



ORIGINAL RESEARCH ARTICLE

Designing and Evaluating a Virtual Teaching Laboratory for Assessing and Developing Preservice Teachers' Oral Presentation Competencies

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ABSTRACT

This study aimed to design and preliminarily evaluate a Virtual Teaching Laboratory grounded in an eight-domain framework of oral presentation competence, while operationalizing six domains through a rule-based multimodal assessment module. The two non-operationalized domains, content organization and quality and audience interaction, were retained within the broader competency framework but were not included in automated assessment because of their semantic and interactional complexity. Adopting a Design-Based Research (DBR) approach, the study was conducted in four phases: needs analysis and identification of design requirements, development of the virtual teaching laboratory, validation and refinement of the design, and pilot implementation and evaluation. The laboratory integrated microteaching, an Electronic Performance Support System (EPSS), learning analytics, and structured feedback mechanisms. To examine preliminary outcomes and the feasibility of the environment, 26 student teachers participated in the pilot implementation. Data were collected and analyzed using an oral presentation competence rubric, a knowledge assessment, an attitude questionnaire, and a user experience questionnaire. The findings showed higher post-test scores than pre-test scores across the six automatically assessed domains of oral presentation competence. User experience findings also indicated that participants perceived the environment as useful, motivating, and authentic, and considered the feedback beneficial for supporting their performance. These findings provide preliminary evidence of improvement and feasibility associated with participation in the virtual teaching laboratory. However, given the single-group pretest-posttest design, the observed changes cannot be attributed definitively to the laboratory, as alternative explanations such as practice effects, task familiarity, Hawthorne effects, and maturation cannot be ruled out. ©authors

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1. Introduction

Oral presentation competence is one of the most essential professional competencies for teachers, playing a pivotal role in shaping instructional interactions and facilitating the achievement of learning objectives. A substantial proportion of teaching activities is carried out through verbal communication, explanation of concepts, facilitation of classroom discussions, responding to students' questions, and providing feedback. Consequently, effective teaching depends not only on teachers' subject-matter knowledge but also on their ability to communicate that knowledge effectively and engage learners. Previous studies have consistently shown that oral presentation competence is a prerequisite for effective teaching and is closely associated with the quality of instructional interactions, learner engagement, and the overall success of the teaching–learning process (Gomez, 2019; Thienpermpool, 2021; Jaca & Javines, 2020).

Despite its importance, research evidence indicates that deficiencies in communication and oral presentation skills remain a significant challenge within the teaching profession. Numerous studies have demonstrated that the quality of verbal interaction, the nature of feedback, and teachers' communication practices substantially influence educational effectiveness. Conversely, weaknesses in communication skills may negatively affect student learning, classroom management, and instructional interactions (Aghdasi et al., 2013; Mohammadzadeh, 2017; Ranjbar, 2015; Dashteh et al., 2021).

Although oral presentation competence is an acquired and trainable skill, providing sufficient opportunities for its development within teacher education programs remains challenging (Vaghour Kashani et al., 2019). In many cases, communication skills are taught primarily through theoretical coursework, while student teachers are afforded limited opportunities for systematic practice, feedback, and performance refinement. In addition to the scarcity of practice opportunities, conventional assessment and feedback approaches present further limitations. Oral presentations are typically evaluated through direct observation and human judgment. While feedback from instructors and supervisors is valuable, such approaches are time-intensive, require considerable human resources, have limited scalability, and often fail to provide immediate, continuous, and multidimensional feedback (Van Ginkel, 2019). Moreover, practical and scheduling constraints frequently reduce opportunities for repeated and deliberate practice. As a result, many student teachers receive insufficient feedback regarding the strengths and weaknesses of their performance. These challenges underscore the need for innovative approaches capable of providing meaningful practice opportunities and continuous feedback in a more efficient and scalable manner.

One well-established approach for developing teaching and presentation skills is microteaching. Microteaching provides a controlled environment in which student teachers can practice instructional skills while observing, analyzing, and reflecting on their performance. Research has shown that microteaching can enhance instructional skills, professional competencies, self-confidence, and attitudes toward teaching (Reddy, 2019; Ledger & Fischetti, 2020; Wangchuk, 2019). However, traditional microteaching remains heavily dependent on human feedback and often lacks systematic mechanisms for recording, analyzing, and evaluating performance.

Recent advances in educational technologies, instructional simulations, artificial intelligence, and Electronic Performance Support Systems (EPSS) have created new opportunities for designing practice-based learning environments that address some of the limitations of traditional approaches. These technologies enable learners to engage in practice within safe, repeatable, and controllable environments while receiving performance-based feedback. Furthermore, the ability to capture and analyze performance data can facilitate both assessment and skill development processes (Batrincea et al., 2013; Chollet, 2015; Van Ginkel et al., 2015; Kleftodimos & Triantafyllidou, 2022).

Despite the growing body of research on oral presentation training and assessment, many existing systems and tools focus primarily on observable behaviors such as eye contact,

posture, or vocal characteristics, while paying limited attention to the multidimensional nature of oral presentation competence within the teaching profession (Ishino et al., 2022; Chollet et al., 2015; Tanveer et al., 2015). To address this gap, a previous systematic review conducted by the authors (Maleki et al., 2026) identified and synthesized the dimensions and components of teachers' oral presentation competence, resulting in an evidence-based competency framework comprising eight domains: verbal skills, vocal skills, body movement, facial expression and eye contact, content structure, presentation management, personal and behavioral characteristics, and audience interaction. The present study builds upon this conceptual foundation but differs substantially in its objectives and methodology. Rather than identifying competency dimensions, it focuses on designing, developing, and evaluating a Virtual Teaching Laboratory that operationalizes the competency framework within an authentic technology-enhanced learning environment. These findings suggest that the development of oral presentation competence requires simultaneous attention to multiple dimensions of teaching performance and cannot be adequately captured through a limited set of behavioral indicators. While this framework provides a theoretical foundation for understanding oral presentation competence, a critical question remains unanswered: How can these competencies be translated into an operational learning environment that supports practice, assessment, feedback, and continuous development?

Accordingly, the primary challenge is no longer merely identifying the components of oral presentation competence but designing an educational environment capable of assessing, practicing, and developing these competencies in an integrated manner. In response to this need, the present study draws upon the findings of the previous systematic review and leverages the affordances of educational technology to design and evaluate a virtual teaching laboratory for assessing and developing student teachers' oral presentation competence. The laboratory aims to provide a structured environment for repeated practice, competency-based feedback, and progressive performance improvement within a controlled and accessible setting.

To address this challenge, the study adopts a Design-Based Research (DBR) approach. By emphasizing problem analysis, solution design, implementation, evaluation, and iterative refinement, DBR provides a methodological framework for bridging theory and practice. Within this framework, the present study seeks to design, develop, and preliminarily evaluate a Virtual Teaching Laboratory grounded in the eight-domain competency framework identified through the systematic review. The laboratory's rule-based multimodal assessment module operationalizes six domains that can be assessed through observable audio-visual indicators: body movement, facial expression and eye contact, vocal skills, verbal skills, presentation management, and personal and behavioral characteristics. The two remaining domains—content organization and quality and audience interaction—remain part of the broader eight-domain competency framework but are not automatically assessed in the current version because of their semantic and interactional complexity. Thus, the automated module is positioned as a behavioral and multimodal assessment component within the broader eight-domain framework rather than as a comprehensive substitute for the full competency construct.

Grounded in the competency framework identified through the systematic review, principles of microteaching, Bandura's Social Cognitive Theory, Electronic Performance Support Systems, and learning analytics, the laboratory was designed to support repeated practice, structured feedback, and continuous performance improvement. Beyond introducing a technology-enhanced learning environment, this study also aims to generate design knowledge that may inform the development of similar environments in teacher education.

2 .Literature Review

2.1. Oral Presentation Competence in Teacher Education

Oral presentation competence is a fundamental professional competency in teaching that plays a crucial role in knowledge transmission, learning facilitation, and the establishment of effective instructional interactions (Gomez, 2019; Thienpermpool, 2021). This competence extends beyond the mere delivery of information and encompasses a combination of knowledge, skills, and attitudes that teachers employ to explain concepts, organize content, engage learners, and guide the learning process (De Grez, 2009). From this perspective, oral presentation competence can be regarded as a central component of teaching practice that bridges instructional design and the realization of learning outcomes.

Although oral presentation competence is related to concepts such as verbal communication, classroom management, and instructional lecturing, it is not synonymous with them. Verbal communication refers broadly to spoken interaction between individuals, whereas teachers' oral presentation competence involves purposeful and structured communication aligned with instructional goals. Furthermore, unlike instructional lecturing, which is often characterized by one-way information delivery, oral presentation competence in teaching is inherently interactive, encompassing questioning, feedback provision, responsiveness, and the facilitation of learner participation (DeVito & DeVito, 2019; Evertson & Weinstein, 2006; Emmer & Sabornie, 2015; Marzano & Marzano, 2003; Hatami, 2022; Gholami, 2014). Research has consistently conceptualized teachers' oral presentation competence as a multidimensional construct that emerges from the interaction of verbal, vocal, nonverbal, cognitive, and interpersonal skills. These dimensions do not operate independently; rather, their integration shapes the overall quality of teaching performance. In a previous study conducted by the authors, teachers' oral presentation competence was conceptualized as a multidimensional construct comprising eight domains: verbal skills, vocal skills, body movement, facial expression and eye contact, content structure and quality, presentation management, personal and behavioral characteristics, and audience interaction (Maleki et al., 2026). This competency framework served as the conceptual foundation for the design of the virtual teaching laboratory developed in the present study.

2.2. Virtual Teaching Laboratories

One of the emerging applications of information and communication technologies (ICT) in teacher education is the development of virtual laboratories that enable the practice and assessment of professional competencies in controlled, safe, and repeatable environments. Virtual laboratories are technology-enhanced learning environments that employ simulation and digital tools to provide opportunities for experiencing instructional situations without the temporal and spatial constraints of traditional settings. These environments allow learners to perform, repeat, and refine activities that would otherwise take place in real-world contexts (Adarkwah, 2021; Das, 2019; Hatami et al., 2018).

Research has demonstrated that virtual laboratories can enhance instructional flexibility, provide increased opportunities for practice, and reduce the costs associated with practical training. Unlike traditional settings, where opportunities for practice and feedback are often restricted to face-to-face sessions, virtual laboratories facilitate performance recording, replay, structured feedback, and progress monitoring. As a result, learning can be transformed from a discrete event into a continuous cycle of practice, feedback, and performance improvement (Sasongko & Widiastuti, 2019).

Within teacher education, virtual laboratories become particularly valuable when integrated with practice-based approaches such as microteaching. These environments enable repeated teaching performances, observation of practice, feedback provision, and subsequent refinement of instructional behaviors. Moreover, the integration of learning analytics, simulation technologies, and artificial intelligence can enhance assessment processes and support performance-based learning. Accordingly, a virtual teaching laboratory can be conceptualized as a technology-enhanced environment that supports the development of

teachers' professional competencies through opportunities for practice, feedback, and reflection. Building upon these affordances, the present study focuses on the design and evaluation of a virtual teaching laboratory for assessing and developing student teachers' oral presentation competence. The design of the laboratory was grounded in three primary foundations: microteaching, Electronic Performance Support Systems (EPSS), and learning analytics.

2.3. Bandura's Social Cognitive Theory

Bandura's Social Cognitive Theory provides one of the most influential theoretical frameworks for understanding learning processes and the development of human behavior. According to this theory, learning results from the reciprocal interaction among personal factors, environmental influences, and behavior. Individuals are not passive recipients of information; rather, they actively engage in learning through observation, reflection, self-evaluation, and self-regulation (Zhang et al., 2023; Chinh et al., 2021).

The theory further emphasizes the importance of feedback and performance observation in learning. When individuals have opportunities to observe their own performance, receive feedback, and evaluate their progress, they are more likely to modify their behaviors and adopt effective strategies for achieving learning goals (Shan, 2021). Guided by these principles, the virtual teaching laboratory developed in this study was designed to provide student teachers with opportunities for repeated practice, performance observation, and structured feedback, thereby supporting continuous improvement and competence development.

3. Method

3.1. Research Design

This study employed a Design-Based Research (DBR) approach. DBR has been defined as a systematic yet flexible methodology aimed at improving educational practices through iterative processes of analysis, design, development, implementation, and refinement (Wang & Hannafin, 2005). The primary goal of DBR is to generate practical solutions grounded in theory and prior research while simultaneously producing design knowledge that can inform future educational innovations (Azimi et al., 2023).

The selection of DBR was guided by the developmental and intervention-oriented nature of the study, as well as the need to design, implement, refine, and evaluate a virtual teaching laboratory within an authentic teacher education context. Unlike traditional experimental approaches that focus primarily on measuring the effectiveness of a predefined intervention, DBR emphasizes iterative cycles of design, implementation, evaluation, and redesign. Educational solutions are developed, tested in practice, examined for strengths and limitations, and continuously refined based on empirical evidence. This process continues until a functional and validated design solution is achieved. Accordingly, DBR provided an appropriate framework for integrating theoretical foundations, educational needs, stakeholder feedback, and empirical evidence throughout the development of the virtual teaching laboratory.

The study was organized into four overarching phases: (a) needs analysis and identification of design requirements, (b) design and development of the virtual teaching laboratory, (c) expert validation and iterative refinement, and (d) implementation and evaluation. Although these phases are presented sequentially for ease of reporting, the development process itself was iterative rather than linear. Following the initial prototype development, the laboratory underwent expert review, and the resulting feedback informed a series of design revisions. A pilot implementation was subsequently conducted to evaluate the agreement between automated and human assessment, leading to further refinements before the main implementation and effectiveness evaluation. Thus, each stage informed subsequent design decisions, reflecting the iterative nature of the Design-Based Research process.

In the present study, a one-group pretest–posttest design was adopted as part of the pilot implementation phase of the Design-Based Research (DBR) approach. The purpose of this phase was to examine within-participant changes in oral presentation competencies following engagement with the Virtual Teaching Laboratory and to evaluate the feasibility and preliminary outcomes of the developed environment. Therefore, participants' post-intervention performance was interpreted in relation to their own baseline performance.

3.1.1. Phase 1: Needs Analysis and Identification of Design Requirements

The design of the Virtual Teaching Laboratory was guided by the competency framework established in the authors' previous systematic review (Maleki et al., 2026), which identified eight competency domains and thirty-two components of preservice teachers' oral presentation competence. This framework served as the conceptual foundation for Phase 1 of the Design-Based Research process and informed the design of the assessment rubric, automated feedback mechanisms, and instructional activities implemented within the virtual laboratory.

The first phase focused on analyzing the educational problem and identifying design requirements. To establish a conceptual foundation, the study drew upon a previously conducted systematic review by the authors (Maleki et al., 2026), which synthesized findings from 88 studies and conceptualized teachers' oral presentation competence as a multidimensional construct. The review identified eight major domains: body movement, facial expression and eye contact, vocal skills, verbal skills, content structure and quality, presentation management, personal and behavioral characteristics, and audience interaction. The findings of this review served as the primary conceptual basis for the virtual teaching laboratory. Based on the identified competency framework, several key design requirements were specified, including opportunities for repeated practice, competency-based assessment, structured feedback, performance recording and analysis, self-assessment, and longitudinal progress monitoring (Table 1).

Table 1. Examples of Design Revisions During the Development Process

Component	Expert Feedback	Revision
Rubric	Some indicators overlapped conceptually	Similar indicators were merged
Feedback Reports	Reports were excessively lengthy	Reports were summarized and streamlined
Dashboard	Information load was too high	Data visualization was simplified

3.1.2. Phase 2: Design and Development of the Virtual Teaching Laboratory

In the second phase, the virtual teaching laboratory was designed and developed based on the identified requirements. The design integrated principles of microteaching, Social Cognitive Theory, Electronic Performance Support Systems (EPSS), learning analytics, and artificial intelligence. The resulting environment enabled student teachers to deliver instructional presentations, record their performances, receive automated analyses, and obtain structured feedback.

The learning process within the laboratory consisted of four major stages: presentation delivery, data capture, performance analysis and feedback generation, and subsequent re-performance based on the received feedback.

To support performance assessment, a dedicated software platform was developed to capture and process video and audio recordings. The system allowed both real-time recording through a webcam and offline submission through uploaded video files. Recorded presentations were segmented into temporal units and prepared for further analysis.

Subsequently, a variety of audio and visual features were extracted from each presentation segment. These features included speech-related indicators, vocal characteristics, body movements, gaze behaviors, and other observable presentation behaviors. Performance was then evaluated using predefined rules derived from the oral presentation competence rubric. The system relied on rule-based algorithms developed from the competency framework

reported in the authors' previous study (Maleki et al., 2026), ensuring both interpretability and alignment with the theoretical model of oral presentation competence.

To facilitate learning and performance improvement, the laboratory incorporated EPSS principles. Following each presentation, student teachers received individualized feedback reports highlighting strengths, areas for improvement, and specific recommendations. Performance data were stored across multiple sessions, enabling longitudinal comparisons and progress monitoring. Through these features, the environment functioned as a platform for practice, reflection, and progressive competence development.

3.1.2.1. Instructional Training Cycle of the Virtual Teaching Laboratory

The Virtual Teaching Laboratory was designed not only as an automated assessment environment but also as an instructional system that supports the progressive development of preservice teachers' oral presentation competencies through iterative cycles of practice and feedback. The instructional approach integrates the principles of microteaching, Social Cognitive Theory (SCT), Electronic Performance Support Systems (EPSS), learning analytics, and artificial intelligence into a coherent learning process. Rather than providing a single performance evaluation, the laboratory enables learners to repeatedly practice, receive individualized feedback, reflect on their performance, and improve their competencies over successive iterations.

The instructional process begins by asking preservice teachers to select a specific segment of a teaching session and deliver it as a microteaching presentation. Limiting the task to a focused teaching segment allows participants to concentrate on improving observable presentation competencies while reducing the cognitive demands associated with delivering a complete lesson. During the presentation, the laboratory simultaneously records the participant's audio and video streams for subsequent analysis.

Following each presentation, the recorded performance is automatically analyzed using the system's multimodal assessment engine. Audio features (e.g., speech rate, pauses, pronunciation, pitch variation, volume, and voice stability) together with visual indicators (e.g., posture, gestures, facial expressions, eye contact, and body movement) are extracted and mapped to the competency framework through rule-based scoring algorithms. Based on these analyses, the system generates an individualized competency report that identifies strengths, weaknesses, and specific aspects requiring improvement for each participant.

The generated feedback serves as an Electronic Performance Support System (EPSS), providing immediate, criterion-referenced guidance that learners can use to improve subsequent performances. Participants review both their competency scores and the accompanying recommendations before preparing a revised presentation. This reflective stage encourages self-monitoring, self-assessment, and self-regulation, which are central mechanisms of Social Cognitive Theory for developing professional competence.

After reviewing the feedback, participants repeat the same teaching segment, allowing them to apply the recommendations directly in a new performance. The laboratory then conducts another automated analysis and generates a new competency report. Because the system stores the results of successive performances, participants can compare their previous and current feedback reports to monitor their progress over time and identify areas of improvement that still require additional practice. This iterative cycle of performance, automated analysis, feedback, reflection, and re-performance continues to support gradual competency development through deliberate practice.

Accordingly, the Virtual Teaching Laboratory functions as more than an assessment tool; it constitutes an instructional environment in which automated analytics, structured feedback, reflective learning, and repeated microteaching are integrated to facilitate the continuous development of oral presentation competencies in preservice teachers.

Table 2. *Theoretical Foundations of the Instructional Training Cycle in the Virtual Teaching Laboratory*

Training Stage	Theoretical Foundation
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Selecting and delivering a teaching segment	Microteaching
Audio–video recording	Learning Analytics
Automated performance analysis	Artificial Intelligence, Computer Vision, Signal Processing
Competency-based feedback	Electronic Performance Support System (EPSS)
Reflection and self-assessment	Social Cognitive Theory
Re-performance	Deliberate Practice and Microteaching
Progress comparison	Self-regulated Learning and Learning Analytics

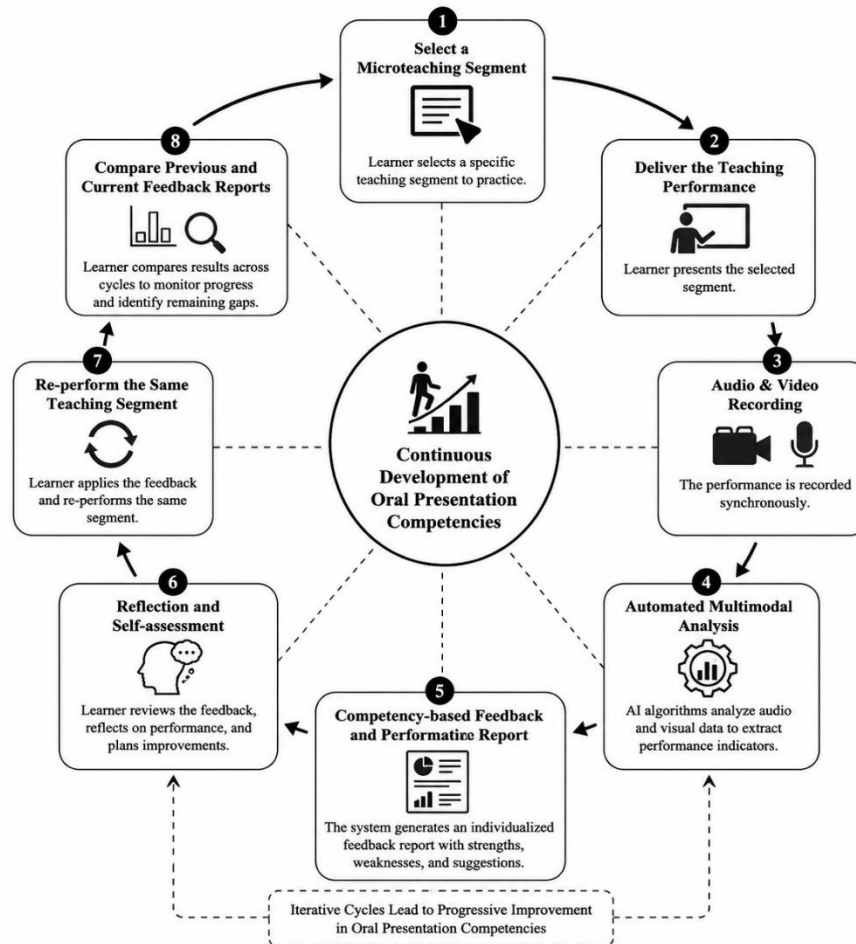


Figure 1. Instructional Training Cycle of the Virtual Teaching Laboratory

3.1.3. Phase 3: Validation and Refinement

Following the development of the initial prototype, a validation process was conducted. The oral presentation competence framework and the corresponding assessment rubric were reviewed by five experts in educational technology and teacher education. The experts evaluated the framework and rubric in terms of relevance, clarity, conceptual comprehensiveness, and the operational feasibility of the assessment criteria. This review served as a qualitative content validation and refinement process rather than a formal psychometric validation. Based on the experts' feedback, several components were revised, merged, or redefined; performance descriptors and scoring criteria were clarified; overlapping indicators were consolidated; ambiguous wording was resolved; and consistency across rubric dimensions was improved, resulting in a refined version suitable for implementation within the virtual teaching laboratory. Overlapping indicators were identified through expert review of conceptual similarity and content coverage, and decisions to merge or remove indicators were made based on the experts' qualitative judgments regarding redundancy and whether the intended competency was adequately represented by another indicator. The rubric also underwent qualitative expert review for content coverage and face validity. The rubric also underwent qualitative expert review for

content coverage and face validity. Formal quantitative content validity indices (e.g., CVR and CVI) were not calculated, and this is acknowledged as a limitation of the present study. Previous research on teacher education and presentation assessment has shown that observational rubrics achieve acceptable reliability when scoring procedures are stable, reproducible, and independent of individual raters. Therefore, reliability in such instruments is commonly assessed through inter-rater or procedural reliability rather than internal consistency.

To evaluate the agreement between the automated assessment system and the human evaluator, a pilot study involving 15 female student teachers enrolled in educational sciences programs at Farhangian University was conducted. Although appropriate for pilot validation, this sample size should be considered preliminary, and larger validation studies are needed to further examine the robustness and generalizability of the agreement estimates. During this phase, presentation performances were evaluated independently by both a human expert and the automated assessment system. This dual-rating approach enabled examination of agreement between human and automated scoring procedures.

Scores assigned by the instructor and those generated by the system were compared across six dimensions of oral presentation competence: body movement, facial expression and eye contact, vocal skills, verbal skills, presentation management, and personal and behavioral characteristics. Agreement between the automated assessment system and the human evaluator was quantified using a two-way random-effects Intraclass Correlation Coefficient (ICC) model with absolute agreement. This model was selected because the study aimed to estimate the agreement between two independent rating methods while allowing the agreement framework to be generalized beyond the specific ratings obtained in this pilot implementation. Absolute agreement was adopted because the objective was to examine whether the automated system produced scores comparable to those assigned by the human evaluator.

Results indicated ICC values ranging from .81 to .92 across the rubric dimensions, reflecting good to excellent agreement between the automated assessment system and the human evaluator (Koo & Li, 2016). Furthermore, the overall agreement for the total oral presentation competence score reached $ICC = .89$, indicating a high level of scoring agreement between the two rating sources. These findings suggest that the automated assessment system produced scores that were highly consistent with those assigned by the human evaluator across the assessed dimensions.

3.1.4. Phase 4: Implementation and Evaluation

In the final phase, the virtual teaching laboratory was implemented, and its effectiveness was evaluated. Participants were female student teachers enrolled in Educational Sciences programs at Farhangian University of Hamedan who had previously completed a science teaching methods course. A convenience sampling strategy was employed, resulting in a sample of 26 student teachers.

Four measures were used to evaluate the effectiveness of the laboratory: (a) the Oral Presentation Competence Rubric, (b) the Oral Presentation Attitude Questionnaire (PAOCS; Langlois & Cormier, 2021), (c) an open-ended knowledge assessment measuring participants' understanding of oral presentation competence components, and (d) a User Experience Questionnaire adapted from Van Ginkel et al. (2017).

The **Oral Presentation Competence Rubric** was developed based on the competency framework identified through the systematic review conducted in the first phase of the study. The rubric covered the identified domains and competency components of oral presentation competence, including motor/body skills, facial expression and gaze, vocal skills, verbal skills, presentation management, and personality/behavioral characteristics. The rubric consisted of observable and operationalized behavioral indicators, with performance descriptions designed to reduce ambiguity in scoring and facilitate consistent assessment.

The final rubric was reviewed by five experts in educational technology and teacher education to examine the clarity, simplicity, and relevance of the items to the objectives of the study. Based on the experts' feedback, several items were revised or integrated. Specifically, items addressing arm position and hand gestures were consolidated where they overlapped conceptually; posture- and head-position indicators were integrated into a single indicator; and two grammar-related items were removed because their content was fully represented by a broader grammar-accuracy indicator. These revisions were intended to improve the content coverage, clarity, and coherence of the rubric.

Given the performance-based and observational nature of the rubric, its reliability was examined through agreement between human and automated scoring rather than through internal consistency indices such as Cronbach's alpha. During the pilot validation, the presentations of 15 student teachers were scored by a human evaluator who was an expert in educational technology and teacher education, as well as by the automated assessment system. The system extracted quantitative indicators from the audio and video recordings and converted them into rubric scores according to predefined operational rules. Agreement between the human and automated scores was assessed using a two-way random-effects intraclass correlation coefficient (ICC) with absolute agreement. The ICC coefficients across the rubric dimensions ranged from 0.81 to 0.92, while the overall ICC was 0.89, providing initial evidence of agreement between the automated and human scoring procedures.

The **Oral Presentation Attitude Questionnaire (PAOCS)** developed by Langlois and Cormier (2021) was used to assess participants' attitudes toward oral presentation across five dimensions: perceived importance, enjoyment, anxiety, self-efficacy in norms and content, and self-efficacy in performance. In the present study, the internal consistency of the questionnaire was examined using Cronbach's alpha. The obtained coefficients were .772 for perceived importance, .951 for enjoyment, .909 for anxiety, .836 for self-efficacy in norms and content, and .865 for self-efficacy in performance, indicating acceptable to excellent internal consistency across the dimensions.

The **open-ended knowledge assessment** was developed based on the oral presentation competence framework identified in the previous systematic review. Participants were asked to identify the main components of teachers' oral presentation competence and briefly explain each component. Because this measure consisted of a single open-ended knowledge question rather than a multi-item psychometric scale, internal consistency reliability was not applicable. Instead, responses were evaluated using a predefined coding framework derived from the competency components identified in the systematic review. The unit of analysis for quantitative scoring was the number of correctly identified components, with each correctly identified component receiving one point. The total score reflected participants' knowledge of oral presentation competence components before and after the intervention. In addition, deductive thematic analysis was conducted to examine changes in participants' conceptual understanding of oral presentation competence across the pre- and post-intervention responses. Responses were coded by the researcher using the established competency framework.

The **User Experience Questionnaire**, adapted from Van Ginkel et al. (2017), was used to assess participants' perceptions of their experience with the virtual teaching laboratory. The questionnaire addressed three dimensions: content structure, nonverbal behaviors, and audience interaction. Internal consistency was examined using Cronbach's alpha, yielding coefficients of .86 for content structure, .84 for nonverbal behaviors, and .82 for audience interaction, indicating acceptable internal consistency across the three dimensions.

The implementation process began with a pretest assessment of participants' oral presentation competence, knowledge, and attitudes. The pretest was administered before the intervention under standardized conditions. For the oral presentation assessment, participants completed a microteaching activity in the Virtual Teaching Laboratory, in which they delivered an instructional presentation on a predefined and identical topic and using the same presentation

text to control for the potential effects of task content on presentation performance. Each presentation lasted a maximum of 20 minutes. All participants completed the presentation individually in the same room under equivalent environmental conditions, using the same camera and microphone and without a live audience. Following the first performance, participants received system-generated feedback, including performance scores, feedback reports, and recommendations for improvement. They were also able to review their recorded presentations to reflect on their performance. The knowledge assessment was administered before and after the intervention using the same open-ended question: “In your opinion, what are the main components of teachers’ oral presentation competence? Name them and briefly explain each one.” The attitude questionnaire was administered online at both pretest and posttest.

After one week, participants repeated the same microteaching activity in the Virtual Teaching Laboratory under the same standardized conditions and received a second round of automated assessment and feedback. Finally, posttests were administered to examine changes in oral presentation competence, knowledge, and attitudes, and participants’ perceptions of their learning experiences within the virtual teaching laboratory were collected and analyzed. The posttest procedures followed the same conditions and procedures as the pretest. Quantitative data were analyzed using appropriate statistical procedures to examine changes following participation in the learning environment.

Table 3. Iterative Design Cycles of the Design-Based Research Process

DBR Phase	Data Informing the Design	Design Decision	Design Refinement
Phase 1: Needs Analysis	Findings of the authors’ previous systematic review and relevant literature	Define competency framework and system requirements	Design specifications established
Phase 2: Design and Development	Educational theories and design requirements	Develop the initial prototype of the Virtual Teaching Laboratory	Prototype completed
Phase 3: Expert Validation and Refinement	Expert review and validation feedback	Revise the assessment rubric, feedback reports, and system functions	Prototype refined based on expert recommendations
Phase 4: Implementation and Evaluation	Pilot testing, ICC results, participant feedback, and effectiveness evaluation	Finalize the system and evaluate its educational effectiveness	Final version of the Virtual Teaching Laboratory

3.1.5. Ethical Considerations

Participation in this study was entirely voluntary. All participants were informed about the purpose and procedures of the study before participation, and informed consent was obtained from each participant. Participants were assured that their data would be treated confidentially and used solely for research purposes. They were also informed that they could withdraw from the study at any stage without any consequences.

4. Findings

4.1. Design Outcomes

4.1.1. Architecture of the Virtual Teaching Laboratory

A major outcome of the design process was the development of an integrated virtual teaching laboratory capable of assessing oral presentation competence through the simultaneous processing of audio and video data. The system was designed to capture teaching performances either synchronously through a webcam or asynchronously through uploaded video recordings. Drawing on signal processing, computer vision, and behavioral analytics techniques, the laboratory extracts and evaluates multiple dimensions of oral presentation performance.

The system architecture consists of four interconnected layers: data acquisition, temporal segmentation, performance analysis, and feedback generation. During data acquisition, video streams are converted into sequential frames for the analysis of body posture, gestures, facial expressions, and eye contact, while audio signals are simultaneously recorded for

speech analysis. To support continuous operation and minimize interruptions, audio and video processing are conducted asynchronously.

Following data acquisition, presentations are segmented into equal temporal intervals that serve as units of analysis. This approach reduces the influence of momentary fluctuations and enables the monitoring of performance patterns throughout the presentation. Within each segment, a set of quantitative features is extracted, including vocal variation, speech rate, pauses, body movement, posture stability, gaze behavior, and emotional indicators.

These features are subsequently transformed into educationally interpretable indicators aligned with the oral presentation competence rubric. Finally, performance data are aggregated across presentation segments and converted into competency scores using a five-level rating framework. In addition to providing overall scores, the system generates longitudinal performance profiles that enable users to monitor changes and improvements over time. All recordings, analyses, scores, and feedback reports are stored in a structured database, allowing retrieval, progress tracking, and report generation. Through this architecture, the laboratory provides a systematic, objective, and repeatable framework for assessing oral presentation competence in teacher education.

4.1.2. Development of the Oral Presentation Competence Rubric

Another key design outcome was the development of a competency-based assessment rubric derived from the oral presentation competence framework identified in the authors' previous systematic review (Maleki et al., 2026). The original framework consisted of eight competency domains: body movement, facial expression and eye contact, vocal skills, verbal skills, content structure and quality, presentation management, personal and behavioral characteristics, and audience interaction.

Although the eight-domain framework was retained as the conceptual foundation of the virtual teaching laboratory, only six domains were operationalized for automated assessment. The two remaining domains—content organization and quality, and audience interaction—were not implemented in the current version because they require advanced semantic understanding and authentic learner interaction beyond the capabilities of the present rule-based audio-visual analysis. Nevertheless, the eight-domain rubric was retained as the theoretical framework guiding the overall design of the laboratory, while the automated assessment and feedback modules were limited to the six operationalized domains.

4.1.3. Feedback System

The performance feedback system constituted a central component of the virtual teaching laboratory. Following each presentation, audio and video data were analyzed, and a structured feedback report was generated for each competency domain. The feedback included both performance ratings and qualitative information regarding strengths and areas requiring improvement.

The primary purpose of the feedback system was to support self-assessment, reflection, and performance improvement. Rather than functioning solely as an assessment tool, the laboratory was designed as a learning environment that actively supports competence development. Accordingly, the feedback mechanism was informed by the principles of Electronic Performance Support Systems (EPSS), providing learners with actionable guidance that could be immediately applied in subsequent practice sessions. This iterative feedback cycle enabled student teachers to identify weaknesses, monitor progress, and refine their oral presentation skills over time.

4.1.4. Performance Analysis Logic

The analytical engine of the virtual teaching laboratory was based on a multimodal analysis of audio and video data. Using signal processing and computer vision techniques, the system extracted behavioral indicators associated with oral presentation performance. These

indicators were then mapped onto competency scores through a set of predefined decision rules derived from the oral presentation competence framework.

Unlike many contemporary assessment systems that rely primarily on machine learning algorithms, the present laboratory adopted a rule-based analytical approach. This design choice was made to ensure transparency, interpretability, and theoretical alignment with the underlying competency model. By explicitly linking observable performance indicators to rubric criteria, the system generated assessment results that could be readily understood by both learners and educators. Consequently, the analytical framework not only supported automated assessment but also strengthened the educational value and trustworthiness of the feedback provided by the laboratory.

4.2. Evaluation Outcomes

4.2.1. Effects of the Virtual Teaching Laboratory on Preservice Teachers' Oral Presentation Competence

The evaluation findings demonstrated that participation in the virtual teaching laboratory led to statistically significant improvements in preservice teachers' oral presentation competence. Statistical analyses revealed significant gains across all assessed dimensions, including body movement and posture, facial expression and eye contact, vocal skills, verbal communication skills, presentation management, and personal and behavioral characteristics. Effect sizes ranged from moderate to large, indicating a substantial impact of the learning environment on the development of oral presentation performance. Furthermore, comparisons between human ratings and system-generated ratings revealed no statistically significant differences, supporting the reliability of the virtual laboratory in assessing participants' performance (Tables 4 and 5).

Table 4. Wilcoxon Signed-Rank Test Results

Competency Dimension	Normality W	p-value (Normality)	Test	Test Statistic	p-value	Interpretation
Body Movement and Posture	0.908	0.0241	Wilcoxon	30.0	0.0020	Significant improvement after intervention
Facial Expression and Eye Contact	0.859	0.0022	Wilcoxon	25.5	0.0026	Significant improvement after intervention
Vocal Skills	0.728	0.0000	Wilcoxon	6.5	0.0039	Significant improvement after intervention
Verbal Skills	0.604	0.0000	Wilcoxon	0.0	0.0000	Significant improvement after intervention
Presentation Management	0.885	0.0074	Wilcoxon	30.5	0.0459	Significant improvement after intervention
Personal and Behavioral Characteristics	0.866	0.0029	Wilcoxon	18.0	0.0235	Significant improvement after intervention

Table 5. Paired Wilcoxon Test Comparing Human and System Ratings

Competency Dimension	Test	Test Statistic (W)	p-value	Statistical Conclusion
Body Movement and Posture	Paired Wilcoxon	182.0	0.317	No significant difference
Facial Expression and Eye Contact	Paired Wilcoxon	176.5	0.284	No significant difference
Vocal Skills	Paired Wilcoxon	190.0	0.412	No significant difference
Verbal Skills	Paired Wilcoxon	168.0	0.201	No significant difference
Presentation Management	Paired Wilcoxon	185.0	0.356	No significant difference
Personal and Behavioral Characteristics	Paired Wilcoxon	172.5	0.249	No significant difference

4.2.2. Effects of the Virtual Teaching Laboratory on Preservice Teachers' Attitudinal Competencies

The findings indicated that engagement with the virtual teaching laboratory produced positive changes in several attitudinal dimensions associated with oral presentation performance. Significant increases were observed in participants' perceived importance of oral presentation, while presentation-related anxiety decreased significantly. In addition, participants reported higher levels of self-efficacy regarding presentation delivery. However,

no significant changes were found in presentation enjoyment or self-efficacy related to content organization.

These findings suggest that the virtual laboratory created a supportive learning environment that enhanced participants' confidence in oral presentation activities and fostered more positive perceptions of their presentation capabilities. Overall, perceived attitudes and self-efficacy improved significantly following participation in the virtual teaching laboratory, particularly through reductions in anxiety and increases in confidence regarding presentation performance (Table 6).

Table 6. *Inferential Statistics for Pretest–Posttest Comparisons*

Construct	Raw p-value	Adjusted p-value	Significant?	Effect Size	Interpretation
Perceived Importance	0.0053	0.0201	Yes	–0.732	Strong increase in perceived importance
Enjoyment	0.3298	0.4123	No	–0.241	No significant change
Anxiety	0.0080	0.0201	Yes	0.634	Strong reduction in anxiety
Self-Efficacy for Organizing and Delivering Academic Content	0.5382	0.5382	No	–0.147	No significant improvement observed
Self-Efficacy for Effective Presentation Delivery	0.0190	0.0316	Yes	–0.562	Moderate-to-strong improvement in presentation confidence

Note. The direction of effect sizes should be interpreted according to the nature of each construct. For positively oriented dimensions (e.g., perceived importance and self-efficacy), higher posttest scores indicate improvement, whereas for anxiety, lower posttest scores represent improvement. The positive and negative signs reflect the direction of score changes based on the calculation method and do not independently indicate improvement or decline.

4.2.3. Effects of the Virtual Teaching Laboratory on Preservice Teachers' Knowledge Competencies

The findings indicated that participation in the virtual teaching laboratory was associated with a broader understanding of oral presentation competence. The thematic analysis of participants' responses before and after the intervention revealed a shift from a primarily surface-level understanding toward a more comprehensive conceptualization of oral presentation competence. Before the intervention, participants' responses mainly emphasized observable aspects such as speech clarity, voice volume, and content mastery. After the intervention, their responses reflected additional dimensions, including content organization, time management, audience interaction, instructional media use, emotional regulation, and problem-solving. These findings suggest that participation in the virtual teaching laboratory supported the development of a more multidimensional understanding of oral presentation competence.

4.2.4. Preservice Teachers' Perceptions of the Virtual Teaching Laboratory Experience

Participants' experiences with the virtual teaching laboratory were examined using the six-item questionnaire developed by Van Ginkel et al. (2017). The results revealed highly positive perceptions of the learning environment. Mean scores exceeded 4.4 across all questionnaire items, indicating a high level of satisfaction with the effectiveness of the virtual laboratory. Participants perceived the laboratory as a valuable tool for developing oral presentation competence, regarded the feedback as constructive and actionable, and reported that the environment provided realistic preparation for instructional presentations. The findings also suggested that the laboratory enhanced learners' motivation to practice and improve their presentation skills. The highest mean score was obtained for the item recommending the virtual laboratory to other learners ($M = 4.61$), reflecting strong user acceptance and overall satisfaction with the learning experience.

Collectively, these findings suggest that the virtual teaching laboratory successfully provided a supportive, repeatable, and pedagogically effective environment for practice, feedback, reflection, and the development of oral presentation competence among preservice teachers (Table 7).

Table 7. *Descriptive Statistics for Preservice Teachers' Experiences with the Virtual Teaching Laboratory*

Item	Mean	SD	Min	25%	Median	75%	Max
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The virtual teaching laboratory was beneficial for developing my presentation skills.	4.461	0.947	2	4	5	5	5
The virtual teaching laboratory increased my motivation to improve my oral presentation skills.	4.461	0.989	1	4	5	5	5
I received constructive feedback on my presentations through the virtual teaching laboratory.	4.500	0.948	1	4	5	5	5
The virtual teaching laboratory provided realistic preparation for oral presentations.	4.500	0.761	2	4	5	5	5
The virtual teaching laboratory increased my motivation to practice presentations.	4.461	0.859	2	4	5	5	5
I would recommend the virtual teaching laboratory to other learners.	4.61	0.752	2	4.25	5	5	5

5. Discussion

5.1. Implications of the Design and Evaluation Findings

The purpose of this study was to design, develop, and evaluate a virtual teaching laboratory for assessing and fostering preservice teachers' oral presentation competence. Unlike many previous studies that have focused on teaching or assessing isolated presentation skills, the present study employed a Design-Based Research approach to develop an integrated environment that supports practice, assessment, feedback, and continuous improvement of oral presentation competence.

Unlike the authors' previous systematic review (Maleki et al., 2026), which focused on identifying and synthesizing the conceptual dimensions of oral presentation competence, the present study extends that work by operationalizing the competency framework within a Virtual Teaching Laboratory. The contribution of this research lies in the design, validation, implementation, and evaluation of an instructional environment that integrates automated assessment, competency-based feedback, and iterative microteaching to support competency development. Therefore, the novelty of this study is methodological and applied rather than conceptual, demonstrating how an evidence-based competency framework can be translated into an authentic technology-enhanced learning environment.

The design findings demonstrated that integrating an evidence-based oral presentation competency framework with microteaching principles, Electronic Performance Support Systems, and learning analytics can facilitate the development of a learning environment that not only evaluates preservice teachers' performance but also actively supports their learning process. Within this environment, assessment was not treated as a terminal event; rather, it became an integral component of a continuous learning cycle consisting of performance enactment, performance capture, feedback generation, reflection, and iterative improvement. This finding is consistent with previous research highlighting the value of simulation-based learning environments and immediate feedback in promoting rapid behavioral adjustment and skill development (Lee & Liu, 2022; Saragih et al., 2022). The controlled and low-risk nature of the virtual laboratory enabled participants to engage in repeated practice without fear of judgment, review recordings of their own performances, and identify areas requiring improvement through structured feedback. Consequently, the virtual laboratory activated a systematic cycle of performance, analysis, feedback, and re-performance that aligns with the pedagogical principles of microteaching while extending them through intelligent technological support.

The evaluation findings further indicated that participation in the virtual teaching laboratory resulted in significant improvements in preservice teachers' oral presentation competence. These improvements can largely be attributed to the availability of repeated practice opportunities, structured performance feedback, and opportunities for reflective review. From the perspective of Social Cognitive Theory, observing one's own performance and receiving feedback are important mechanisms for developing self-regulation and strengthening self-efficacy. By incorporating these elements, the virtual laboratory created conditions that enabled participants to identify their strengths and weaknesses and engage in purposeful performance improvement.

Beyond behavioral performance, the findings revealed positive effects on participants' knowledge and attitudes regarding oral presentation competence. Following participation in the laboratory, preservice teachers demonstrated a more comprehensive understanding of effective presentation practices and no longer conceptualized oral presentation primarily in terms of surface-level characteristics such as speech clarity or vocal projection. Instead, their understanding expanded to include dimensions such as content organization, audience engagement, emotional regulation, and instructional decision-making. These findings suggest that competency-based feedback can contribute not only to performance improvement but also to the reconstruction of professional knowledge and pedagogical understanding.

From a design perspective, one of the most significant contributions of the study lies in demonstrating the value of integrating microteaching with learning analytics and performance support technologies. Traditional microteaching approaches rely heavily on instructor observation and human feedback. In contrast, the virtual laboratory supported part of this process through automated performance analysis and structured feedback generation. This finding highlights the potential of technology-enhanced learning environments to support the development of professional competencies in teacher education programs while reducing dependence on intensive instructor involvement.

Compared with traditional teacher-only assessment, the automated multimodal assessment environment developed in this study offers several potential advantages, particularly in terms of assessment time, scalability, consistency, and the provision of structured feedback. In teacher-only assessment, evaluating oral presentation competence requires the evaluator to observe the presentation, attend to multiple verbal, vocal, facial, gaze, and motor behaviors, and subsequently provide feedback. This process can be time-consuming and may become difficult to sustain when the number of learners increases. In contrast, the present environment automatically analyzes multiple observable dimensions of presentation performance and generates structured results, potentially reducing the evaluator's workload and enabling more frequent assessment and practice. The system also provides a more standardized application of the assessment criteria, which may reduce variation associated with differences among human evaluators. However, automated assessment should not be considered a complete replacement for expert judgment. Human evaluators may provide richer interpretations of contextual, cognitive, emotional, and interactional aspects that are difficult to capture from observable audio-visual features alone. In addition, the development, maintenance, and technical infrastructure required for an automated system may involve substantial initial costs and require technical support. Regarding feedback depth, the present system can provide timely and structured feedback based on predefined observable indicators, whereas human instructors may offer more contextualized and pedagogically nuanced feedback. Thus, the main advantage of the proposed environment is not the elimination of human assessment but the possibility of complementing teacher judgment with scalable, consistent, and timely automated assessment. Compared with similar technology-supported assessment approaches, the distinctive feature of the present environment is its integration of multimodal analysis with a competency framework derived from a systematic review of teachers' oral presentation competence, although further comparative studies are needed to establish its relative efficiency, cost-effectiveness, and feedback quality empirically.

5.2. Design Principles Derived from the Study

One of the primary goals of Design-Based Research is to move beyond evaluating a specific intervention and generate transferable design knowledge that can inform future educational innovations. Accordingly, analysis of the design, validation, and evaluation processes led to the formulation of a set of preliminary design principles that may inform the development of similar technology-enhanced learning environments in comparable teacher education contexts.

Principle 1: Competency-based virtual learning environments should be grounded in a valid and evidence-based competency framework.

The findings indicated that the effectiveness of the virtual laboratory was strongly associated with the use of a clear and systematically developed oral presentation competency framework. The competency model derived from the authors' previous systematic review provided alignment among learning objectives, assessment indicators, feedback mechanisms, and performance analytics. This alignment enabled preservice teachers to better understand performance expectations and perceive the feedback as meaningful and actionable.

Principle 2: The development of professional competencies requires iterative cycles of practice, feedback, and performance refinement.

The findings demonstrated that repeated opportunities for performance enactment, feedback reception, and re-performance played a central role in participants' improvement. By integrating microteaching with structured feedback mechanisms, the learning process was transformed from a one-time assessment activity into a continuous cycle of performance, reflection, revision, and growth. Therefore, competency-development environments should be designed to support repeated practice and progressive performance enhancement.

Principle 3: Learning analytics are most effective when they are explicitly oriented toward learning improvement rather than performance measurement alone.

The findings suggest that learning analytics should not function solely as a mechanism for monitoring or evaluating performance. Instead, analytics should generate meaningful and actionable insights that support learners' improvement efforts. In the present study, analytical indicators were directly linked to specific dimensions of oral presentation competence, and the resulting analyses were translated into educational feedback. This approach transformed performance data into a resource for learning and self-improvement.

Principle 4: Evidence-based reflection should be considered an essential component of professional learning environments.

Participants' experiences indicated that reviewing recorded performances, accessing feedback reports, and comparing multiple performances created valuable opportunities for reflective practice. These opportunities enabled preservice teachers to develop greater awareness of their strengths and weaknesses and to make informed decisions regarding future improvement. Consequently, competency-development environments should provide accessible performance evidence and structured opportunities for reflection.

Taken together, the findings suggest that technology-enhanced environments for professional competency development should be built upon the integration of competency-based frameworks, authentic practice opportunities, structured feedback, learning analytics, and reflective learning activities. These principles represent the design knowledge generated through the present study and may provide initial guidance for the development of future learning and assessment environments in teacher education.

The findings should nevertheless be interpreted cautiously in light of the study design. The one-group pretest–posttest design provides preliminary evidence of improvement following participation in the virtual teaching laboratory, but it does not permit a definitive attribution of the observed changes to the laboratory itself. In the absence of a control or comparison group, alternative explanations, including practice effects, increased familiarity with the presentation task, Hawthorne effects, and maturation, cannot be ruled out. Therefore, the observed gains should be interpreted as being associated with participation in the laboratory rather than as demonstrating a causal effect. This distinction is particularly important when interpreting changes in oral presentation competence, knowledge, and attitudes.

5.3. Limitations and Directions for Future Research

Despite its promising findings, this study has several limitations. First, some dimensions of oral presentation competence could not be assessed automatically because of their conceptual complexity and the current technical limitations of automated analysis systems.

Consequently, these dimensions remained dependent on human judgment. In addition, although the assessment rubric underwent qualitative expert review and refinement, formal psychometric validation using quantitative content validity indices (e.g., CVR and CVI) was beyond the scope of this study. Therefore, further validation of the rubric using larger expert panels and quantitative validity evidence is warranted.

Second, the study involved a small convenience sample of 26 female preservice teachers from a single university, which limits the transferability and generalizability of the findings to other populations and contexts. Given that this study represented the pilot implementation and evaluation phase of a Design-Based Research project, the sample was intended primarily to assess feasibility, identify design refinements, and obtain preliminary evidence of improvement rather than to estimate population parameters. Future research should therefore examine the virtual laboratory with larger and more diverse samples across multiple institutions and teacher education contexts.

Third, the pilot validation of agreement between the human evaluator and the automated assessment system was based on a relatively small sample ($n = 15$) and a single human evaluator. Accordingly, the reported agreement estimates should be interpreted as preliminary evidence of agreement rather than definitive evidence of the general validity of the automated assessment system. Further validation with larger samples and multiple trained evaluators is needed to examine the robustness and generalizability of the agreement between human and automated scoring.

Fourth, the evaluation employed a one-group pretest–posttest design without a control or comparison group. Although this design was appropriate for the pilot implementation phase of the Design-Based Research process and allowed within-participant changes to be examined, it does not permit definitive causal conclusions. In particular, alternative explanations for the observed changes, including practice effects, increased familiarity with the presentation task, Hawthorne effects, and maturation, cannot be ruled out. Accordingly, the observed gains should be interpreted as preliminary evidence of improvement associated with participation in the Virtual Teaching Laboratory rather than as evidence of a causal effect or definitive effectiveness of the laboratory. Future studies should employ controlled or quasi-experimental designs to examine whether changes in oral presentation competence, knowledge, and attitudes can be attributed specifically to participation in the virtual laboratory.

Fifth, the evaluation focused primarily on short-term outcomes, and the sustainability of the observed changes over time was not examined. Future research should investigate whether improvements associated with participation in the laboratory are maintained over longer periods and whether they transfer to teachers' actual classroom performance and instructional practice.

An additional consideration concerns the practical challenges of implementing the Virtual Teaching Laboratory in university settings. Reliable use of the laboratory requires adequate technical infrastructure, including suitable audio-visual equipment and stable system access, as well as user orientation and technical support. Because the system processes audio-visual recordings, clear procedures for informed consent, secure data storage, and confidentiality are also necessary. These challenges could be addressed through standardized technical requirements, user training, appropriate data-governance procedures, and phased implementation within existing teacher education activities.

Finally, the current version of the laboratory was designed to automatically assess six of the eight domains in the competency framework. The two non-operationalized domains—content organization and quality and audience interaction—were retained within the broader framework but were not included in automated assessment because of their semantic and interactional complexity. Future research should investigate how advanced semantic and interaction-aware analytical approaches can be used to extend automated feedback to these two domains and determine whether such feedback is valid and pedagogically useful.

Research should also examine whether and how improvements developed through the virtual laboratory transfer to teachers' actual classroom performance and instructional practice across different teacher education contexts and academic disciplines.

6. Conclusion

The present study aimed to design, develop, and evaluate a Virtual Teaching Laboratory for the assessment and enhancement of pre-service teachers' oral presentation competence. Employing a Design-Based Research approach, the study developed an integrated learning environment that combined a competency-based framework of oral presentation competence with the principles of microteaching, Electronic Performance Support Systems, learning analytics, and data-driven feedback mechanisms.

The findings provided preliminary evidence that participation in the Virtual Teaching Laboratory was associated with improvements in pre-service teachers' oral presentation competence and supported practice, assessment, and reflection within the learning environment. Following participation in the intervention, pre-service teachers showed improvements in oral presentation performance, conceptual understanding of oral presentation competence, and several attitudinal dimensions related to public speaking and instructional presentation. Furthermore, user-experience findings indicated high levels of perceived usefulness, motivation, and satisfaction, suggesting that the environment successfully fostered a learning process grounded in deliberate practice, structured feedback, and reflective performance improvement.

Beyond the development of a technological solution, the primary contribution of this study lies in the generation of transferable design knowledge for teacher education. The findings suggest that the integration of competency-based frameworks, structured feedback, learning analytics, and iterative opportunities for practice represents a potentially valuable strategy for supporting professional competence development in teacher preparation programs. The design principles derived from this study provide actionable guidance for researchers, instructional designers, and teacher educators seeking to develop technology-enhanced environments for professional learning and performance assessment.

Overall, the Virtual Teaching Laboratory presented in this study illustrates how emerging educational technologies can be leveraged to address persistent challenges associated with practice-based teacher education. As such, it represents a promising direction for the development of technology-enhanced learning, assessment, and professional development environments within teacher education and educational technology contexts.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

- Adarkwah, M. A. (2021). "I'm not against online teaching, but what about us?": ICT in Ghana post Covid-19. *Education and information technologies*, 26(2), 1665-1685.
- Aghdasi, S., Kiamanesh, A., Mahdavi Hazaveh, M., & Safarkhani, M. (2013). Teacher-student interaction in successful and unsuccessful schools' classrooms: A case study of elementary schools participating in PIRLS 2006 and TIMSS 2007. *Journal of Education*, 119, 93-120. [In Persian]
- Azimi, E., Jafari, L., & Mahdavinassab, Y. (2023). Using a design-based research methodology to develop and study prompts integrated into GeoGebra to support mathematics learning of gifted students. *Education and Information Technologies*, 1-23.
- Batrinca, L., Stratou, G., Shapiro, A., Morency, L.-P., & Scherer, S. (2013). Cicero: Towards a multimodal virtual audience platform for public speaking training. In Y. Nakano, M. Neff, A. Paiva, & M. Walker (Eds.), *Intelligent Virtual Agents* (pp. 116-128). https://doi.org/10.1007/978-3-642-40415-3_10

- Chinh, N. T. M., Ngoc, P. T. B., Loi, N. M., Hang, D. T. T., Huy, D. T. N., & Van Tung, P. (2021). Deepening analysis on preventing fall risk with knowledge and practices of nurses and nursing. *Sys Rev Pharm*, 12(3), 308-313.
- Chollet, M., Wörtwein, T., Morency, L. P., Shapiro, A., & Scherer, S. (2015, September). *Exploring feedback strategies to improve public speaking: an interactive virtual audience framework*. In Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing (pp. 1143-1154).
- Das, K. (2019). The role and impact of ICT in improving the quality of education: An overview. *International Journal of Innovative Studies in Sociology and Humanities*, 4(6), 97-103.
- Dashteh, A., Nourian, M., & Samiei Zafarghandi, M. (2021). Exploring teachers' experiences regarding barriers and challenges in learning mathematics. *Education Strategies in Medical Sciences*, 14(6), 175–185. [In Persian].
- De Grez, L. (2009). *Optimizing the instructional environment to learn presentation skills* (Doctoral dissertation, Ghent University).
- DeVito, J. A., & DeVito, J. (2019). *The interpersonal communication book*. Instructor, 1(18), 521-532.
- Emmer, E. T., & Sabornie, E. J. (Eds.). (2015). *Handbook of Classroom Management*. New York: Routledge.
- Evertson, C. M., & Weinstein, C. S. (2006). Classroom management as a field of inquiry. *Handbook of classroom management: Research, practice, and contemporary issues*, 3(1), 16.
- Gholami, K. (2014). *Definition of education/teaching*. In *the Iranian curriculum encyclopedia* (Axis 6: Curriculum implementation) .[In Persian]
- Gomez, A. (2019). Oral proficiency assessment of pre-service teachers of a public University in the Philippines. *The ASTR Research Journal*, 1 (1).
- Hatami, J. (2022). *Educational technology*. SAMT. [In Persian]
- Hatami, J., Hasanzadeh, M., Badali, M., & Hasanzadeh, R. (2018). *Science education and virtual laboratory*. Ayandeh Amoozan Ata .[In Persian]
- Ishino, T., Goto, M., & Kashihara, A. (2022). Robot lecture for enhancing presentation in lecture. *Research and Practice in Technology Enhanced Learning*, 17 (1), 1-22. <https://doi.org/10.1186/s41039-021-00176-6>
- Jaca, C. A. L., & Javines, F. B. (2020). Oral Communication Needs of Pre-Service Teachers in Practice Teaching. *Randwick International of Education and Linguistics Science Journal*, 1(1), 67-73.
- Kleftodimos, A., & Triantafillidou, A. (2022). The use of the video platform FlipGrid for practicing science oral communication. *TechTrends*, 1-21. <https://doi.org/10.1007/s11528-022-00801-1>
- Koo, T. K., & Li, M. Y. (2016). A guideline of selecting and reporting intraclass correlation coefficients for reliability research. *Journal of Chiropractic Medicine*, 15(2), 155–163.
- Langlois, S., & Cormier, C. (2021). Developing the PAOCS Scale (Perceptions and Attitude toward Oral Communication in Science) for Postsecondary Science Students. *Mesure et évaluation en éducation*, 44 (spécial), 89-128.
- Ledger, S., & Fischetti, J. (2020). Micro-teaching 2.0: Technology as the classroom. *Australasian Journal of Educational Technology*, 36(1), 37-54.
- Lee, Y. J. J., & Liu, Y. T. (2022). Promoting oral presentation skills through drama-based tasks with an authentic audience: A longitudinal study. *The Asia-Pacific Education Researcher*, 31 (3), 253-267. <https://doi.org/10.1007/s40299-021-00557-x>
- Maleki, S. , Hatami, J. , Elf, N. , Azimi Yancheshmeh, E. and Khosravi, R. A. (2026). Identifying and Explaining the Key Components of Teachers' Oral Presentation Competence. *Research in Teaching*, (), -. doi: 10.22034/trj.2026.145339.2304.
- Marzano, R. J., & Marzano, J. S. (2003). *Classroom management that works: Research-based strategies for every teacher*. Ascd.
- Mohammadzadeh, R. (2017). *Classroom management: Psychological principles and applications*. In Proceedings of the Conference on Modern Research in Iran and the World in Psychology, Educational Sciences, Law, and Social Sciences. [In Persian]
- Ranjbar, M. (2015). *Teachers' educational and managerial competencies and skills in the cultural, social, and economic development of students*. In Proceedings of the Second International Conference on Research in Science and Technology, Turkey. [In Persian].
- Reddy, K. R. (2019). Teaching how to teach: microteaching (a way to build up teaching skills). *Journal of Gandaki Medical College-Nepal*, 12(1), 65-71.

- Saragih, W., Saragih, N. A., Siregar, R. A., & Natalia, C. H. (2022). Investigating EFL teachers' perception on task-based language teaching for speaking skills. *Teaching English Language*, 16 (1), 203–234.
- Sasongko, W. D., & Widiastuti, I. (2019, December). *Virtual lab for vocational education in Indonesia: A review of the literature*. In AIP Conference Proceedings (Vol. 2194, No. 1). AIP Publishing.
- Shan, Z. (2021). Behaviorism reinforcement learning and its application in mathematics teaching in primary and middle schools. *Frontiers in Educational Research*, 4(4), 93-98.
- Tanveer, M. I., Lin, E., & Hoque, M. (2015, March). *Rhema: A real-time, in-situ intelligent interface to help people with public speaking*. In Proceedings of the 20th International Conference on Intelligent User Interfaces (pp. 286-295). <https://doi.org/10.1145/2678025.2701386>
- Thienpermpool, P. (2021). Teachers' practice and perceptions of self-assessment and peer assessment of presentation skills. *English Language Teaching*, 14 (12), 183-188. <https://doi.org/10.5539/elt.v14n12p183>
- Vaghour Kashani, M., Hajihosseinejad, G., Mousapour, N., & Ebrahimzadeh, E. (2019). Strategies for enhancing teachers' professional competencies and determining their effectiveness. *Research in Curriculum Planning*, 16(2), 55–76. [In Persian]
- van Ginkel, S. (2019). *Fostering oral presentation competence in higher education* (Doctoral dissertation, Wageningen University and Research).
- Van Ginkel, S., Gulikers, J., Biemans, H., & Mulder, M. (2015). Towards a set of design principles for developing oral presentation competence: A synthesis of research in higher education. *Educational Research Review*, 14, 62-80.
- Van Ginkel, S., Laurentzen, R., Mulder, M., Mononen, A., Kytä, J., & Kortelainen, M. J. (2017). Assessing oral presentation performance: Designing a rubric and testing its validity with an expert group. *Journal of Applied Research in Higher Education*, 9(3), 474-486.
- Wang, F., & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments. *Educational technology research and development*, 53(4), 5-23.
- Wangchuk, S. (2019). Effects of Microteaching on the Pre-Service Teachers' Teaching Competence--A Case in Bhutan. *International Journal of Education and Development using Information and Communication Technology*, 15(1), n1.
- Zhang, X., Ling, Y. L., Zheng, K., & Li, C. (2023). Correlation Between University Music Teachers' Self-efficacy and Autonomous Learning. *Environment-Behaviour Proceedings Journal*, 8(25), 55-60.