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Bridging Teacher Readiness and Deep Learning-Based Teaching Practice: Assessing the Effectiveness of the ACTIVE Model for Enhancing Teacher Pedagogy

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Abstract

This study was motivated by the low readiness of physical education (PE) teachers to implement a Deep Learning approach, which emphasizes meaningful, reflective, and values-based learning. Key challenges include limited conceptual understanding, pedagogical constraints, and resistance to change, particularly at the elementary school level. The purpose of this study was to develop and evaluate the effectiveness of a values-based teacher training model named ACTiVE (Authentic Collaborative Teaching in Values-Based Education) to holistically enhance teacher readiness. Employing a mixed-methods approach within a design-based research framework, the study involved 38 teachers from three school clusters: rural, transitional, and urban. Data were collected through readiness questionnaires, interviews, reflections, and microteaching observations, and analyzed using descriptive, inferential, and thematic techniques. The results revealed a significant improvement in teacher readiness scores, from a mean of 2.69 (moderate category) to 4.29 (high category), supported by a t-value of 66.44 ($p < 0.001$) and an average N-Gain of 0.69. Teachers also demonstrated active participation and high reflective capacity following the training. The study concludes that the ACTIVE model is effective in improving teachers' readiness to implement the deep learning approach. The primary contribution of this research lies in the development of a contextualized, reflective, and collaborative values-based training model, offering a strategic reference for teacher education reform in the era of transformative learning.

Keywords: ACTIVE Model, Deep Learning, Physical Education, Reflective Training, Teacher Readiness.

Introduction

The Deep Learning approach has emerged as a global educational trend that emphasizes in-depth learning, collaboration, and the cultivation of critical thinking skills (1). In Indonesia, it has been embraced as a national policy to foster meaningful understanding and application of knowledge (2). The three core principles of this approach—Mindful, Meaningful, and Joyful Learning—aim to develop students who are reflective, engaged, and capable of deep comprehension (3, 4). Deep Learning also aligns with constructivist pedagogy, which views knowledge as actively built through meaningful experience (5). Within Indonesia's education policy, these principles are enhanced by an emphasis on social context and emotional experience (2, 6). However, the successful implementation of Deep Learning hinges significantly on teacher readiness. A survey of 50 physical education (PE) teachers in a West Java district found that 83% had only minimal understanding of the concept, 12.38% had no understanding, and just 4.76% demonstrated an adequate grasp. These findings suggest a profound epistemological and pedagogical gap among teachers that could hinder Indonesia's broader educational reform objectives and the cultivation of critical, creative, and adaptive learners. Prior research has consistently identified barriers to Deep Learning implementation, including limited teacher capacity, insufficient institutional support, and the absence of practice-based training (7,8). Effective educational transformation, moreover, requires a paradigm shift in pedagogy (9). According to Barron and Darling-Hammond, systemic backing and continuous professional development are essential (10). In the elementary

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context, teachers must also align their pedagogical strategies with students' developmental needs (9). Most existing studies on Deep Learning have concentrated on STEM education (11, 12), leaving PE underexplored—particularly in terms of its potential to integrate affective, social, and cognitive learning domains. Addressing this gap, the current study focuses on elementary PE teachers' readiness to implement Deep Learning principles. Teacher readiness is strongly influenced by self-efficacy and belief in one's competence and the value of proposed changes (13). Ongoing professional development and experiential learning are key to fostering this readiness (14). These ideas align with the Teacher Change Theory, which suggests that meaningful reform requires simultaneous shifts in attitude, understanding, and skill (14,15), as well as the Theory of Planned Behavior, which asserts that behavior is shaped by attitudes, social pressures, and perceived control (16,17). Sharma further categorizes readiness into epistemological, pedagogical, and affective domains (9).

At the same time, numerous contextual challenges hinder the implementation of deep learning, including limited resources, unclear pedagogical guidelines, and resistance to change (18). These challenges correspond with Rogers' Diffusion of Innovations Theory, which posits that adoption is influenced by complexity, compatibility, and visibility (19, 20). In under-resourced schools, infrastructure issues—such as lack of devices or internet—further hinder technology-enhanced Deep Learning (21, 22). Moreover, conceptual ambiguity regarding what constitutes deep learning also contributes to confusion and inconsistent classroom practices (23).

Existing intervention models, such as Response to Intervention (RtI) and the Building Bridges (BB) project, provide tiered support for student learning and teacher development (24, 25). However, these models are often hindered by teacher uncertainty and lack of adaptation to specific contexts. As an alternative, Kolb's Experiential Learning Theory offers a more dynamic approach by framing learning as a cyclical process of concrete experience, reflective observation, abstract conceptualization, and active experimentation (26). This model emphasizes authentic, reflective learning—especially relevant to physical education and value-based instruction.

Taken together, these theoretical perspectives form the foundation of this study:

- Deep Learning is grounded in constructivism,
- Teacher readiness is informed by Teacher Change Theory and the Theory of Planned Behavior,
- Implementation challenges are viewed through the lens of Diffusion of Innovations, and
- The intervention strategy is built upon Experiential Learning Theory.

As Lister affirms, educational reform succeeds when theoretical foundations are linked to practical needs through strategic, experience-based interventions (8). Based on these theoretical perspectives and contextual challenges, this study aimed to examine elementary physical education teachers' readiness to implement deep learning principles and the strategic needs that arise in the process. The objectives were threefold: to assess teachers' initial level of understanding and preparedness, to identify the main challenges encountered in integrating deep learning into instructional practice, and to design, implement, and evaluate a practice-based intervention model that could effectively enhance teachers' instructional capacity.

Methodology

Research Approach and Design

This study employed a Design-Based Research (DBR) approach, grounded in the theoretical framework developed by Jetnikoff, (27). DBR was chosen due to its alignment with the research aim of developing, implementing, and evaluating a practice-based intervention model to enhance physical education (PE) teachers' readiness in applying deep learning principles. This approach is particularly relevant as it integrates theoretical development with the improvement of educational practice in real-world contexts, characterized by iterative cycles aimed at continuous refinement (28). Its applicability is further reinforced by the context of this study, which seeks to identify real-world challenges faced by teachers, design practice-driven solutions, and assess their impact within authentic elementary school learning environments.

Research Procedure

The research was conducted in ten stages, beginning with problem identification, followed by teacher needs analysis, the design and validation of

the intervention model, and culminating in both limited and broader-scale implementation. The process concluded with an evaluation of the model's effectiveness to generate practical implementation recommendations. Table 1 outlines the ten stages of the research procedure.

Table 1: Research Procedure

No	Research Stage	Main Activities	Output
1	Problem Identification	Literature review, document analysis, exploratory interviews	Formulated real-world problem
2	Needs Analysis	Teacher readiness survey, preliminary observations	Mapping of needs and challenges
3	Intervention Model Design	Development of a practice-based draft model	Initial draft of intervention model
4	Design Validation	Validation by educational experts and practitioners	Revised model
5	Limited-Scale Implementation	Implementation in selected schools	Initial implementation data
6	Data Collection	Observations, questionnaires, interviews	Quantitative and qualitative data
7	Data Analysis	Descriptive statistics, thematic analysis	Empirical findings
8	Reflection and Revision	Reflections from teachers and researchers	Finalized intervention model
9	Large-Scale Implementation	Implementation with a broader teacher population	Broad-scale implementation data
10	Effectiveness Evaluation	Impact measurement of the model	Implementation recommendations

Research Setting and Participants

The study was conducted in Sumedang Regency, West Java, which was selected for its potential as an emerging educational hub. A total of 38 elementary school physical education (PE) teachers were purposively selected, based on the criteria of having at least two years of teaching experience and a willingness to participate in all stages of the research. Of the participants, 3 teachers were involved only up to the limited-scale implementation phase, while 35 teachers participated in the large-scale implementation phase. The demographic profile of the 38 participants is presented in Table 2 below.

Table 2: Participant Demographics

Category	Frequency	Percentage (%)
Gender		
Male	23	60.53
Female	15	39.47
Years of Teaching Experience		
2–5 years	12	31.58
6–10 years	12	31.58
11–15 years	7	18.42
More than 20 years	7	18.42
Educational Level		
Bachelor's degree	33	86.84
Master's degree	5	13.16
Academic Background		
Physical Education	17	44.74
Sports Education	11	28.95
Elementary PE Education	10	26.32

School Cluster		
Rural	12	31.58
Transitional	12	31.58
Urban	13	34.21

Data Collection and Data Analysis Techniques

Data were collected using a combination of quantitative and qualitative methods, including a teacher readiness questionnaire (pre-test and post-test), implementation observation sheets, in-depth interviews, and teacher reflection documentation. Quantitative data were analyzed using descriptive and inferential statistical techniques, with a paired t-test employed to assess changes in teacher readiness before and after the intervention. Qualitative data were analyzed using thematic analysis to identify key themes related to challenges, teacher experiences, and the effectiveness of the intervention model. To enhance the validity of the findings, a triangulation approach was adopted by integrating data from multiple sources and methods.

Research Instruments

The research employed the following instruments: a teacher readiness questionnaire on deep learning, developed based on the dimensions of mindful, meaningful, and joyful learning; an observation sheet for monitoring the implementation of deep learning in classroom settings; a semi-structured interview guide designed to explore teachers' experiences in implementing the model; and a teacher reflection journal completed after the intervention. Each instrument was designed to comprehensively capture both quantitative and qualitative data, aligned with the study's objectives to measure teacher readiness, evaluate implementation practices, and identify the supporting and inhibiting factors influencing the successful adoption of deep learning in physical education.

Instrument Validity and Reliability

Content validity was assessed for the teacher readiness questionnaire related to deep learning, involving three experts in physical education, educational innovation, and evaluation. The evaluation focused on content relevance, clarity of wording, and alignment of indicators with the dimensions of mindful, meaningful, and joyful learning. All items were deemed relevant, with a Content Validity Index (CVI) ranging from 0.83 to 0.87, and several items were revised for improved clarity.

Reliability testing was conducted on the teacher readiness questionnaire, which comprised three core dimensions: epistemological readiness, pedagogical readiness, and affective readiness. The reliability test employed Cronbach's Alpha, using pilot data collected from 30 elementary physical education teachers in Sumedang who were not involved in the main study. The results confirmed that the instrument was reliable. The detailed reliability scores are presented in the following Table 3.

Table 3: Instrument Reliability Test Results

Dimension	Number of Items	Cronbach's Alpha	Interpretation
Epistemological Readiness	5	0.801	Reliable
Pedagogical Readiness	5	0.843	Reliable
Affective Readiness	5	0.788	Reliable
Total	15	0.851	Highly Reliable

The qualitative instruments—namely, the interview guide and teacher reflection journal—were validated through expert judgment and assessed for credibility using member checking and data triangulation. Confirmation and cross-source comparison indicated that the instruments demonstrated a high level of credibility and trustworthiness.

Results

Initial Data Description of Teacher Readiness

To gain an initial overview of physical education teachers' readiness to implement the deep learning approach, measurements were conducted across three main dimensions: epistemological readiness, pedagogical readiness, and affective

readiness. Data were collected through a questionnaire administered to 38 teachers who met the participation criteria. Each dimension was analyzed using descriptive statistics, including mean scores and standard deviations. The purpose of this analysis was to assess the initial level of teacher readiness and to inform the design of an appropriate intervention model. The descriptive statistical results for each dimension of readiness are presented in the following Table 4.

Table 4: Descriptive Results of Initial Teacher Readiness

Dimension	Mean	Standard Deviation	Category
Epistemological Readiness	2.96	0.46	Moderate
Pedagogical Readiness	2.82	0.63	Moderate
Affective Readiness	3.47	0.44	Moderate

The analysis results indicate that all three dimensions of teacher readiness fall within the moderate category. The scores for Epistemological Readiness (M = 2.96) and Pedagogical Readiness (M = 2.82) suggest that teachers' conceptual understanding and pedagogical capacity to implement deep learning still require significant improvement. In contrast, Affective Readiness obtained the highest score (M = 3.47), indicating that teachers are generally open and motivated to adopt the approach, despite not being fully prepared in terms of knowledge and practical application. These findings underscore the urgency of implementing a comprehensive training intervention.

Implementation Challenges

Challenges in implementing the deep learning approach were explored through interviews with 12 teachers selected as representatives from each school cluster, with four teachers drawn from each cluster (rural, transitional, and urban). The interview analysis yielded a total of 627 statements, which were synthesized into three major themes representing the primary challenges in implementing deep learning: pedagogical barriers, technical barriers, and affective barriers. These themes were derived through a thematic analysis process and supported by authentic quotations from participating teachers. Each of these thematic categories is described in detail below:

Pedagogical Barriers

The majority of teachers expressed difficulties in understanding the concept of deep learning, particularly in translating the principles of mindful, meaningful, and joyful learning into physical education activities. A lack of familiarity with approaches that promote critical and reflective thinking led many teachers to continue using traditional instructional patterns that are predominantly demonstrative and focused solely on motor skills. This was illustrated by several teachers' statements:

> "I don't really understand the difference between deep learning and regular teaching methods." (Teacher 1)
>
> "I've only heard the term, but I don't know how it's applied in practice." (Teacher 6)
>
> "When asked to design a mindful or meaningful activity, I get confused." (Teacher 8)
>
> "I usually just focus on students' motor skills, not their cognitive development." (Teacher 3)
>
> "Creating a lesson that encourages critical thinking is difficult." (Teacher 11)

These findings align with the quantitative results on the Epistemological Readiness dimension, which showed an average score of 2.96 (moderate category). This underscores the fact that teachers' conceptual understanding of deep learning remains insufficient and represents a key weakness in their overall readiness for implementation.

Technical Barriers

Teachers reported several technical challenges, including limited facilities, restricted instructional time, and a curriculum structure that was perceived as unsupportive of deep learning implementation. Many struggled to adapt lesson plans and instructional tools due to administrative burdens and a lack of institutional support. These challenges were reflected in several teacher statements:

> "In my school, sports equipment is very limited." (Teacher 4)
>
> "Physical Education (PE) is scheduled only once a week, so

there's not enough time for exploration." (Teacher 2)
"The field is often used for other school activities." (Teacher 7)
"The curriculum doesn't allow space for innovation." (Teacher 10)
"I don't feel supported because there's no training provided." (Teacher 5)

Although these technical barriers were not directly measured through the questionnaire, they had a significant impact on the low score of Pedagogical Readiness (mean = 2.82). Without adequate system-level support and resources, teachers were unable to develop instructional designs that aligned with the deep learning approach.

Affective Barriers

Some teachers exhibited resistance to change, expressed low self-confidence in adopting new approaches, or felt comfortable with their existing teaching methods. These psychological factors served as internal obstacles, despite teachers' awareness of the importance of change. The following teacher statements illustrate these affective challenges:

"I feel comfortable with the way I've been teaching." (Teacher 9)
"I'm not sure I can implement it correctly." (Teacher 6)
"I don't feel confident trying something new." (Teacher 12)
"New methods require preparation, and I don't have the time." (Teacher 3)
"The students aren't ready either, so I'm not motivated to change my teaching style." (Teacher 1)

These findings align with the results for the Affective Readiness dimension (mean = 3.47), which lies at the upper end of the moderate category. While there is initial motivation, many teachers still face affective barriers—such as lack of confidence and attachment to traditional teaching methods—that hinder meaningful change.

The three thematic challenges identified through interviews reinforce the quantitative findings and clarify that teacher readiness is not solely conceptual, but is also constrained by technical and affective factors. Therefore, the intervention model must address not only knowledge-related aspects but also provide emotional and systemic support through contextual, collaborative, and practice-oriented training.

Intervention Model Design

In response to the readiness gap among physical education teachers in implementing the deep learning approach, this study developed an intervention model called ACTIVE, which stands for Authentic Collaborative Teaching in Values-Based Education. The model integrates contemporary pedagogical principles with reflective practice through six systematically connected and interdependent steps. Each letter in the acronym ACTIVE represents a critical phase of the intervention process: Assess, Clarify, Try, Interact, Validate, and Empower. These six steps are summarized in the matrix presented in the following Table 5.

Table 5: Steps in the ACTIVE Intervention Model

Letter	Step	Brief Description	Actions	Target Outcome
A	Assess Understanding	Initial identification of teachers' readiness and understanding of Deep Learning.	Readiness survey, pre-test, exploratory discussions	Teachers' understanding levels are mapped and training needs are identified.
C	Clarify Concepts	Workshops and discussions to clarify the principles of mindful, meaningful, and joyful learning.	Training sessions, case studies, concept mapping	Teachers gain a clear understanding of Deep learning principles in PE context.

T	Try Out Practice	Simulations and microteaching using the Deep learning approach.	Microteaching, lesson plan design, simulation observation	Teachers are able to design and trial Deep learning-based instruction.
I	Interact and Collaborate	Peer mentoring and collective feedback for improving teaching strategies.	Peer review discussions, collaborative forums, co-teaching	Teachers receive peer input and revise their instructional strategies.
V	Validate and Reflect	Reflective practices through discussions, journaling, and self-feedback.	Reflection journals, focused group discussions	Teachers reflect critically and systematically on their teaching practices.
E	Empower Transformation	Strengthening changes in attitudes and skills for sustainable teaching practices.	Portfolio development, implementation action plans	Teachers demonstrate readiness and commitment to apply transformative learning.

Each stage in the ACTIVE model is designed to be mutually reinforcing, forming a holistic cycle of competency development. Teachers are not only provided with conceptual understanding but are also trained to design, implement, and reflect on instruction based on the principles of mindful, meaningful, and joyful learning. Moreover, collaborative and reflective values serve as the foundational pillars of every training process, aiming to foster a professional culture that supports praxis-oriented transformation within schools.

The ACTIVE model employed a variety of intervention methods, including interactive workshops, project-based microteaching, peer mentoring, individual and group reflections, as well as digital support through an online platform. The model was validated by three experts: a specialist in physical education, a curriculum expert, and a learning model expert. The experts concluded that the model was not only conceptually sound but also contextually relevant and adaptable to the realities of elementary school teachers.

Nevertheless, the experts provided several critical recommendations that guided the refinement of the model design, including:

- Simplifying theoretical terminology in the training modules to ensure accessibility for teachers from diverse academic backgrounds.
- Adding concrete examples to each step of the model, particularly in the form of physical education learning scenarios based on mindful, meaningful, and joyful learning principles.
- Adjusting the training schedule to be more flexible and realistic in alignment with teachers' workloads, without compromising instructional substance.
- Strengthening formative evaluation by incorporating implementation assessment tools and reflective prompts at the end of each session.

In response to the expert feedback, the researcher revised the model design. The improvements included restructuring the training module to be more practical, incorporating physical education lesson scenarios based on the Deep learning approach, and adding reflection sheets and formative assessment tools to each stage of the ACTIVE model.

Small-Scale Implementation Phase

To assess the initial feasibility and contextual responsiveness of the ACTIVE (Authentic Collaborative Teaching in Values-Based Education) intervention model, a small-scale implementation trial was conducted involving three elementary physical education teachers from three distinct geographical contexts in Sumedang Regency: rural, transitional, and urban areas. This pilot aimed to evaluate the adaptability,

applicability, and potential impact of the model on meaningful teaching practices. The three participating teachers underwent three core training sessions: a workshop on deep learning concepts, project-based microteaching, and collaborative reflection. Table 6 presents a summary of the quantitative results from this initial implementation with the three teachers:

Table 6: Small-Scale Implementation Results

Teacher	School Cluster	Readiness		Participation	Reflection
		(Pretest)	(Posttest)	(%)	Score
G-1	Pedesaan	2.6	4.0	94	4.1
G-2	Transisi	2.9	4.1	96	4.2
G-3	Perkotaan	3.0	4.3	100	4.5
	Average	2.83	4.13	96.67	4.27

Based on Table 6, the quantitative results show that all participating teachers experienced an increase in readiness scores, indicating successful transfer of understanding and application of the principles of mindful, meaningful, and joyful learning. This is reflected in the improvement of the average readiness score from 2.83 (moderate category) in the pretest to 4.13 in the posttest

In terms of participation, all teachers completed the sessions with a high participation rate of 96.67%, demonstrating strong enthusiasm toward experimenting with the deep learning approach. The average reflection score of 4.27 suggests that despite differences in school contexts, the ACTIVE model was successfully implemented in a flexible manner and was effective in shifting teachers' perspectives toward valuing not only physical activity but also meaningful, reflective, and context-based learning. Qualitative data from teacher reflections supported the quantitative findings, as illustrated in the following authentic statements:

> G-1: "I have just realized the importance of using reflective questions in PE lessons, even when facilities are limited."
>
> G-2: "I need more practice in balancing motor activities with student reflection."
>
> G-3: "This model is highly integrative; students were actively engaged in discussions and understood the meaning behind physical activities."

Feedback from teachers and facilitators during the implementation phase led to several improvement recommendations. Teachers from rural schools suggested the development of simpler and more visually oriented modules. Teachers in transitional school contexts requested more practical and applicable lesson plan (RPP) examples, while teachers from urban schools proposed the integration of digital reflective activities to enhance student engagement. These inputs led to specific revisions to the model, as outlined in Table 7 below.

Table 7: Field Feedback and Model Revisions

No	Feedback from the Field	Revisions Made
1	The module was too dense and theoretical	Developed a concise version of the module with info graphics and case studies
2	Lack of reflective activity-based learning examples	Added three teaching scenarios incorporating open-ended questions
3	Not all schools have stable digital access	Provided a printed version and alternative non-digital activities
4	Microteaching time was too short for reflection exploration	Extended the duration of the post-microteaching reflection session

Large-Scale Implementation Phase

Following the limited-scale implementation and subsequent model revisions based on field feedback, the next phase involved large-scale implementation to examine the feasibility, effectiveness, and acceptability of the ACTIVE

(Authentic Collaborative Teaching in Values-Based Education) model in a broader context. In this phase, the intervention was applied to 35 physical education teachers from 35 elementary schools across various regions of Sumedang Regency, representing diverse geographical settings, resource availability, and student characteristics. An overview of the implementation outcomes is presented as follows:

Teacher Readiness

Teacher readiness was measured through a pre-test and post-test. The results of these assessments are presented in Table 8 below.

Table 8: Teacher Readiness in the Large-Scale Implementation

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest	35	2.43	2.99	2.69	.17297
Posttest	35	4.16	4.45	4.29	.07983

The results in table 8 show a significant improvement in teachers' pedagogical readiness. The average pre-test score of 2.69 increased to 4.29 in the post-test (on a 1–5 scale), with the standard deviation decreasing from 0.17297 to 0.07983. This shift indicates that the ACTIVE-based training effectively strengthened teachers' understanding and skills in implementing deep learning principles. Teacher readiness, which was initially categorized as low, increased to a high and consistent level across participants. These quantitative findings were reinforced by qualitative evidence, suggesting that the ACTIVE model helped teachers understand deep learning in a concrete and practical manner. This is supported by the following teacher reflections:

> "Previously, I thought deep learning was just a theoretical term. After the simulation, I was able to connect physical activities with deeper values and meaning." (Teacher 17, transitional school)
>
> "The hands-on practice and microteaching made me confident to apply it in class, even though I had never tried it before." (Teacher 6, rural school)

Teacher Participation

Teacher participation was assessed based on attendance percentage and active involvement in training sessions. Table 9 presents the level of active teacher participation.

Table 9: Teacher Participation Level

	N	Minimum	Maximum	Mean	Std. Deviation
Participation	35	90.00	99.00	93.63	2.90117

As shown in Table 9, the average level of teacher participation across the intervention sessions was 93.63%, with scores ranging from 90% to 99% (SD = 2.90). This high level of participation reflects strong enthusiasm and acceptance of the training process by the teachers. The low standard deviation also indicates stability and consistent engagement across all participants throughout the intervention process. These quantitative findings are supported by qualitative data, which revealed that the ACTIVE approach provided a safe and collaborative space for questioning, discussion, and peer learning. This is reflected in the following teacher comments:

> *"I enjoyed being actively involved, not just listening. The discussion and reflection activities made me feel valued."* (Teacher 23, urban school)
>
> *"This model is different—more participatory and not rigid. I felt like I had a role in every session."* (Teacher 12, transitional school).

Teacher Reflection

Teacher reflection was assessed using a post-intervention reflection scale instrument. Table 10 presents the evaluation results of teachers' reflective capacity.

Table 10: Teacher Reflection

	N	Minimum	Maximum	Mean	Std. Deviation
Reflection	35	3.90	4.94	4.29	.20580

As shown in Table 10, teachers demonstrated a high level of reflective ability following the intervention, with an average reflection score of 4.29 and a standard deviation of 0.20580. These results indicate that teachers were able to critically evaluate their instructional practices and recognize the significance of collaborative learning approaches and value-based education in physical education.

Beyond these quantitative findings, qualitative evidence from teacher reflections and classroom observations further confirmed these improvements. The reflection process—facilitated through journals, group discussions, and microteaching observations—encouraged teachers to analyze their teaching more critically and to experiment with more meaningful instructional strategies. Teachers reported increased confidence in guiding students through reflective questions and value-based activities. For example, one rural teacher noted, *"I realized that physical education is not only about movement but also about helping students think critically about the meaning behind activities* (Teacher 4, rural school). Another teacher added, *"Reflection helped me see that physical" education can be a tool for character formation, not just for developing motor skills."* (Teacher 30, urban school). Similarly, a teacher from a transitional school emphasized, *"I became more structured in allocating time, and I learned how to use limited facilities creatively to ensure learning remained meaningful." (Teacher 2, transitional school).*

Observational data during microteaching sessions supported these reflections. Teachers were observed implementing more systematic lesson planning, balancing physical activities with reflective discussions, and encouraging broader student participation. Students were seen more engaged, asking questions, and articulating their understanding of the meaning behind physical activities.

Taken together, the three core indicators—readiness, participation, and reflection—confirm that the large-scale implementation of the ACTIVE model successfully achieved its intended objectives. The significant improvement in teacher readiness, high and consistent levels of participation, and strong reflective capacity indicate that the model is effective, feasible, and contextually relevant for widespread application in deep learning-based physical education at the elementary level. These results also reinforce the potential of the ACTIVE model as an adaptive and transformative teacher training approach in support of national educational reform. Furthermore, teacher narratives reveal that the model was not only understood conceptually but also transformed their perspectives and teaching approaches, leading to more meaningful and context-rich physical education practices.

Model Effectiveness Evaluation

To evaluate the effectiveness of the ACTIVE training model in enhancing physical education teachers' readiness to implement the deep learning approach, a paired *t*-test was conducted on pre-test and post-test scores. The test was performed after confirming the normality of data distribution. This analysis aimed to determine whether there was a statistically significant difference between teacher readiness before and after the training intervention. The results of the *t*-test are presented in Table 11.

Table 11: Paired Sample t-Test Results

	Mean Difference	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Pair 1 (Post – Pre)	1.6029	0.13722	0.02455	66.4437	34	0.000

The results in Table 11 show a substantial mean difference of 1.6029. The t-value of 66.44 and the significance level ($p = 0.000$) indicate a statistically significant difference ($p < 0.05$) between pre-test and post-test scores. These findings suggest that the ACTIVE intervention model significantly improved the readiness of physical education teachers to understand and implement deep learning principles. This result reinforces the model's effectiveness as a collaborative, reflective, and values-oriented learning approach—the foundational components of the ACTIVE model's design. To assess the practical effectiveness of the ACTIVE model implementation, an N-Gain analysis was conducted on the pre-test and post-test scores of physical education teachers' readiness. The N-Gain method was selected as it effectively illustrates the magnitude of improvement

achieved by participants on a 1–5 scale, taking into account the maximum possible individual score. Table 12 presents the N-Gain analysis results.

The results show an average N-Gain score of 0.69, which is generally classified as moderate-to-high. The minimum N-Gain score was 0.65 and the maximum was 0.75, with a low standard deviation of 0.0285. This indicates that the improvement occurred consistently across participants. No teachers fell into the low category, and most participants approached the threshold for high effectiveness.

Table 12: Effectiveness Level Based on N-Gain Analysis

	N	Minimum	Maximum	Mean	Std. Deviation
N-Gain	35	0.65	0.75	0.69	.02855

These findings confirm that the ACTIVE intervention model was both effective and equitable in enhancing teacher readiness. The average improvement was near the high-performance threshold, with minimal variability, further validating the model's strength as a collaborative and reflective training approach for deep learning-based physical education.

To further clarify the nature of these improvements, additional analysis highlighted specific instructional changes observed among participating teachers. First, in terms of teacher self-efficacy, most participants reported greater confidence in designing and delivering lessons that integrated the principles of mindful, meaningful, and joyful learning. This was evident in post-intervention survey responses and reflection journals, where teachers expressed assurance in applying reflective questions and embedding value-based activities. Second, notable improvements emerged in classroom procedures and management techniques. Teachers demonstrated more systematic lesson planning, more effective time allocation, and creative use of limited facilities, as observed during microteaching sessions and peer feedback activities. Finally, while direct student outcomes were not measured in this study, teachers' reflections suggested signs of enhanced student engagement. Students were reported to be more responsive, actively involved in discussions, and capable of articulating the underlying meaning of physical activities. Collectively, these results indicate that the ACTIVE model not only strengthened conceptual readiness but also facilitated practical changes in instructional methodology and classroom organization, creating conditions that support deeper student learning experiences.

Discussion

The findings of this study indicate that the readiness of physical education teachers to implement the deep learning approach was initially at a moderate level, particularly in the epistemological and pedagogical dimensions. While affective motivation was relatively high, teachers had not yet fully developed the conceptual understanding or pedagogical skills required. Korzhuev et al., argue that epistemological unpreparedness is a common barrier in adopting pedagogical innovations—especially in contexts that demand paradigm shifts, such as deep learning (29). This is supported by Casey et al., who found that interventions focusing solely on conceptual delivery without practical experience often fail to transform teachers' mindsets and instructional practices (30).

Qualitative data further identified pedagogical, technical, and affective barriers as dominant factors limiting the optimization of deep learning implementation. Teachers expressed difficulty in designing value-based and reflective learning, particularly in the context of physical activities that are typically motor-oriented. Technical constraints—such as limited equipment, restricted time allocation, and administrative pressures—were also cited as major obstacles that are often overlooked in training program designs. Richards *et al.,* emphasize the importance of institutional support and resource availability to ensure the success of learning innovations (31). Meanwhile, affective resistance reflected a lingering comfort with existing teaching habits and a lack of self-efficacy, as noted in Chen, study on teachers' confidence with new pedagogical approaches (32). The development of the ACTIVE intervention model strategically addresses all three dimensions

of readiness through a practice-based, collaborative, and value-oriented approach. Both small- and large-scale trials demonstrated significant improvements in teacher readiness scores post-intervention, statistically confirmed through paired *t*-tests and N-Gain analysis. These results support the findings of Kyndt *et al.,* who assert that the effectiveness of teacher training lies in experiential learning and active involvement throughout the design, implementation, and reflection cycle (33). Fernandez-Rio and Iglesias, also argue that pedagogical transformation cannot rely solely on theoretical approaches, but must be driven by emotional engagement and meaningful peer participation (34).

Teachers' active participation throughout the training process serves as a strong indicator of model acceptability. High average attendance and active contributions during training sessions, reflections, and microteaching illustrate the development of professional awareness and intrinsic motivation fostered by the intervention. Simon and Johnson, explain that professional learning communities enhance commitment to instructional transformation (35). In this context, ACTIVE not only functioned as a training tool but also as a platform for cultivating a peer-learning ecosystem that empowered teachers collectively. Shum *et al*., further suggest that community-based learning contributes to the construction of a new professional identity that is more reflective and collaborative (36).

One of the ACTIVE model's key strengths lies in the integration of critical reflection at every stage. The high average reflection scores indicate that the training encouraged teachers to reconstruct their understanding of physical education—not merely as a vehicle for physical training, but as a value-based, meaningful, and character-building educational medium. Shum *et al.,* argue that reflection is a prerequisite for long-term change in teaching practice (36). Accordingly, ACTIVE has succeeded in establishing a new pedagogical space that integrates affective, cognitive, and social dimensions into physical education learning.

Building on these findings, it is also important to identify which particular instructional improvements were most evident, as well as how the ACTIVE model may be further applied in practical contexts. Teachers reported improvements in instructional methodologies, particularly in designing reflective and value-based lesson plans that integrated mindful, meaningful, and joyful learning (30, 32, 34). They also demonstrated progress in classroom management techniques, such as more structured time allocation, creative use of limited facilities, and better organization of collaborative activities. While direct student outcomes were not quantitatively measured, teacher reflections indicated positive changes in student engagement, including higher participation, increased responsiveness, and deeper understanding of the meaning behind physical activities. These findings suggest that the ACTIVE model contributes not only to teacher readiness but also to broader instructional quality in physical education.

From a practical perspective, the ACTIVE model also offers valuable implications for educational policy and professional development. The six-step cycle (Assess, Clarify, Try, Interact, Validate, and Empower) can be integrated into curricular reforms, particularly by embedding reflective practices into physical education curricula. Furthermore, the collaborative and reflective features of the model make it adaptable for digital platforms, where peer mentoring, reflection journals, and microteaching simulations could be facilitated through online learning management systems. Finally, the ACTIVE model aligns with the goals of professional development programs, as it promotes experiential, practice-based, and community-oriented teacher training. By scaling up its application, policymakers and decision-makers could establish sustainable teacher learning communities that strengthen the long-term adoption of deep learning across diverse school contexts (10, 21, 33, 37).

Another important consideration concerns whether the efficacy of the ACTIVE model depended on teachers' initial preparedness or their level of teaching experience. As shown in Table 2, participants represented a wide range of professional backgrounds, including novice teachers with 2–5 years of experience, mid-level teachers with 6–10 years, and more senior teachers with over 15 years of experience. The N-Gain analysis (Table 12) indicated a consistent improvement across all participants, with scores ranging narrowly between 0.65 and 0.75 and a low standard deviation of 0.02855. This suggests that

the ACTIVE model was effective regardless of teachers' prior preparedness or years of service.

Qualitative reflections further supported this finding. Novice teachers frequently reported that the model enhanced their self-efficacy and confidence in designing reflective lesson plans, while more experienced teachers emphasized that the training encouraged them to rethink long-established practices and adopt more student-centered and value-based approaches. These insights demonstrate that the ACTIVE model not only supports teachers who initially lacked preparedness but also provides meaningful benefits for those with greater teaching experience by enriching their instructional repertoire.

Finally, the statistical evaluation of the model's effectiveness yielded consistent and significant results. The average N-Gain score of 0.69—categorized as moderate-to-high, with low variability—indicates that the training was equitably effective across participants. The importance of impact-based evaluation in assessing the quality of teacher development programs (38). Ritzmann *et al.,* also emphasize that effective training should be measured not only by knowledge gains but also by changes in attitudes, skills, and reflective practices (39). Based on these findings, the ACTIVE model can be recommended as a relevant, contextual, and transformative teacher training approach in support of national educational reform focused on character-building through deep learning.

Conclusion

Based on the research findings, it can be concluded that the ACTIVE intervention model proved to be effective in significantly enhancing the readiness of physical education teachers to implement the deep learning approach. The improvement was evident across all dimensions of readiness—epistemological, pedagogical, and affective—which were previously at a moderate level. Teachers' active participation, high reflective capacity, and positive acceptance of the collaborative and reflective approach indicate that the model not only strengthened conceptual understanding but also fostered meaningful and contextual transformation in teaching practices. These findings affirm that teacher training programs designed around core values, grounded in experiential learning, and tailored to real classroom contexts hold strong potential for replication as a strategic model for professional development in the context of national education reform.

Recommendations

Based on the findings and conclusions of this study, it is recommended that the ACTIVE model be more widely implemented as a professional development strategy for physical education teachers to support the deep learning approach in primary schools. Local governments and educational institutions should facilitate practice- and reflection-based training programs tailored to local contexts, while also promoting the establishment of sustainable teacher learning communities. Training materials should be designed to be practical and visually accessible to accommodate the diverse academic backgrounds of teachers. Future research is encouraged to examine the flexibility and adaptability of the ACTIVE model across different educational levels and subject areas.

Limitation

This study was limited to the geographical context of Sumedang Regency, which restricts the generalizability of the findings to broader populations. The relatively short duration of the intervention also limited the ability to measure long-term impacts. Additionally, the reflective data collected were inherently subjective, and external factors such as school support and facility availability were not fully controlled, which may have influenced the overall effectiveness of the training program.

Abbreviations

None.

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Author Contributions

All authors contributed equally to the conception and design of the study, data collection, analysis, and interpretation. They collaboratively developed

the manuscript, revised it critically for important intellectual content, and approved the final version for publication. All authors take full responsibility for the content of this article.

Conflict of Interest

The authors declare no conflict of interest related to this study or its publication

Declaration of Artificial Intelligence (AI) Assistance

The authors declare that they did not use AI-assisted tools (ChatGPT, OpenAI) during the writing process.

Ethics Approval

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