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DEVELOPMENT OF A REFLECTIVE VIRTUAL REALITY-ASSISTED MICROTEACHING MODEL TO STRENGTHEN THE TEACHING READINESS OF HISTORY EDUCATION STUDENTS

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Abstract

This study developed and evaluated the preliminary feasibility of PRAKTIS-VR, a reflective microteaching model that integrates simulated practice, performance evidence, feedback, structured reflection, and virtual reality in the preparation of pre-service history teachers. The study employed a research and development design based on the ADDIE framework in an American History course within the History Education Study Program at Universitas Persatuan Islam. The development process involved 30 students and five expert validators and produced a seven-phase model, simulation scenarios, instructional materials, a reflection guide, and a 48-item teaching-readiness instrument. Content validation yielded a mean Aiken's V of 0.87, while the instrument demonstrated a Cronbach's alpha of 0.899. The needs profile indicated relative weaknesses in pedagogical reflection and in digital pedagogy, VR, and safety. The pretest-posttest analysis was not treated as an empirical finding because the available paired dataset consisted of synthetic data created for analytical simulation. The available evidence supported the prototype's preliminary content feasibility and identified revision priorities before comparative effectiveness testing.

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1. INTRODUCTION

Preparing pre-service history teachers requires the integration of disciplinary knowledge, historical reasoning, instructional design, classroom management, assessment, and professional reflection. These competencies are essential because effective history teaching involves not only the transmission of historical information but also the ability to facilitate critical inquiry, interpret historical evidence, and accommodate diverse perspectives in classroom learning. The complexity of teaching readiness increases when instructional practices are mediated by digital technologies, as technological proficiency does not necessarily translate into effective pedagogical decision-making. Technology contributes meaningfully to learning when its application is aligned with instructional objectives, pedagogical strategies, and institutional contexts rather than being introduced merely as an additional teaching medium (Voogt & Knezek, 2021). In history education, these challenges are particularly significant because pre-service teachers must transform historical knowledge into meaningful instructional experiences while addressing historical interpretations, student misconceptions, and diverse learner characteristics. Furthermore, the development of pedagogical content knowledge among

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pre-service history teachers is often uneven, particularly when content knowledge, curriculum understanding, knowledge of learners, and instructional strategies must be integrated simultaneously (Smets & Tuithof, 2024). These conditions highlight the importance of developing instructional models that systematically connect disciplinary understanding with practical teaching competencies.

Teaching readiness is a multidimensional construct encompassing pedagogical knowledge, instructional competence, professional confidence, reflective capacity, and the ability to respond appropriately to classroom situations. Research indicates that perceived preparedness, professional engagement, and teaching self-efficacy are interconnected dimensions influencing pre-service teachers' readiness to enter the teaching profession (Abraham & Sickel, 2025). Consequently, teacher education programs need to provide structured opportunities through which students can apply theoretical knowledge, examine their instructional decisions, and progressively develop professional competencies. Microteaching represents an important pedagogical approach because it allows pre-service teachers to practice teaching within a controlled environment, receive feedback, and improve instructional performance. However, conventional microteaching activities may provide limited opportunities for systematic reflection when instructional practice is treated primarily as a single performance rather than as an iterative process of planning, implementation, evidence-based evaluation, and improvement. Therefore, a more structured microteaching model is needed to facilitate continuous professional learning through repeated practice and critical reflection.

Reflective practice plays a central role in transforming practical teaching experiences into professional knowledge and pedagogical improvement. Reflective capacity enables pre-service teachers to identify discrepancies between instructional plans and actual classroom practices, evaluate pedagogical decisions, and formulate appropriate improvement strategies (Baisarinova & Toleubekova, 2023). Technology-supported reflection offers additional opportunities for documenting and evaluating teaching performance through recorded instructional activities, digital portfolios, and observable learning interactions (Näykki et al., 2022; Xerri, 2025; Yuan et al., 2022). Nevertheless, meaningful reflection requires more than reviewing teaching experiences; it demands structured analytical processes that encourage students to examine instructional objectives, teaching decisions, learner responses, and their pedagogical consequences (Chen, 2023; Suhendar et al., 2023). Research further suggests that reflection supported by virtual reality recordings can achieve a quality comparable to reflection based on authentic classroom recordings when learning tasks and evidence-based reflective procedures are appropriately designed (Richter et al., 2022; Ukur et al., 2025). These findings indicate that reflective microteaching should incorporate systematic documentation, evidence-based feedback, critical interpretation, and opportunities to apply the results of reflection in subsequent teaching practices.

Virtual reality (VR) offers considerable potential to strengthen microteaching by providing immersive, repeatable, and relatively controlled environments in which pre-service teachers can practice instructional decisions without directly affecting actual classroom learning. VR-supported learning environments can enhance visualization, engagement, experiential understanding, and decision-making when their instructional design is consistent with targeted learning competencies (Di Natale et al., 2020; Plackett et al., 2021). Immersive experiences may also facilitate deeper engagement with complex situations by encouraging participants to observe, interpret, and respond actively to simulated conditions (Dhunnoo et al., 2023). However, the educational effectiveness of VR cannot be separated from pedagogical design, technological accessibility, and participant readiness. Previous studies have identified technical disruptions, unequal device access, cybersickness, and user discomfort as challenges that may reduce the quality and inclusiveness of immersive learning experiences (Anifowose et al., 2023; Mareta et al., 2022; Stracke et al., 2025). Moreover, the novelty effect associated with immersive technologies may temporarily increase enthusiasm without necessarily producing sustainable improvements in professional competence (Miguel-Alonso et al., 2023). Accordingly, integrating VR into microteaching requires a pedagogically grounded model that prioritizes instructional processes, reflective learning, accessibility, and user safety rather than technological immersion alone.

Previous research has demonstrated the potential of VR-assisted microteaching to support teacher professional development, although existing studies have emphasized different aspects of its implementation. Zhang et al. (2024) examined the contribution of VR-based microteaching to pre-service teachers' teaching skills, particularly instructional strategies and classroom management. Hu et al. (2025) investigated a staged VR microteaching approach and demonstrated the importance of

sequential training in developing diverse teaching behaviors. Meanwhile, Jacobsen et al. (2026) highlighted the potential of VR-based microteaching to facilitate evidence-based peer feedback, emphasizing the importance of feedback quality in improving teaching practice. From another perspective, Lee & Wu (2024) demonstrated differences in performance between pre-service and experienced teachers in immersive VR environments, indicating that pedagogical knowledge and professional experience remain essential for effective technology integration. Ogegbo et al. (2024) further identified psychological and social factors influencing pre-service teachers' acceptance and intended use of VR classrooms. Collectively, these studies provide important empirical foundations for VR-assisted teacher education. However, their different analytical emphases also indicate the need for a more explicitly integrated instructional framework that connects simulation, systematic reflection, instructional redesign, and repeated practice within the distinctive disciplinary requirements of history education.

Despite these developments, a specific research gap remains concerning the systematic integration of reflective microteaching, immersive simulation, and history-specific pedagogical reasoning into a coherent instructional development model. Existing research has provided valuable insights into VR-supported teaching performance, sequential skill development, peer feedback, and technology acceptance. Nevertheless, the extent to which these elements can be organized into a unified and operationally specified practice–reflection–improvement cycle for pre-service history teachers remains insufficiently established. This gap is particularly relevant because history teaching requires competencies that extend beyond general classroom management and instructional presentation, including historical source evaluation, multiperspectivity, contextual interpretation, recognition of historical misconceptions, and evidence-based argumentation. In addition, the development of technology-supported instructional models requires systematic alignment between learner needs, pedagogical objectives, instructional design, implementation procedures, and formative evaluation (Abuhassna et al., 2024). Without such integration, VR-based microteaching risks emphasizing simulated teaching experiences without adequately explaining how those experiences contribute to reflective pedagogical reasoning and subsequent instructional improvement. The urgency of developing a more comprehensive model therefore arises from the need to bridge the gap between technological simulation and the development of discipline-specific, evidence-based teaching readiness among pre-service history teachers.

To address this gap, the present study developed PRAKTIS-VR, a reflective virtual reality-assisted microteaching model specifically designed for history education students. The novelty of PRAKTIS-VR does not lie solely in the use of virtual reality or reflective microteaching, both of which have been explored in previous studies, but in their systematic integration into seven interconnected instructional phases: (1) Readiness Mapping and Orientation, (2) Instructional Design, (3) Simulated Action, (4) Review of Pedagogical Events, (5) Evidence-Based Reflective Interpretation, (6) Improvisation and Redesign, and (7) Resimulation and Transfer. Unlike studies that primarily examine particular outcomes or components of VR-based teacher training, PRAKTIS-VR explicitly organizes the relationships among readiness diagnosis, history-specific instructional planning, simulation, documented teaching performance, evidence-based reflection, instructional revision, and repeated practice. A distinguishing feature of this model is its emphasis on transforming simulation experiences into traceable pedagogical evidence that can be critically examined and used to inform subsequent teaching decisions. Furthermore, PRAKTIS-VR incorporates historical reasoning, source-based interpretation, and sensitivity to multiple historical perspectives into its instructional activities, thereby addressing the disciplinary characteristics of history education. The model also integrates technological accessibility and safety considerations through alternative simulation pathways, ensuring that learning opportunities are not exclusively dependent on immersive VR devices. These characteristics position PRAKTIS-VR as a proposed pedagogical framework that connects technological innovation with reflective professional learning, rather than treating technological immersion as an independent indicator of teaching competence.

The development of PRAKTIS-VR adopts the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) framework to ensure that instructional components are systematically designed, validated, and refined according to identified learning needs. Within this framework, preliminary evaluation focuses on the content validity of the developed model, the internal consistency of the teaching-readiness instrument, and the identification of components requiring further improvement. This evaluation is particularly important because the validity of a developed instructional model cannot be established solely through conceptual arguments or favorable responses to technological innovation. Expert validation provides preliminary evidence concerning the relevance and

coherence of model components, whereas instrument reliability supports the quality of the measurement procedure. Nevertheless, content validity and instrument reliability should be distinguished from empirical evidence of model effectiveness, which requires verified outcome data and more rigorous comparative evaluation.

Based on these considerations, this study aims to develop and preliminarily validate PRAKTIS-VR as a reflective virtual reality-assisted microteaching model for strengthening the teaching readiness of history education students. Specifically, the study seeks to: (1) identify the teaching-readiness needs and pedagogical challenges of pre-service history teachers as the empirical foundation for model development; (2) design and develop the seven-phase PRAKTIS-VR model through the ADDIE framework and evaluate its content validity based on expert judgment; and (3) examine the preliminary internal consistency of the teaching-readiness instrument while establishing the methodological requirements for subsequent evaluation of changes in teaching readiness. Accordingly, this study addresses three research questions: (1) What teaching-readiness needs and pedagogical challenges justify the development of PRAKTIS-VR? (2) How is PRAKTIS-VR designed and developed through the ADDIE framework, and to what extent do expert judgments support its content validity? (3) What preliminary reliability evidence supports the teaching-readiness instrument, and what requirements must be fulfilled before changes in teaching readiness can be evaluated empirically? The study is therefore positioned as a model-development and preliminary-validation investigation rather than a definitive test of instructional effectiveness. Its expected contribution is to provide a theoretically informed, systematically structured, and preliminarily validated instructional prototype that can serve as a foundation for subsequent practicality and effectiveness testing.

2. RESEARCH METHOD

This study employed a research and development (R&D) design using the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) framework (Branch, 2009). ADDIE was selected to connect the diagnosis of student needs, instructional design, prototype construction, limited implementation, and formative evaluation within a systematic and revisable development process. The framework is appropriate for technology-supported instructional products because decisions made during each phase can be informed by evidence and used to refine subsequent development (Abuhassna et al., 2024).

The products comprised the seven-phase PRAKTIS-VR model, historical microteaching simulation scenarios, instructional materials, a structured reflection guide, and a teaching-readiness questionnaire. The current investigation focused on needs analysis, model development, expert-based content validation, preliminary instrument reliability, and documentation of the limited implementation procedure. A one-group pretest–posttest assessment was specified as a preliminary evaluation design; however, because the original paired individual scores were unavailable for audit, changes in teaching readiness were not analyzed as verified empirical outcomes.

The study was conducted over one semester in a two-credit American History course offered in the third semester of the History Education Study Program at Universitas Persatuan Islam. All 30 students enrolled in the course were included through total population sampling in both the needs analysis and the limited implementation. Five validators with expertise in history education, educational technology, and instrument development assessed the content of the model and its supporting materials. The same participants were scheduled to complete a pretest before the Readiness Mapping phase and a posttest after the Resimulation and Transfer phase. The available analytical documents did not contain the original individual scores for these two measurement points; therefore, this manuscript explicitly distinguished needs-analysis data and validation data from example data used solely to simulate statistical procedures.

The development procedure followed the five ADDIE phases, with specified outputs at each phase. During Analysis, student readiness, microteaching needs, course context, technological access, and relevant literature were examined. During Design, the objectives, teaching-readiness construct, seven-phase syntax, simulation scenarios, reflection guide, assessment procedures, and safety protocols were formulated. During Development, the prototype and supporting materials were produced and subsequently reviewed by five experts to obtain evidence of content validity and inform formative revision. Implementation included orientation, simulated practice, collection of performance evidence, feedback, reflection, and repeated practice. Evaluation integrated evidence across phases to determine

which components should be retained, revised, or subjected to further testing. This structure treated ADDIE as an iterative, evidence-informed process rather than merely an administrative sequence of development activities (Crompton et al., 2024).

Table 1. ADDIE Development Procedure

Stage	Main activities	Outputs
Analysis	Analysis of readiness, needs, context, access, and literature	Needs profile and problem specification
Design	Formulation of objectives, constructs, sequence, scenarios, reflection, assessment, and safety	Model design, storyboard, instrument blueprint, and supporting materials
Development	Prototype development, validation by five experts, and formative revision	Prototype and Aiken's V results
Implementation	Orientation, simulated practice, feedback, reflection, and limited trial	Pretest-posttest data and usage notes
Evaluation	Cross-phase formative evaluation and prioritization of revisions	Improvement recommendations and follow-up testing agenda

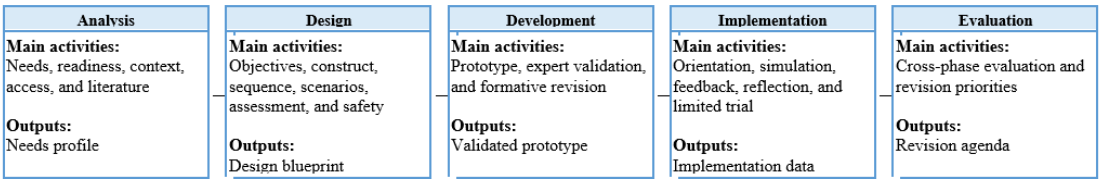


Figure 1. ADDIE Development Procedure

The teaching-readiness questionnaire comprised 48 items rated on a five-point Likert scale and covered eight dimensions: history content knowledge, historical reasoning, instructional design, classroom facilitation and management, assessment and feedback, pedagogical reflection, digital pedagogy and safety, and ethics and inclusion. Internal consistency was assessed using Cronbach's alpha and corrected item-total correlations. The model-validation form comprised 25 items rated on a five-point scale by five validators, and the content-validity coefficient was calculated using Aiken's V (Setiyadi & Kurniady, 2026). Descriptive statistics, including minimum, maximum, mean, standard deviation, and percentage, were used to profile needs across dimensions. Alpha was interpreted as preliminary evidence of internal consistency and was not used as the sole basis for judging the quality of all items.

The analysis of changes in teaching readiness was designed to use paired pretest and posttest scores from the same participants. Normality of the difference-score distribution was to be examined using the Shapiro-Wilk test, after which change would be analyzed using a paired-samples t test if the normality assumption was adequately met or the Wilcoxon signed-rank test if the assumption was violated. The magnitude of change was to be reported with confidence intervals and effect sizes so that interpretation would not rely on p values alone (Williams et al., 2023). The dataset currently available for this procedure consisted of synthetic data created as an example for data entry and analytical practice. Statistics generated from that dataset were not used in this manuscript as evidence of empirical change among the students.

Participants were informed about the study objectives, procedures, potential discomfort associated with VR use, data confidentiality, and their right to withdraw. Participant identities were anonymized in all analytical documents. The VR-use protocol included device orientation, limits on exposure duration, discontinuation when discomfort occurred, sanitation of equipment between users, and the provision of a non-VR alternative pathway. Strengthening the safety protocol was important because immersive experiences can produce cybersickness symptoms and different levels of user burden across individuals. The ethics approval number or institutional authorization should be added to the final manuscript after verification by the research team.

3. RESULT AND ANALYSIS

RESULT

The needs analysis was conducted to identify the initial teaching-readiness conditions of 30 third-semester history education students enrolled in the American History course at Universitas Persatuan Islam. Data were obtained from a 48-item teaching-readiness questionnaire covering eight dimensions of pedagogical and professional readiness. Each item was assessed using a five-point Likert scale. Descriptive statistical analysis, including minimum and maximum scores, means, standard deviations, and percentages, was employed to identify students' relative strengths and areas requiring further instructional support. The mean scores were interpreted in relation to the five-point response scale, while the percentages represented the scores relative to the maximum possible value. Since independently validated categorical thresholds were not established in the available documentation, the results were interpreted comparatively rather than classified into predetermined low, moderate, or high readiness categories.

The results indicated an overall mean teaching-readiness score of 3.36 (SD = 0.24), corresponding to approximately 67.11% of the maximum possible score. History content knowledge demonstrated the highest mean score (M = 3.74; SD = 0.34), followed by historical reasoning (M = 3.52; SD = 0.32) and ethics and inclusion (M = 3.52; SD = 0.44). Conversely, digital pedagogy, VR, and safety obtained the lowest mean score (M = 3.06; SD = 0.35), followed by pedagogical reflection (M = 3.13; SD = 0.37), assessment and feedback (M = 3.20; SD = 0.36), and classroom facilitation and management (M = 3.24; SD = 0.34). These differences suggested that students perceived themselves as relatively more prepared in disciplinary knowledge than in applying that knowledge through technology-supported instructional practice, reflective decision-making, and classroom assessment.

Table 2. Teaching Readiness Profile of Students (N = 30)

Dimension	Min	Max	Mean	SD	%
History content knowledge	3.17	4.33	3.74	0.34	74.78
Historical reasoning	2.83	4.17	3.52	0.32	70.44
Instructional design	2.67	4.00	3.43	0.33	68.67
Classroom facilitation and management	2.67	3.83	3.24	0.34	64.78
Assessment and feedback	2.17	3.83	3.20	0.36	64.00
Pedagogical reflection	2.17	3.83	3.13	0.37	62.56
Digital/VR pedagogy and safety	2.33	4.00	3.06	0.35	61.22
Ethics and inclusion	2.33	4.00	3.52	0.44	70.44
Overall	2.73	3.77	3.36	0.24	67.11

The findings presented in Table 2 provided an empirical foundation for identifying the instructional priorities of the PRAKTIS-VR model. The comparatively lower score in digital pedagogy, VR, and safety indicated the importance of incorporating technological orientation, simulation guidance, safety procedures, and alternative participation pathways into the model. Similarly, the lower pedagogical reflection score highlighted the need for structured reflective activities that encouraged students to examine observable teaching evidence rather than rely exclusively on subjective impressions. The assessment and feedback findings informed the incorporation of evidence-based evaluation procedures, while the classroom facilitation results supported the integration of simulated instructional decision-making.

Furthermore, the relatively higher scores in history content knowledge and historical reasoning suggested that the primary instructional challenge was not simply the acquisition of additional historical information but the transformation of disciplinary understanding into effective teaching practices. Accordingly, PRAKTIS-VR was designed to facilitate the application of historical knowledge through instructional planning, source-based interpretation, management of historical misconceptions, and reflective evaluation of pedagogical decisions. These relationships established a direct connection between the needs-analysis findings and the development of the model's operational phases. However, because the readiness profile was derived from questionnaire responses, the findings should be

interpreted as indicators of reported readiness rather than direct observational measures of actual teaching competence.

PRAKTIS-VR Model Design

The PRAKTIS-VR model was developed as a structured reflective microteaching framework integrating virtual reality-assisted simulation, evidence-based evaluation, and iterative instructional improvement. The acronym PRAKTIS-VR represents seven interconnected Indonesian instructional phases: Pemetaan (Mapping), Rancang (Design), Aksi (Action), Kajian (Review), Tafsir (Interpretation), Improvisasi (Improvisation), and Simulasi Ulang dan Transfer (Resimulation and Transfer). These phases were designed to facilitate a systematic progression from identifying individual readiness and developing instructional plans to simulated teaching, critical reflection, instructional redesign, and repeated practice.

The distinctive feature of PRAKTIS-VR lies in its integration of simulated teaching experiences with structured reflection and subsequent instructional improvement. Rather than emphasizing technological immersion as an independent learning outcome, the model positions performance documentation, evidence-based feedback, and reflective interpretation as mechanisms for developing pedagogical reasoning. This instructional organization is consistent with previous findings indicating that VR-assisted microteaching becomes more productive when learning activities follow a structured sequence and provide opportunities for repeated teaching practice (Hu et al., 2025).

The model also accommodates different technological conditions by integrating headset-based VR with 360-degree video, desktop-supported simulation, or non-VR alternatives. These pathways were included to reduce dependence on immersive devices and address potential barriers associated with technical limitations, unequal access, or user discomfort (Anifowose et al., 2023; Stracke et al., 2025). The intended learning objectives and reflective assessment criteria remain consistent across these pathways, although their practical equivalence requires further empirical evaluation.

Table 3. Seven Operational Phases of PRAKTIS-VR

Phase	Name	Operational steps	Evidence/artifacts
P	Readiness Mapping and Orientation	Diagnose historical knowledge, source reasoning, teaching experience, technological comfort, and access needs; establish safety agreements and individual targets	Readiness map, safety agreement, individual targets
R	Instructional Design	Specify course sub-learning outcomes (Sub-CPMK), essential questions, historical sources, misconceptions, decision points, assessment, and contingency plans	Mini lesson plan (mini-RPS), storyboard, contingency plan
A	Simulated Action	Conduct 10-15 minutes of microteaching through VR or an equivalent alternative and make pedagogical decisions during practice	Video or action log and response artifacts
K	Review of Pedagogical Events	Reconstruct one or two critical events and distinguish observation, interpretation, and evaluation	Incident timeline and evidence
T	Evidence-Based Reflective Interpretation	Connect goals, actions, responses, historical sources, assumptions, identity, and ethical consequences through claims, evidence, and reasoning	Claims, evidence, reasoning, patterns
I	Improvisation and Redesign	Generate alternatives, evaluate consequences, identify priority changes, and design the next test	Revision plan and success indicators
S	Resimulation and Transfer	Reteach the critical episode, compare evidence across rounds, and formulate transfer to real classrooms or other historical contexts	Second-round video, performance change, transfer commitment

As illustrated in Table 3, each instructional phase was designed with clearly defined learning activities and expected performance artifacts. The Readiness Mapping and Orientation phase focuses on identifying students' prior historical knowledge, technological familiarity, teaching experience, and

individual learning needs. For example, students may examine their initial readiness profiles to identify difficulties in facilitating historical discussion or responding to contrasting historical interpretations. These findings can then be used to establish individual improvement targets and determine the assistance required during simulated teaching activities.

The Instructional Design phase requires students to prepare a focused history microteaching plan by identifying learning objectives, selecting historical sources, anticipating misconceptions, and developing appropriate instructional strategies. For instance, in an American History course, students could design a short lesson examining different historical interpretations of the American Revolution. The activity may involve selecting primary historical documents, formulating questions that encourage multiperspectivity, and designing assessments that measure students' ability to construct evidence-based historical arguments.

During the Simulated Action phase, students are expected to implement a 10–15-minute teaching session through an available VR-supported or equivalent instructional pathway. Simulated learning activities are designed to present pedagogical situations requiring students to explain historical concepts, facilitate discussion, respond to learner questions, and make instructional decisions. An illustrative scenario could involve a learner expressing an oversimplified interpretation of a historical event, requiring the prospective teacher to respond through clarification and relevant historical evidence. The expected teaching performance is documented through recordings, observation notes, or action logs.

The Review of Pedagogical Events phase encourages students to identify and examine critical moments in their simulated teaching performance. Instead of evaluating the lesson solely through general impressions, students are guided to distinguish between observable teaching actions, interpretations, and evaluative judgments. For example, they may examine whether a question concerning historical causation was clearly formulated, whether sufficient source evidence was provided, and how the simulated learner response related to the intended learning objectives.

The Evidence-Based Reflective Interpretation phase extends the review process by requiring students to analyze the relationship between instructional intentions, teaching actions, learner responses, and pedagogical consequences. Students are encouraged to construct reflective explanations using claims, supporting evidence, and reasoning. This process emphasizes critical interpretation of teaching performance rather than simple descriptions of what occurred during the simulation.

The Improvisation and Redesign phase requires students to formulate alternative instructional strategies based on the identified evidence. Activities may involve revising historical questions, reorganizing source materials, modifying classroom interaction strategies, or improving assessment procedures. The subsequent Resimulation and Transfer phase provides an opportunity to implement revised instructional decisions, compare performance evidence across teaching attempts, and consider the application of improved strategies in authentic classroom settings.

These examples illustrate the intended operationalization of PRAKTIS-VR rather than independently verified observations from the limited trial. Collectively, the seven phases establish an instructional framework that connects historical understanding, pedagogical decision-making, documented teaching experiences, structured reflection, and iterative improvement. The novelty of PRAKTIS-VR therefore lies in the systematic integration of these components within a discipline-specific microteaching model, rather than in the use of VR technology alone.

Content Validation of the Model

Content validation was conducted to evaluate the relevance, coherence, and appropriateness of the PRAKTIS-VR model and its supporting instructional components. Five expert validators assessed 25 items using a five-point rating scale. The resulting assessments were analyzed using Aiken's V coefficient, producing an overall mean value of 0.87, with aspect-level coefficients ranging from 0.80 to 0.90.

The interpretation of Aiken's V considered the number of validators and rating categories rather than relying exclusively on a universal numerical threshold (Ismarau Tajuddin et al., 2025). With five validators and five response categories, the coefficients provided preliminary evidence supporting the content relevance of the model components. Nevertheless, validation results were interpreted as evidence of content feasibility rather than proof of instructional effectiveness or implementation practicality.

Table 4. Summary of Model Validation by Five Validators

Aspect	Items	Mean	Aiken's V
Construct	2	4.50	0.88
Theory	2	4.50	0.88
Instructional syntax	2	4.60	0.90
Social system	1	4.40	0.85
Principles of reaction	1	4.40	0.85
Support system	1	4.60	0.90
Impact	1	4.40	0.85
Course lesson plan (RPS)	2	4.50	0.88
Content	2	4.60	0.90
Scenario	2	4.50	0.88
Reflection	1	4.60	0.90
Questionnaire	1	4.40	0.85
Rubric	1	4.60	0.90
Assessment	1	4.40	0.85
Technology	1	4.40	0.85
Safety	1	4.20	0.80
Access	1	4.40	0.85
Language	1	4.40	0.85
Feasibility	1	4.60	0.90
Overall	25	4.49	0.87

The findings presented in Table 4 indicate that the instructional syntax, support system, content, reflection, rubric, and feasibility components received relatively favorable expert assessments, with several aspects reaching V = 0.90. These results suggest that the fundamental instructional organization and supporting materials were considered relevant to the intended objectives of the developed model.

However, the safety component obtained the lowest validation coefficient (V = 0.80), indicating a comparatively greater need for refinement. The associated revision priorities included user screening, exposure-duration guidelines, procedures for discontinuing VR activities when discomfort occurs, equipment sanitation, technical support, and alternative access arrangements. These considerations were important for strengthening the model's safety and accessibility provisions.

The validation findings supported retaining the principal seven-phase instructional structure while prioritizing improvements to components requiring greater specification. Nevertheless, the available documentation did not include a complete validator-comment matrix or an auditable record of every modification made following expert review. Therefore, the identified improvements were treated as documented revision priorities rather than presented as completed changes without supporting evidence.

Further development should include systematic documentation of validator recommendations, revisions made to individual components, and subsequent verification of the revised prototype. Such documentation would strengthen the transparency of the development process and establish a clearer relationship between expert evaluation and instructional model improvement.

Reliability of the Teaching-Readiness Instrument

The teaching-readiness instrument comprised 48 questionnaire items representing eight dimensions of professional and pedagogical preparedness. Preliminary reliability analysis produced a Cronbach's alpha coefficient of 0.899, indicating good overall internal consistency among the questionnaire items in the sample of 30 students.

However, item-level analysis revealed variation in the contribution of individual statements to the overall instrument. Corrected item-total correlations ranged from 0.015 to 0.631, with 46 of the 48 items exceeding 0.20. Two items demonstrated comparatively weak correlations, suggesting the need for further examination of their wording, scoring direction, response distributions, and conceptual relevance.

Table 5. Reliability of the Teaching-Readiness Instrumen

Cronbach's alpha	Number of items	Interpretation
0.899	48	Good internal consistency; two items require further review

As indicated in Table 5, the overall reliability coefficient provided favorable preliminary evidence concerning the consistency of the teaching-readiness instrument. Nevertheless, a high Cronbach's alpha coefficient does not necessarily indicate that all items function adequately or measure their intended dimensions with equal precision.

The two items with relatively low corrected item-total correlations require a more detailed evaluation. The proposed follow-up procedure includes examining whether the statements contain ambiguous wording, verifying possible reverse-coded items, identifying restricted response variability, and reconsidering their alignment with the theoretical dimensions of teaching readiness. This evaluation should also involve reviewing the substantive importance of the items before decisions regarding modification or removal are made.

Automatic elimination of the two items based solely on their statistical correlations would risk narrowing the conceptual coverage of the instrument. Instead, instrument improvement should combine statistical evidence with expert judgment and theoretical relevance. The revised items would subsequently require additional testing using a larger and more diverse sample.

Because the available analytical records did not identify the exact statements requiring correction or provide a completed post-revision reliability analysis, the present findings were interpreted as preliminary evidence of internal consistency. Further research should also examine the reliability of individual dimensions to determine whether the eight components of teaching readiness demonstrate adequate measurement consistency.

Status of the Pretest–Posttest Evaluation

The preliminary evaluation of teaching readiness was designed to involve paired pretest and posttest measurements from the same 30 participants. The pretest was intended to be administered before the Readiness Mapping phase, while the posttest was planned following the Resimulation and Transfer phase. This procedure was intended to establish a basis for examining possible changes in teaching readiness following participation in the PRAKTIS-VR learning sequence.

However, examination of the available analytical documentation revealed that the dataset used to demonstrate the planned statistical procedures consisted of synthetic data generated for analytical simulation and practice. Although the dataset could be processed using statistical methods, the scores did not represent verified measurements obtained from the participating students.

Consequently, statistical values derived from the synthetic dataset, including pretest and posttest means, significance levels, test statistics, and effect sizes, were not treated as empirical findings. Such values cannot demonstrate that PRAKTIS-VR improved teaching readiness or produced measurable instructional benefits.

Table 6. Data Status and Planned Pretest-Posttest Analysis

Component	Status
Measurement plan	Pretest before the Readiness Mapping phase and posttest after the Resimulation and Transfer phase for the same participants.
Target N	30 complete pairs of scores.

Component	Status
Planned analysis	Shapiro-Wilk test on difference scores; paired-samples t test or Wilcoxon signed-rank test as appropriate; 95% confidence intervals and effect size.

As summarized in Table 6, the evaluation framework established the procedures required for a subsequent empirical assessment, but the original participant-level measurements were unavailable for verification. A valid analysis requires 30 original pretest scores and 30 corresponding posttest scores linked to the same individuals through anonymized participant identifiers.

Once authentic data become available, the analysis should begin by examining the normality of paired difference scores using the Shapiro–Wilk test. A paired-samples t test may be employed when the relevant assumptions are adequately satisfied, whereas the Wilcoxon signed-rank test may be considered when the distributional assumptions are not met. Appropriate confidence intervals and effect sizes should accompany the interpretation of the results.

The synthetic dataset was useful only for illustrating the computational procedures, analytical workflow, and statistical reporting format. It did not provide evidence of empirical improvement among the participating students. Accordingly, the findings of the present investigation were restricted to the needs analysis, development of the PRAKTIS-VR prototype, preliminary expert-based content validation, and internal consistency assessment of the teaching-readiness instrument.

This methodological distinction is essential because apparent improvements obtained from simulated data cannot be attributed to the developed instructional model. Moreover, even when authentic paired measurements become available, a one-group design will remain vulnerable to maturation, testing effects, other learning experiences occurring during the semester, and temporary enthusiasm associated with VR technology. Stronger conclusions concerning instructional effectiveness therefore require verified empirical observations and an appropriate comparison design.

ANALYSIS

Content Feasibility and Pedagogical Foundations of the PRAKTIS-VR Model

The principal contribution of the present study concerns the development and preliminary content validation of a reflective VR-assisted microteaching model designed specifically for history education students. The integration of needs analysis, instructional model development, and expert evaluation provides an initial foundation for assessing whether the proposed instructional structure is relevant to the pedagogical challenges encountered by prospective history teachers.

The development process reflects the principle that instructional innovation should be guided by systematic analysis, design, development, implementation, and evaluation rather than by the introduction of technology alone. The ADDIE framework provides a coherent structure for connecting instructional problems with design decisions and formative improvements (Quandour & Dabaj, 2026). Within this framework, expert-based content validation contributes evidence regarding the relevance and coherence of instructional components, while the interpretation of validation coefficients must consider the characteristics of the evaluators and rating procedures (Ismarau Tajuddin et al., 2025).

From a theoretical perspective, PRAKTIS-VR addresses a fundamental challenge in history teacher education: the relationship between disciplinary knowledge and the ability to transform that knowledge into effective instructional practice. Historical understanding does not automatically guarantee the ability to facilitate historical inquiry, respond to competing interpretations, or assess students' historical reasoning.

Previous research has demonstrated that pre-service history teachers' pedagogical content knowledge may develop unevenly because effective teaching requires the simultaneous integration of subject knowledge, curriculum understanding, learner characteristics, and instructional strategies (Smets & Tuithof, 2024). The needs-analysis findings are consistent with this concern, as comparatively stronger disciplinary readiness coexisted with lower reported readiness in reflection, assessment, classroom facilitation, and digital pedagogy.

PRAKTIS-VR responds to this challenge by organizing learning activities around the transformation of historical understanding into instructional decisions. Students are expected to select historical sources, anticipate misconceptions, examine contrasting perspectives, and formulate evidence-based explanations within simulated teaching situations. In this way, the developed model

provides a conceptual connection between historical reasoning and the pedagogical actions required in classroom instruction.

Another important theoretical dimension concerns the relationship between teaching experience and reflective professional learning. Recordings, digital documentation, and video-supported reflection can support the examination of instructional events and encourage prospective teachers to reconsider their decisions based on observable evidence (Näykki et al., 2022; Richter et al., 2022; Yuan et al., 2022). PRAKTIS-VR incorporates this principle by positioning documented teaching performance as the basis for reflection and subsequent instructional redesign.

The theoretical contribution of the model therefore lies in its proposed integration of history-specific pedagogical reasoning, simulated teaching experiences, evidence-based reflection, and iterative improvement. Nevertheless, the current evidence demonstrates preliminary content feasibility rather than empirically established effectiveness. The extent to which this instructional structure improves teaching readiness requires further investigation.

Pedagogical Meaning of the Practice–Reflection Cycle

The pedagogical value of PRAKTIS-VR lies in the systematic relationship among instructional action, performance evidence, feedback, interpretation, redesign, and repeated practice. This sequence reflects the understanding that professional learning requires more than participation in teaching simulations; it also involves examining the reasoning behind instructional decisions and considering alternative approaches to classroom situations.

Previous studies have demonstrated that VR-assisted microteaching can support teaching efficacy, instructional strategies, classroom management, and the development of diverse teaching behaviors when simulation activities are organized through purposeful learning sequences (Hu et al., 2025; Zhang et al., 2024). Similarly, evidence-based peer feedback can contribute to professional learning when comments are grounded in observable teaching performance rather than general impressions (Jacobsen et al., 2026).

PRAKTIS-VR integrates these principles by establishing Review of Pedagogical Events and Evidence-Based Reflective Interpretation as distinct instructional phases. This distinction is significant because identifying an instructional difficulty is not equivalent to explaining its causes or consequences. For example, recognizing that a learner provides an inaccurate historical explanation represents an observation, whereas identifying whether the misconception results from insufficient historical context, unclear questioning, or inappropriate source selection requires reflective pedagogical reasoning.

The subsequent Improvisation and Redesign phase gives practical direction to reflection by requiring students to develop alternative instructional strategies based on identified evidence. Resimulation and Transfer then provides an opportunity to reconsider revised instructional decisions within another teaching episode. In this respect, the model positions reflection as a mechanism connecting successive teaching experiences rather than merely as a concluding activity.

However, the potential benefits of this practice–reflection cycle should be distinguished from demonstrated empirical outcomes. Although the model offers a theoretically coherent instructional structure, the available study data do not establish that repeated simulation has resulted in measurable improvements in teaching performance or professional readiness.

Technological readiness also influences the interpretation of simulation performance. Previous research has indicated that pre-service teachers' acceptance of VR environments is shaped by psychological and social factors, including perceived competence and social influence (Ogegbo et al., 2024). Differences between pre-service and experienced teachers further suggest that effective performance in immersive environments depends on pedagogical experience and professional knowledge as well as technological proficiency (Lee & Wu, 2024).

Consequently, the Readiness Mapping phase serves an important diagnostic function by allowing instructors to distinguish difficulties associated with technological operation from those related to pedagogical understanding. This distinction may support more appropriate instructional assistance and reduce the risk of interpreting technical discomfort as inadequate teaching competence.

Furthermore, perceived preparation, professional engagement, and teaching self-efficacy are interconnected dimensions that may develop progressively over time (Abraham & Sickel, 2025). Initial enthusiasm for immersive environments may also be influenced by novelty effects without necessarily producing sustained competence development (Miguel-Alonso et al., 2023). Therefore, subsequent evaluation of PRAKTIS-VR should incorporate repeated measurements, observational performance

assessment, and comparison conditions to determine whether the model produces meaningful and durable instructional benefits.

Theoretical and Practical Contributions to History Education

The theoretical contribution of PRAKTIS-VR is the formulation of an integrated instructional framework that connects history-specific pedagogical reasoning, virtual simulation, performance documentation, structured reflection, and iterative instructional improvement. Although previous studies have investigated VR-supported teaching skills, simulation activities, and professional feedback, PRAKTIS-VR organizes these components into a systematic seven-phase sequence designed for the specific requirements of history teacher preparation.

This disciplinary orientation is particularly important because history education involves distinctive epistemic processes, including historical source evaluation, contextual interpretation, multiperspectivity, and evidence-based argumentation. Consequently, the preparation of history teachers requires instructional experiences that support both general pedagogical competencies and the ability to transform historical knowledge into meaningful learning activities.

PRAKTIS-VR incorporates these requirements by encouraging prospective teachers to engage with historical sources, anticipate competing interpretations, respond to misconceptions, and evaluate instructional decisions through documented evidence. Its theoretical contribution should therefore be understood as an integrated pedagogical design rather than as a claim that VR simulation or reflective microteaching constitutes an entirely new educational approach.

From a practical perspective, PRAKTIS-VR offers a structured instructional sequence that may be adapted for microteaching courses within history teacher education programs. The Readiness Mapping phase provides a basis for identifying individual learning needs, while Instructional Design connects historical knowledge with pedagogical planning. Simulated Action offers opportunities to practice instructional decisions, and the subsequent review and interpretation phases establish procedures for evaluating performance through evidence-based reflection.

The model also provides a possible foundation for more systematic microteaching assessment. Teaching performance may be examined through indicators such as the relevance of historical sources, clarity of instructional explanations, appropriateness of questioning strategies, responsiveness to historical misconceptions, sensitivity to multiple perspectives, and the quality of formative assessment.

The integration of instructional redesign and repeated simulation may further support the development of teaching practices that respond to identified weaknesses. However, these are intended pedagogical benefits rather than outcomes demonstrated by the present study. Their realization depends on the quality of implementation, instructor guidance, student engagement, and the availability of appropriate assessment procedures.

Another practical contribution concerns technological flexibility. PRAKTIS-VR was designed to accommodate headset-based VR, 360-degree video, desktop-supported activities, and non-VR alternatives. This flexibility may make the model more adaptable to educational institutions with different levels of technological infrastructure.

Nevertheless, the availability of alternative pathways does not automatically establish equivalent educational experiences or learning outcomes. Further research should therefore examine whether these approaches provide comparable opportunities for pedagogical decision-making, evidence-based reflection, and instructional improvement.

Taken together, the theoretical and practical contributions of PRAKTIS-VR lie in its proposed alignment of historical reasoning, technology-supported teaching practice, and reflective professional development. The current study establishes an initial instructional framework that can be refined and subsequently evaluated through authentic implementation and outcome data.

Safety and Access

Safety and accessibility constitute essential considerations in the responsible implementation of immersive technologies within teacher education. VR-supported learning experiences can be affected by cybersickness, limitations in avatar responsiveness, privacy concerns, unequal technological access, and differences in user comfort. These factors may influence participation and complicate the interpretation of teaching performance during simulation.

Previous research has indicated that cybersickness can occur among students and may be influenced by movement characteristics, viewing perspectives, and the visual properties of virtual environments (Mareta et al., 2022). Reviews of immersive VR in educational contexts have also

identified technological accessibility, instructional design, technical support, and user comfort as important implementation challenges (Di Natale et al., 2020; Stracke et al., 2025).

Within PRAKTIS-VR, safety and access are incorporated into the instructional design through technological orientation, proposed exposure limitations, discontinuation procedures, equipment sanitation, and alternative learning pathways. These provisions reflect the principle that the educational purpose of simulated teaching should take precedence over maximizing technological immersion.

The inclusion of non-headset alternatives also raises an important assessment consideration. Comparable learning objectives and evaluation criteria are necessary to ensure that differences in technological access do not produce inequitable instructional expectations. However, the equivalence of these pathways remains a question requiring empirical investigation.

Accordingly, safety and accessibility should be treated as integral components of instructional quality rather than secondary technical concerns. Future development should include verified safety procedures, documented participant experiences, records of technical incidents, and systematic evaluation of alternative simulation environments.

Study Limitations

The findings of this study should be interpreted in relation to several methodological and evidentiary limitations. First, the research involved 30 students from a single American History course. Although this cohort provided a relevant context for preliminary needs analysis and limited model development, the sample size and institutional specificity restrict the generalizability of the findings. The sample was also insufficient for comprehensive subgroup comparisons or robust examination of the instrument's multidimensional structure.

Second, expert-based content validation supported the preliminary relevance and coherence of the developed model but did not establish instructional practicality or effectiveness. Although the validation findings identified priorities for improvement, the available documentation did not provide a complete record connecting individual validator recommendations with verified modifications to the prototype. Additional documentation is therefore required to strengthen the transparency and reproducibility of the development process.

Third, despite the favorable overall internal consistency of the teaching-readiness questionnaire, two items demonstrated weak corrected item-total correlations. These items require further examination of wording, scoring direction, response variability, and conceptual alignment. Additional studies involving larger samples are also necessary to assess dimensional reliability and provide stronger evidence of construct validity.

Fourth, the most substantial limitation concerns the absence of verifiable original individual pretest–posttest records. The available paired dataset consisted of synthetic data generated for analytical simulation. Consequently, statistical values derived from that dataset, including Z values, p values, confidence intervals, and effect sizes, cannot be treated as empirical study findings. The present investigation therefore cannot demonstrate that PRAKTIS-VR increased teaching readiness or produced measurable improvements in instructional performance.

Fifth, the proposed one-group pretest–posttest design would remain vulnerable to maturation, repeated testing, concurrent educational experiences, and novelty effects even if original outcome records were subsequently recovered. A comparison group would therefore be necessary to provide stronger evidence regarding the model's comparative effectiveness.

Future research should verify original participant-level measurements, document the fidelity of model implementation, and assess microteaching performance through structured observation involving at least two independent raters. Further studies should also reassess the weak questionnaire items, document validator recommendations and completed revisions, examine students' technological experiences, and evaluate the equivalence of alternative simulation pathways.

A quasi-experimental or experimental design incorporating a comparison group and follow-up measurements would provide a stronger basis for determining whether PRAKTIS-VR contributes to meaningful and sustained improvements in teaching readiness. Such research would extend the contribution of the current investigation from preliminary model development and content validation toward empirically supported conclusions concerning instructional practicality, effectiveness, and applicability across different teacher-education contexts.

4. CONCLUSION

The study produced a PRAKTIS-VR prototype that integrated readiness diagnosis, instructional planning, simulated practice, review of performance evidence, interpretive reflection, improvisation, and resimulation and transfer across seven operational phases. Validation by five experts yielded a mean Aiken's V of 0.87, while the teaching-readiness instrument demonstrated a Cronbach's alpha of 0.899, with two items still requiring further review. The needs analysis identified digital pedagogy, user safety, pedagogical reflection, assessment, and classroom management as areas requiring further strengthening. The available evidence supported the model's preliminary content feasibility and pedagogical rationale but did not support claims of empirical improvement or effectiveness because the available pretest-posttest dataset was synthetic. Subsequent testing should use verified individual scores, implementation-fidelity documentation, microteaching performance assessment, and a comparison group so that changes in teaching readiness can be estimated validly and interpreted proportionately.

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6. CONFLICT OF INTEREST

The authors declare that no conflict of interest affected the design, implementation, analysis, or reporting of this study. This statement should be revised if any financial, institutional, or product-ownership relationship relevant to PRAKTIS-VR applies.

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