment. Leadership within training management plays a vital role in motivating teachers and promoting collaborative learning communities that encourage continuous professional growth. Lastly, evaluation mechanisms track training effectiveness, refining strategies to enhance long-term teacher competency [9]. Traditional training models often emphasize theoretical knowledge without practical application, limiting their impact on teacher effectiveness [10]. Research supports experiential learning approaches, such as blended learning, classroom simulations, and mentorship programs, which enhance engagement and instructional adaptability [11].

Digital transformation has further revolutionized professional development, integrating interactive learning platforms, real-time assessment tools, and adaptive teaching technologies into training models [12]. However, effective implementation requires structured digital literacy training and ongoing support to maximize impact. Systematic evaluation is essential for sustaining professional development outcomes. Schools that integrate data-driven assessment models within training programs demonstrate higher instructional consistency and improved student engagement [13]. Research suggests that embedding professional learning communities and mentorship frameworks fosters long-term instructional improvement and teacher collaboration. Additionally, aligning training programs with institutional development strategies ensures that professional growth is not isolated but contributes to holistic school advancement [14]. Innovative training management models must prioritize contextual relevance, experiential pedagogy, and technology integration to enhance teacher competence. Future research should focus on scalable, evidence-based frameworks that sustain professional development in evolving educational landscapes. As teaching demands shift, strategic training management remains crucial in fostering effective, student-centered learning environments.

2.2. Indicators of Training Management

Effective training management plays a crucial role in enhancing teacher competencies and ensuring high-quality education. Key indicators of successful training programs include: (1) training content: the curriculum should be aligned with national education standards and updated regularly to meet contemporary educational demands [15], (2) instructional methods: effective training employs diverse pedagogical approaches that cater to various learning styles, improving engagement and retention [16] (3) trainer expertise: the effectiveness of training depends significantly on instructors' pedagogical knowledge, subject expertise, and ability to facilitate learning effectively [17], (4) program duration: training sessions should provide ample time for both theoretical instruction and practical application to

ensure comprehensive knowledge transfer [18] (5) learning environment: adequate infrastructure, including classrooms, digital resources, and learning materials, is essential for optimal teacher training [19]. These indicators collectively contribute to the effectiveness of training programs, fostering an environment where teachers can thrive and, in turn, enhance student learning outcomes.

2.3. Defining Teacher Competence

Teacher competence refers to the essential skills, knowledge, and attitudes required for effective teaching. It involves pedagogical expertise, content mastery, and the ability to adapt to diverse classroom contexts [20]. Competent teachers are reflective practitioners who continuously seek professional development and adapt their teaching methods based on evolving educational needs [9]. Research has shown that structured teacher education programs significantly improve teachers' ability to support student reflection skills, highlighting the importance of professional development [21].

2.4. Essential Competencies for Effective Teaching

To optimize student learning, teachers should develop the following core competencies: (1) learning management planning: designing and organizing instructional activities aligned with educational goals, (2) innovation in teaching: implementing creative and effective teaching strategies to improve student engagement and understanding [22] (3) lesson planning: developing structured lesson plans that include clear objectives, materials, and assessment methods, (4) assessment and evaluation: utilizing a variety of assessment tools to measure student progress and inform instructional decisions [23]. These competencies have been identified as critical for pre-service and in-service teachers, contributing to effective classroom management and improved student outcomes. By focusing on these areas, teacher training programs can better equip educators to meet modern classroom demands and enhance overall educational quality.

2.5. Pedagogical Competence of Elementary School Teachers in the Digital Era

Pedagogical competence, which encompasses knowledge, skills, and attitudes, is a crucial requirement for elementary school teachers, particularly in the digital era. Effective integration of digital tools into instructional strategies enhances student engagement and learning outcomes. However, research indicates that while teachers acknowledge the potential of educational technology, disparities exist in their ability to integrate these tools effectively, necessitating continuous professional development [24].

Teachers must be proficient in selecting digital tools that align with their instructional objectives while catering to diverse student needs. This competency extends beyond technical proficiency; it involves designing interactive and meaningful learning experiences. Moreover, assessing students' technological competencies allows teachers to create appropriate learning activities that challenge and support all learners [25].

The development of digital pedagogical competencies is essential for fostering other significant skills in the modern educational landscape, including effective communication, content creation, and student engagement. Teachers who integrate information and communication technology (ICT) into their pedagogy improve instructional quality and student outcomes [26]. The European framework for the digital competence of educators (DigCompEdu) provides a structured approach, outlining 22 competencies across six key areas to help educators assess and enhance their digital proficiency [27].

Furthermore, in today's rapidly evolving educational landscape, teachers must continuously develop their skills to effectively implement digital learning strategies. Research highlights that continuous professional development and institutional support significantly impact teachers' ability to adopt digital pedagogical practices successfully [28]. Schools must invest in structured training programs that equip teachers with the necessary digital competencies to meet the needs of 21st-century learners. As technology increasingly shapes education, elementary school teachers must continually enhance their pedagogical competencies. Effective integration of digital tools not only improves instructional practices

but also prepares students for a technologically interconnected world. Professional development programs and supportive institutional policies are essential to ensure teachers remain adaptable and well-equipped for the challenges of modern education.

2.6. The Development of a Training Management Model for Enhancing Teachers' Pedagogical Competence

The training management model is designed to enhance teachers' pedagogical competence through a structured and results-oriented approach. This model builds upon a factual framework previously implemented in the field, addressing its limitations while incorporating modern and effective management principles. The theoretical foundation of this model is based on Fayol's management theory, which emphasizes the four fundamental functions of management: planning, organizing, actuating, and controlling [20]. This framework facilitates the efficient allocation of resources and the systematic execution of training programs.

At the mid-level, the model is supported by human resource training management theory, which is a key component of human resource management (HRM). HRM is concerned with regulating workforce relationships and optimizing employee roles within an organization to achieve maximum efficiency and effectiveness. HRM as both a science and an art that governs workforce interactions to fulfill the objectives of organizations, employees, and society [29]. Furthermore, the primary aim of HRM is to ensure that organizations have motivated, high-performing individuals capable of adapting to change and fulfilling their responsibilities in accordance with legal standards [30]. Within this framework, training serves as a critical mechanism for skill enhancement, employing various methods such as classroom instruction, on-the-job training, and technology-based learning [31]. Effective training programs not only help employees address skill deficiencies but also improve morale and job satisfaction, reducing absenteeism and employee turnover. Moreover, well-designed training enables individuals to swiftly adapt to technological advancements and evolving job demands. This underscores the necessity of systematic training management, focusing on competency development as a key organizational asset. In the educational context, this model aims to strengthen teachers' pedagogical competencies through careful planning, structured implementation, and continuous evaluation. The approach integrates essential elements of reflective practice, goal-setting, effective execution, sustained support for educators, and rigorous assessment. By synthesizing these theoretical perspectives, the Training management model provides a comprehensive framework for teacher development, ensuring that pedagogical training is both impactful and sustainable.

2.6.1. Reflexive Learning

Reflective learning theory, also known as reflective learning, is an approach that enables individuals to actively evaluate their learning experiences [32]. This process involves critical thinking, encouraging learners to analyze and question information while drawing conclusions based on their observations and insights. Reflective learning serves as a fundamental cognitive process, fostering deeper understanding through inquiry and experiential engagement [33]. In the context of teacher training, an initial analysis of training needs is crucial to ensure that the programs implemented align with both teacher and student requirements. The process of conducting a needs assessment for managing teacher pedagogical competence training involves the following steps:

2.6.1.1. Problem Identification

The first step is to recognize the challenges teachers face in instruction and student facilitation. Issues may stem from deficiencies in knowledge, pedagogical skills, or instructional strategies. To diagnose these issues, a teacher competency test is administered, assessing professional and pedagogical competencies among elementary school educators in Karo Regency. Additionally, qualitative methods such as in-depth interviews with key stakeholders. Focus group discussions (FGDs) involving teachers, school principals, education authorities further refine the problem identification process. Model developers also participate to ensure a comprehensive approach in designing an effective training model.

2.6.1.2. Data Analysis

Once the issues are identified, the collected data is analyzed to determine specific training needs and establish the root causes of the challenges faced by teachers. This analysis informs the development of targeted interventions to enhance teacher pedagogical competence.

2.6.2. Goal Setting and Target Formulation

Goal-setting theory, pioneered by Edwin A. Locke in the 1960s and expanded with Gary Latham, underscores the significance of defining clear and specific objectives to enhance motivation and performance [33]. According to Locke and Latham, goals represent the desired achievements that drive actions: (a) determining training needs: the pedagogical training needs of teachers encompass curriculum development, instructional strategies, student assessment methods, and classroom management. These needs are identified through teacher performance evaluations, school leadership input, and teacher discussions, (b) defining training goals and objectives: based on identified needs, training objectives must be clearly formulated, measurable, and achievable within a specific timeframe (e.g., one semester or academic year), (c) Establishing success indicators: success criteria must be outlined to evaluate training effectiveness. Indicators may include improved student learning outcomes, increased classroom engagement, and enhanced teacher competency in instructional design, (d) planning follow-up actions: a structured follow-up plan ensures the continuity of learning post-training. This includes defining instructional strategies, developing training materials, selecting evaluation methods, and scheduling implementation.

2.6.3. Implementation of Training Programs

Implementation theory provides a framework for translating policies and programs into practical applications that yield measurable outcomes. Effective training implementation is contingent upon four critical factors: clear communication, consistent information dissemination, resource availability, and the commitment of program implementers [34]. Key stages in teacher training implementation include: (a) resource preparation: ensuring the availability of training venues, instructional materials, presentation tools, and communication equipment, (b) introduction to training content: familiarizing participants with training objectives and theoretical foundations, (c) instructional delivery: employing diverse teaching methodologies such as lectures, discussions, simulations, role-playing, and independent exercises to enhance engagement and retention, and (d) practical application: providing hands-on opportunities for trainees to practice and apply acquired knowledge through structured exercises and simulations.

2.6.4. Nursing as a Sustainable Development Approach

Nursing theory provides a conceptual foundation for understanding human adaptation to environmental changes and stressors. In the context of teacher training, this theory is instrumental in designing programs that equip educators with adaptive strategies for evolving curricular and policy requirements [35]. To maintain the effectiveness of training, post-training support mechanisms are implemented: (a) assignment-based application: assigning projects to reinforce skill application in real-world teaching scenarios, (b) coaching and mentoring: providing continuous professional guidance through teacher working groups to refine pedagogical competencies, and (c) advanced training programs: offering further training opportunities to deepen educators' expertise and extend learning beyond the initial program.

2.6.5. Assessment and Evaluation of Training Effectiveness

Evaluation is an integral component of training management, facilitating the measurement of effectiveness and skill acquisition among participants [36]. Training evaluation employs various methodologies: (a) teaching practice assessment: direct observation and feedback on instructional performance, (b) examinations and tests: evaluating theoretical understanding through written, oral,

and practical assessments, (c) peer assessment: gaining insights into classroom application through peer evaluations, and (d) self-evaluation: encouraging reflective practice among participants to identify strengths and areas for improvement.

3. Materials and Methods

This study employs a development research approach, specifically utilizing the Poudyal, et al. [37] model, which is widely recognized in research and development (R&D) for addressing educational challenges through systematic and structured methodologies [38]. The Plomp model consists of five distinct phases: preliminary investigation, design, realization (or construction), testing, assessment and revision, and implementation. These phases ensure a comprehensive framework for developing and evaluating educational interventions. Figure 1 illustrates the sequential stages of the Plomp model. The study involves a total of 114 participants, consisting of eight key respondents identified as qualified sources of information for this research, along with 100 Catholic religious education instructors teaching in primary schools within Karo regency, Indonesia. The selection of participants was based on purposive sampling to ensure the inclusion of individuals with relevant expertise and experience in the educational domain.

3.1. Data Analysis

The evaluation of the training management model is conducted through comprehensive data analysis. The refinement of research materials is guided by analytical findings, integrating both quantitative and qualitative descriptive approaches. Quantitative descriptive analysis involves the use of frequency distributions and percentages to interpret study outcomes, whereas qualitative descriptive analysis categorizes and structures data to provide a comprehensive representation of the research findings. To assess the effectiveness of the training management model, pretest and posttest data were collected and analyzed using SPSS (statistical product and service solutions) Version 22, with a significance level set at 95%. The following statistical techniques were employed in the data analysis:

Figure 1.
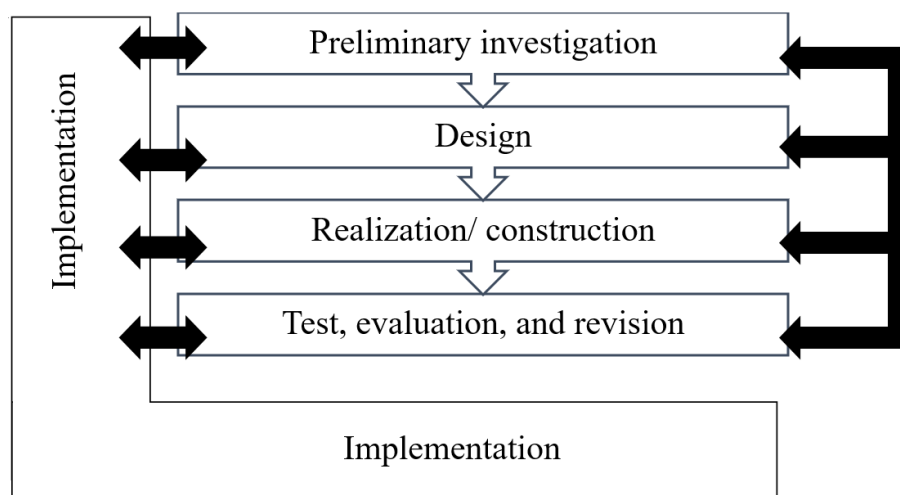Plomp development research model.
Source: Al-Kamzari and Alias [38].

3.1.1. Normality Test

The normality test is a fundamental prerequisite for statistical data analysis, conducted prior to further processing of the dataset. This test aims to determine whether the data distribution within a single variable follows a normal distribution. The Shapiro-Wilk test was applied to assess normality,

following the decision-making criteria outlined: if p-value > 0.05, the data are normally distributed, and if p-value ≤ 0.05, the data are not normally distributed [39]. Ensuring normality is critical, as statistical models assume normally distributed data for valid hypothesis testing.

3.1.2. Homogeneity Test

A homogeneity test was conducted to assess whether the variances among multiple populations were equivalent, ensuring that statistical comparisons remained valid. The Levene's test was employed, with the significance level set at α = 0.05, interpreted as follows, 2013:256): if p-value < 0.05, the population variances are not homogeneous, and if p-value > 0.05, the population variances are homogeneous [39]. Homogeneity testing ensures the reliability of statistical analyses by confirming uniformity in variance distribution across groups.

3.1.3. Paired Sample T-Test

To evaluate the effectiveness of the training model, a paired sample t-test was conducted. This statistical test determines whether there is a significant difference between the mean scores of two paired samples, typically measured before and after a specific intervention. In this study, pretest scores (before training) were compared with posttest scores (after training) to determine the impact of the training management model. The paired sample t-test assumes that if the training model is ineffective, the mean difference between pretest and posttest scores would be zero. The analysis was conducted using the following t-test formula [21].

The obtained t-value was compared against the t-table value at a 5% significance level to determine whether the training model had a statistically significant impact on pedagogical competence. Furthermore, the pretest and posttest scores were converted using standardized scoring guidelines to facilitate meaningful interpretation of the results. This structured methodological approach ensures a rigorous evaluation of the training management model, providing empirical evidence on its effectiveness in improving elementary school teachers' pedagogical competence.

Table 1.
Guidelines for converting pre-test and post-test scores.

Grade	Interval	Category
A	90 –100	Very good
B	80 –89	Good
C	$55 - 79$	Enough
D	40 –54	Less
E	0 - 39	Very poor

Source: Gronlunds [40].

3.1.4. Normalized Gain (N-Gain) Analysis

The normalized gain (N-Gain) is a quantitative metric used to assess the effectiveness of a particular instructional method or treatment in studies employing a *one-group pretest-posttest* design. This measure evaluates the proportion of potential improvement that was actually achieved by participants. According to Mouta, et al. [3] the normalized gain is calculated using the following formula:

$$N - Gain = \frac{Posttest\ score - Pretest\ score}{Ideal\ score - Pretest\ score}$$

This formula provides a normalized value that accounts for the initial proficiency level of the participant and the maximum possible score. The resulting N-Gain value can be interpreted either directly as a decimal value or in percentage form to determine the effectiveness of the intervention. The classification of N-Gain scores is essential for interpreting the level of learning gain achieved.

Table 2.
N-Gain score distribution based on value.

N-Gain value (g)	Category
g > 0.7	High
0.3 ≤ g ≤ 0.7	Moderate
g < 3	Low

As shown in Table 1, N-Gain values are divided into three categories: high (g > 0.7), moderate (0.3 ≤ g ≤ 0.7), and low (g < 0.3). These categories provide a quick reference to assess the effectiveness of the intervention based on raw N-Gain values. In addition to value-based categorization, the effectiveness of the intervention can also be evaluated using percentage interpretations of the N-Gain score. As presented in Table 3, an N-Gain percentage above 75% is categorized as effective, between 56–75% as quite effective, between 40–55% as less effective, and below 40% as not effective. This dual approach to categorization allows for both statistical precision and practical interpretation in educational research.

Table 3.
Categories of N-gain effectiveness interpretation.

Percentage	Interpretation
> 75%	Effective
56 − 75	Quite effective
40-55	Less effective
<40	Not effcetive

4. Results and Discussion

4.1. Results

4.1.1. Feasibility of the Teacher Training Management Model

4.1.1.1. Testing, Evaluation, and Revision Phase

This phase involved a series of systematic procedures including instrument validation and model validation, both of which were conducted through expert judgment. These activities served as part of the model feasibility assessment process by experts, followed by empirical feasibility testing with users in limited and expanded groups. The expert validation was aimed at assessing the alignment of the research instruments with the stated research objectives, as well as evaluating the functionality and usability of the training media. Subsequently, user-based feasibility testing was conducted to determine the appropriateness and practicality of the model's content and media for actual implementation.

4.1.1.2. Trial Phase

During this phase, comprehensive validation of both the model and associated instruments was carried out by subject matter experts to evaluate the overall feasibility and quality of the product content. The validators in this study consisted of academic experts from Universitas Negeri Medan. The validation process yielded average scores along with qualitative feedback from each validator, which were then used to inform revisions and improvements to the model. The average validation scores and qualitative feedback from each expert are summarized in Table 4, which presents the results of the expert validation of the teacher training management model.

Table 4.
Expert validation results of the model

Number	Validador	Aspects being evaluated					Total	Average
		SI	SC	I	SA	UF		
1	Expert 1	27	24	17	13	14	95	90.20
2	Expert 2	29	25	18	13	13	98	92.00
3	Expert 3	28	24	19	12	12	95	88.87
Average		28	24	18	13	13	96	90.36

The expert validation of the training management model was conducted using a 21-item questionnaire developed by the researcher and completed by experts in Training Management. The evaluation focused on five aspects: self-instructional (SI), self-contained (SC), independent (I), self-assessed (SA), and user-friendly (UF). SI measures the model's ability to support independent learning, SC evaluates the sufficiency of materials, independent assesses autonomous learning capabilities, SA checks for self-assessment features, and UF examines usability. The data, presented in Table 5, were collected using a 5-point Likert scale, with item distribution across the aspects as follows: 6 items for SI, 5 for SC, 6 for I, 3 for SA, and 3 for UF. The total average score was 96 out of 105, yielding a feasibility percentage of 91%. This score was interpreted as very feasible [37]. The detailed scores are shown in Table 5.

Table 5.
Average expert assessment validation.

Number	Aspect	Maximum score	Score acquisition	Percentage	Category
1.	Self-instructional	30	28	93.33 %	Very worthy
2.	Self-contained	25	24	96.00 %	Very worthy
3.	Independent	20	18	90.00 %	Very worthy
4.	Self-assessed	15	13	86.67 %	Very worthy
5.	User friendly	15	13	86.67 %	Very worthy
Total		105	96	91.43 %	Very worthy

According to the expert validation results in Table 5, the training management model was deemed very feasible across all aspects. The self-instructional aspect received an average score of 28 (93.33%), the self-contained aspect scored 24 (96%), the independent aspect scored 18 (90%), and both the self-assessed and user-friendly aspects scored 13 (86.67%). The overall average feasibility score was 96 (91.43%), classifying the model as highly feasible for use in improving the competence of elementary school teachers in Karo Regency. Experts also provided suggestions for refining the instruments, as shown in Table 6, to ensure they are ready for testing. A small-scale trial, involving 15 elementary school teachers, was conducted to evaluate the model's feasibility. Feedback from this trial informed further revisions, completing the limited trial phase. As presented in Table 7, the feasibility of the training management model was assessed through product trials conducted by users. Data collection was carried out using a questionnaire developed by the researcher and validated by expert reviewers. The instrument consisted of 54 items measured on a 5-point Likert scale, with 5 representing the highest level of agreement and 1 the lowest. The questionnaire encompassed five core aspects: training needs analysis (AKP) with 9 items, training participants (PP) with 9 items, training materials (MaP) with 12 items, training methods (MoP) with 12 items, and training evaluation (EvP) with 12 items. The feasibility of the product was evaluated using established feasibility criteria. The detailed results of the feasibility assessment conducted by users during the limited trial phase are presented in Table 8. Table 8 indicates that all assessed aspects of the training management model fall into the very feasible category. Training needs analysis scored 83.11%, training participants 82.81%, training materials 91.78%, and both training methods and training evaluation scored 85.56%. The overall feasibility score

was 86.23%, confirming the model's suitability for enhancing teacher competencies. A subsequent product revision phase was conducted based on expert and user feedback to improve the model, particularly in enhancing participant readiness. These revisions aim to optimize the model for broader implementation and greater impact.

Table 6.
Suggestions, improvements, and expert comments.

Number	Validator	Comment
1.	Expert	The instrument is ready for use and needs to be attached to the teacher professional competence measurement instrument (before and after the implementation of the training management model).

Table 7.
User response data from product testing.

Number	Respondents	Measured aspects					Total
		AKP	PP	MaP	MoP	EvP	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.	Teacher 1	38	38	54	51	50	230
2.	Teacher 2	41	41	54	52	48	236
3.	Teacher 3	43	34	58	47	51	233
4.	Teacher 4	41	37	56	51	52	237
5.	Teacher 5	36	41	56	49	45	222
6.	Teacher 6	38	39	56	46	49	228
7.	Teacher 7	38	37	58	59	48	239
8.	Teacher 8	39	38	58	59	45	239
9.	Teacher 9	37	37	56	58	59	247
10.	Teacher 10	37	34	54	51	59	235
11.	Teacher 11	38	36	54	52	52	232
12.	Teacher 12	36	38	53	53	51	231
13.	Teacher 13	35	35	54	59	59	242
14.	Teacher 14	36	37	51	58	52	234
15.	Teacher 15	32	37	54	51	50	222
Average		37.70	37.00	54.70	53.10	51.33	234
Percentage		83.11	82.81	91.78	88.44	85.56	86.23
Category		Very worthy	Very worthy	Very worthy	Very worthy	Very worthy	Very worthy

Table 8.
Recapitulation of user response results from product trials.

Number	Aspect	Average percentage	Category
1	AKP	83.11	Very worthy
2	PP	82.81	Very worthy
3	MaP	91.78	Very worthy
4	MoP	88.44	Very worthy
5	EvP	85.56	Very worthy
Total		86.23	Very worthy

4.2. Improvement of Pedagogical Competence of Elementary School Teachers

The effectiveness of the teacher training management model was evaluated through its implementation, measured by improvements in teachers' pedagogical competence. This was assessed using pretest and posttest scores collected during both limited and extensive trials. The purpose of the testing was to determine the extent of competence improvement following the model's implementation.

4.3. Phase Implementation Trial I

Descriptive statistical analysis was conducted on the pretest and posttest results of 30 teachers, including the mean, minimum, maximum, standard deviation, and frequency distribution. These results,

summarized in Table 9, provide evidence of pedagogical improvement after the initial implementation of the model.

Table 9.

Descriptive results of pretest and posttest Trial I.

	N	Minimum	Maximum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
Pretest	30	26.00	74.00	51.3333	2.33186	12.77210	163.126
Posttest	30	64.00	96.00	80.8667	1.10873	6.07274	36.878
Valid N (listwise)	30						

Table 10.

Completeness of pretest and posttest results of trial I.

Test	Pass				Fail		
	Amount	%	Criteria	Amount	%	Criteria
Pretest	7	23.33	very low	23	76.66	very high
Posttest	26	86.66	very high	4	13.33	very low

Table 9 presents the descriptive statistics from the limited trial involving 30 respondents. The pretest scores ranged from 26.00 to 74.00, with a mean of 51.33 and a standard deviation of 12.772. Following the implementation of the training model, posttest scores improved significantly, ranging from 64.00 to 96.00, with a mean of 80.86 and a reduced standard deviation of 6.072, indicating more consistent performance among participants. Further analysis based on the passing grade (minimum score of 60) revealed a substantial improvement. As shown in Table 10, only 23.33% of teachers passed the pretest, while 86.66% passed the posttest. Conversely, failure rates dropped from 76.67% to 13.33%, demonstrating a marked increase in pedagogical competence.

4.4. Normality Test

To determine the appropriate statistical test, a Shapiro-Wilk normality test was conducted using SPSS 22. A significance value ($p > 0.05$) indicates normally distributed data. The results of this test are presented in Table 11 and confirm whether parametric tests can be applied for further analysis.

Table 11.

Results of the normality test in trial I.

Class		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	Df	Sig.
Test results	Pretest	0.168	30	.031	.939	30	0.084
	Posttest	0.159	30	.050	.950	30	0.173

Table 12.

Results of the homogeneity test in trial I.

Levene Statistic	df1	df2	Sig.
7.035	1	58	0.010

Table 13.

Descriptive data paired sample test trial I.

		Mean	N	Std. deviation	Std. error mean
Pair 1	Pretest	52.60	30	15.014	2.741
	Posttest	81.20	30	8.430	1.539

Table 14.

Paired sample correlation.

		N	Correlation	Sig.
Pair 1	Pretest & Posttest	30	0.396	0.030

Table 15.
Output paired sample t-test.

		Paired differences							
		Mean	Std. deviation	Std. error mean	95% confidence internal of the difference		T	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Pretest-posttest	-28.600	14.006	2.557	-33.830	-23.370	-11.184	29	<0.001

The Shapiro-Wilk normality test, appropriate for sample sizes under 50, was applied to the pretest and posttest data (n = 30; df = 30). Results indicated significance values of 0.084 for the pretest and 0.173 for the posttest (p > 0.05), suggesting that both datasets are normally distributed. To assess variance consistency, a homogeneity test using Levene's method in SPSS 22 was conducted. The results, presented in Table 12, showed a significance value above 0.05, indicating that the variances between pretest and posttest scores are homogeneous, thus satisfying the assumption for further parametric analysis.

To assess the effectiveness of the training model, a paired sample t-test was conducted on pretest and posttest scores of 30 elementary school teachers. Descriptive results (Table 13) show an increase in the mean score from 52.60 (SD = 2.741) to 81.20 (SD = 1.539), indicating an improvement in pedagogical competence. The correlation analysis (Table 14) reveals a coefficient of 0.396 with a significance value of 0.030 (p < 0.05), confirming a significant relationship between the pretest and posttest scores. The paired t-test (Table 15) results show a t-value of -11.184 with p < 0.05 and df = 29. Since the absolute t-value exceeds the critical value (11.184 > 2.045), H_0 is rejected, and H_a is accepted. This confirms a statistically significant improvement in pedagogical competence due to the implementation of the training management model in the limited trial.

4.5. Phase Implementation of Trial II

An extensive trial involving 70 elementary school teachers was conducted to evaluate the effectiveness of the training management model. Descriptive analysis (Table 16) revealed an increase in the mean score from 50.51 (pretest) to 78.37 (posttest). The minimum score improved from 30 to 54, and the maximum score rose from 82 to 96. Additionally, the standard deviation decreased from 11.07 to 9.89, indicating reduced score variability after training. Further analysis compared scores against the national passing grade of 70 (Table 17). In the pretest, only 12 teachers (17.14%) passed, while 58 (82.86%) did not. Posttest results showed a significant improvement, with 65 teachers (92.86%) meeting the passing grade and only 5 (7.14%) failing. These results indicate a substantial increase in teacher competency following the intervention. Normality was assessed using the Kolmogorov-Smirnov test, suitable for samples >50 (df = 70). Results showed significance values of 0.035 (pretest) and 0.019 (posttest), both > 0.05. Using Levene's test, the variance homogeneity between pretest and posttest scores was analyzed. The significance value was 0.321 > 0.05, indicating that the data variances are homogeneous. The paired sample t-test was conducted using SPSS 27 to assess the impact of the training model. Descriptive statistics (Table 18) show the mean increased from 53.26 (SD = 13.38) to 87.17 (SD = 8.22). Correlation analysis (Table 19) revealed a coefficient of 0.233 with p = 0.020 (p < 0.05), suggesting a significant relationship between pretest and posttest scores. Hypothesis testing showed a significant difference (p < 0.05), indicating that the training model had a statistically significant effect on improving teacher pedagogical competence in the extensive trial.

Table 16.
Results of the normality test in trial II.

Class		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	Df	Sig.	Statistic	Df	Sig.
Test	Pretest	0.110	70	0.035	0.976	70	0.188
	Posttest	0.117	70	0.019	0.944	70	0.003

Table 17.
Results of the homogeneity test on the area trial.

Levene Statistic	df1	df2	Sig.
.991	1	138	0.321

Table 18.
Descriptive Data Paired Sample Test Trial II.

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-Test	53.26	70	13.376	1.599
	Post Test	87.17	70	8.218	0.982

Table 19.
Paired sample correlation.

		N	Correlation	Sig.
Pair 1	Pre-Test & Post Test	70	0.233	0.020

Table 20.
Output paired sample t-test.

		Paired differences							
		Mean	Std. deviation	Std. error mean	95% confidence internal of the difference		T	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Pretest-posttest	-33.914	15.925	1.903	-37.712	-30.117	-17.817	69	<.001

The paired sample t-test analysis revealed a significant improvement in the teachers' scores after implementing the training management model. The calculated t-value was -17.817, indicating a higher posttest mean (87.17) compared to the pretest mean (53.26), shown in Table 20. Hypothesis testing, based on the comparison of the calculated t-value (17.817) and the critical t-table value (1.994) at a significance level of 0.05, confirmed the rejection of H_0 and the acceptance of H_a, suggesting that the model effectively improved the teachers' pedagogical competence. The results from both the limited and extensive trials showed marked improvements, with the pretest mean in the limited trial increasing from 52.62 to 81.20, and in the extensive trial from 53.26 to 87.17.

Improvements were observed across three key indicators: (A) Planning and Implementing Learning, (B) Implementing Educative Learning, and (C) Utilizing Learning Information Technology. In the limited trial, Indicator A increased from 49.78 to 72.00, Indicator B from 45.40 to 81.90, and Indicator C from 66.43 to 90.00. In the extensive trial, Indicator A improved from 52.17 to 89.37, Indicator B from 48.65 to 90.75, and Indicator C from 60.66 to 79.30. The overall average scores also increased, from 53.87 to 81.30 in the limited trial, and from 53.83 to 86.47 in the extensive trial. These results collectively indicate that the model significantly enhances teachers' abilities to plan, implement, and integrate technology in their teaching practices. Further evaluation of the model's effectiveness was conducted using the N-Gain score, as shown in Table 21. Based on the categories, the N-Gain scores for both trials indicated that the based training model is Very Effective in improving the pedagogical

competence of elementary school teachers. The results of the N-Gain score calculation for the extensive trial with the help of the IBM SPSS Statistics 27 program can be seen in table 22.

Table 21.
Calculation of N-Gain score trial I (limited).

	Class				Statistic	Std. error
N-Gain Score	Eksperimen	Mean			58.3658	3.33469
		95% Confidence Interval for Mean		Lower Bound	51.5456	
				Upper Bound	65.1860	
		5% Trimmed Mean			59.1714	
		Median			62.0000	
		Variance			333.604	
		Std. Deviation			18.26484	
		Minimum			17.39	
		Maximum			84.62	
		Range			67.22	
		Interquartile Range			30.14	
		Skewness			-0.749	0.427
		Kurtosis			-0.203	0.833

Table 22.
Calculation of N-Gain score trial II (wide).

	Class				Statistic	Std. error
N-Gain Percentage	Experiment	Mean			69.2532	2.56496
		95% Confidence interval for mean		Lower bound	64.1362	
				Upper bound	74.3701	
		5% trimmed mean			71.1884	
		Median			75.0000	
		Variance			460.530	
		Std. deviation			21.45997	
		Minimum			5.88	
		Maximum			92.86	
		Range			86.97	
		Interquartile range			23.65	
		Skewness			-1.387	0.287
		Kurtosis			1.351	0.566

Table 23.
Recapitulation of user response results.

Number	Aspect	Trial		Average percentage	Category
		Limited	Vast		
1	Training Planning	91.86	90.06	90,06	Very effective
2	Implementation of Training	89.56	96.48	89,56	Very effective
3	Training Evaluation	87.83	94.64	91,24	Very effective
Total		88,70	92.35	90.52	Very effective

Based on the results presented in Table 23, the aspect of training planning achieved an average score of 90.06%, categorized as very effective. Similarly, the aspect of training implementation attained an average score of 89.56%, while the aspect of training evaluation obtained an average score of 91.24%, both falling within the very effective category. The overall average effectiveness score of the training management model was 90.52%, indicating a very effective rating. These findings suggest that, according to user assessments, the training management model is highly effective in enhancing the professional competence of elementary school teachers in Karo Regency. Furthermore, the results demonstrate that the training management model significantly improves teachers' pedagogical competencies. This improvement was substantiated through multiple evaluation measures, including the

paired sample t-test, calculation of the t-value, analysis of the normalized gain (N-Gain) score, and user evaluation of training management effectiveness. The paired sample t-test results from both experimental trials yielded significance (Sig. (2-tailed)) values less than 0.05 and t-values exceeding the critical t-table values, leading to the rejection of the null hypothesis (Ho) and acceptance of the alternative hypothesis (Ha). This confirms a statistically significant difference between pretest and posttest results, thereby indicating that the model has a positive impact on the pedagogical competence scores of elementary school teachers. Additionally, the average N-Gain scores across both trials exceeded 55%, classifying the model as effective based on established criteria. User evaluations of training management effectiveness also consistently surpassed 85%, further corroborating the model's categorization as very effective. The implementation of the training management model was found to be highly effective in improving the pedagogical competencies of elementary school teachers in Karo Regency. Specifically, enhancements were observed in the following competence indicators: (1) the ability to plan and implement instructional activities, (2) the ability to conduct educative learning processes, and (3) the ability to integrate and utilize learning information technology effectively.

5. Discussion

5.1. Feasibility of the Teacher Training Management Model

The feasibility of the teacher training management model in enhancing the pedagogical competence of elementary school teachers was confirmed through both expert validation and user testing. Expert validation assessed aspects such as self-instructional capacity, self-contained material structure, independence from external media, self-assessment potential, and user-friendliness. The evaluation resulted in an average feasibility score of 91.43%, categorized as very feasible. Meanwhile, user assessments, based on training needs analysis, participant characteristics, training materials, methods, and evaluation procedures, indicated an average feasibility score of 86.23%, also classified as very feasible. Training models promoting learner autonomy, self-assessment, and technological adaptability are critical for modern teacher professional development [41]. The model compliance with fundamental instructional design principles further reinforces its feasibility. It aligns with the framework proposed by Al-Samarraie and Saeed [42] who argue that effective training models must systematically integrate needs analysis, objective formulation, material development, method selection, piloting, implementation, and evaluation to ensure contextual relevance and sustainability [42]. Furthermore, the importance of media completeness and technological adaptability as highlighted by Maatuk, et al. [43] confirms that learning environments must be self-contained and responsive to technological advancements to enhance user acceptance and learning outcomes [43].

The expert validation and user feedback results obtained in this study also align with the standards set by Gasell, et al. [44] who suggested that a minimum validation threshold of 80% is necessary for a training model to be considered highly feasible [44]. The model achievement of a >90% expert validation score and >85% user validation score thus places it well within the range of high-quality, feasible instructional designs recognized in current educational research.

5.2. Effectiveness of the Based Teacher Training Management Model

The effectiveness of the training management model was demonstrated through significant improvements in pedagogical competence across three primary indicators: the ability to plan and implement learning activities, the ability to conduct educational learning, and the ability to utilize information technology in the learning process. In the limited trial, the overall pedagogical competence scores increased from 53.87 to 81.30, while in the extensive trial, the scores improved from 53.83 to 86.47. Each indicator recorded notable gains, affirming the model's broad effectiveness. These findings are consistent with the work of Alammary [45] who emphasized that blended and reflective training models significantly improve teacher competencies by fostering deeper cognitive engagement [45]. Furthermore, the integration of technology in training, as operationalized in the model, is supported by the study of Hartman, et al. [20] which demonstrated that digital competence training positively

impacts teachers' instructional quality and student learning outcomes [20]. The improvement in pedagogical competence is further validated by N-Gain scores obtained in the trials: 58.36% in the limited trial and 69.25% in the extensive trial, both categorized as effective according to criteria established by Vlaanderen, et al. [46]. Statistical analysis through paired sample t-tests also confirmed significant differences between pretest and posttest results, thereby demonstrating the robust impact of the model [46]. However, these positive outcomes must be interpreted alongside cautionary findings from VanTassel-Baska and Baska [8] who emphasized that without sustained mentoring and contextual support, the benefits of training programs may diminish over time. In particular, continuous coaching and follow-up mechanisms are essential to ensure the long-term transfer of skills into actual teaching practice [8]. Moreover, the contextual limitations, especially regarding technological infrastructure as noted by Sampson, et al. [1] must also be considered when scaling the model to broader rural or resource-constrained settings. These constraints highlight the necessity for adaptive model deployment strategies that are sensitive to the technological readiness of participants.

In addition to effectiveness in terms of competence improvement, the training management aspects, encompassing planning, implementation, and evaluation, also achieved very high user ratings, with an average effectiveness score of 90.52%. Specifically, planning was rated at 90.06%, implementation at 89.56%, and evaluation at 91.24%, each categorized as very effective. These results align with the findings of Huang, et al. [47] who stressed that structured training processes, when aligned with participants' learning trajectories, lead to optimal educational outcomes [47]. Finally, the analysis of the model N-Gain scores, according to the thresholds confirm its classification within the "effective" range. The findings substantiate the theoretical framework that effective professional development models are those that systematically integrate reflective practice, contextual adaptability, and technological enhancement to maximize teacher growth [48]. This study demonstrates that the training management model is both feasible and effective in improving the pedagogical competence of elementary school teachers in Karo Regency. The model addresses critical components of professional learning, including autonomy, adaptability, and technology integration. Nevertheless, to ensure the sustainability of the improvements, it is recommended that future implementations incorporate continuous mentoring, targeted technological support, and mechanisms for strengthening teachers' reflective self-evaluation practices. The model thus makes a significant contribution to the development of competency-based teacher training frameworks and provides an evidence-based solution to the limitations of conventional, passive training models.

6. Conclusion

This study developed and validated an innovative training management model to enhance the pedagogical competence of elementary school teachers, particularly in Karo Regency, Indonesia. Grounded in management, human resource development, and reflective learning theories, the model integrates planning, implementation, and evaluation processes with a strong emphasis on contextual relevance and digital integration. The research findings demonstrate that the model is highly feasible and effective, with significant improvements in teachers' ability to plan learning activities, conduct educational processes, and utilize information technology. Expert validation and user feedback both rated the model as very feasible, while statistical analyses, including paired sample t-tests and normalized gain (N-Gain) scores, confirmed its substantial impact on teacher competence. Despite its success, the study acknowledges limitations regarding broader generalizability and the need for sustained mentoring support. The training management model offers a comprehensive, evidence-based framework for advancing teacher professional development. Future research should focus on expanding the model's application across different educational contexts and incorporating long-term sustainability strategies to maximize its impact on teaching and learning outcomes.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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