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# Enhancing Public Speaking Practice with Pedagogical Agents in Virtual Learning Environments: A Systematic Review

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**Abstract**

This paper presents a systematic literature review on the use of pedagogical agents in virtual learning environments to enhance public speaking skills. The review outlines the search protocol in detail, including the strategy, inclusion, and exclusion criteria that guided the selection of refereed articles. The scope of the review encompasses 42 articles published between 2013 and 2023. These articles explore various public speaking training programs within virtual learning environments and address the limitations of traditional face-to-face training. The findings demonstrate that virtual learning environments allow learners to access content, practice, and assessment, and engage in interactive sessions, regardless of location or time constraints. Three main research areas emerged from the analysis: (1) the components of pedagogical agents in virtual learning environments applicable to public speaking skill training, (2) innovations and features of pedagogical agents that enhance real - life performance, and (3) the integration of teaching and learning theories to develop classroom public speaking skills. Key results indicate that features such as personalized feedback, interactive simulations, and adaptive learning pathways significantly enhance public speaking skills. The analysis also revealed varied results related to the efficacy of pedagogical agents, highlighting an intervention research design approach. This review underscores the potential of pedagogical agents in virtual learning environments to significantly improve public speaking training and contributes to the development of effective educational strategies and practices.

## Introduction

Public speaking skills are crucial in various domains and are a significant focus of this research. Pedagogical agents have gained considerable attention in educational research as tools to enhance student engagement and motivation (Martha, Santoso, Junus, & Suhartanto, 2023). These on - screen agents can enrich learning environments by adding a social component and increasing interactivity, helping learners engage with lessons more meaningfully (Craig & Schroeder, 2018). Using pedagogical agents derived from artificial intelligence in e-learning addresses a significant challenge in traditional classroom - based learning environments (Apoki, Hussein, Al-Chalabi, Badica, &

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Mocanu, 2022). Pedagogical agents have been successfully applied across various subjects, including mathematics, science, and foreign languages, providing personalized instruction, feedback, and motivation (Kim & Baylor, 2016; Al-Kaisi, Arkhangelskaya, Rudenko-Morgun, & Lopanova, 2020). Despite their versatility, there are concerns regarding their usability and practicality, particularly in public speaking training within virtual learning environments. This study aims to explore these challenges and evaluate the effectiveness of pedagogical agents in enhancing public speaking skills.

Therefore, this study aims to systematically review the literature on pedagogical agents in virtual learning environments to determine how and what pedagogical agents develop public speaking skills. To reveal the relationship between the factors, researchers took into account the following three aspects:

RQ 1: What components of pedagogical agents in virtual learning environments can be applied in public speaking skill training?

RQ 2: Which innovations and features of pedagogical agents can improve public speaking skills and apply to real-life performance?

RQ 3: How could instructors integrate teaching and learning theories with pedagogical agents in a virtual learning environment to develop classroom public speaking skills?

In the next section, we provide details on the theoretical background of pedagogical agents in the virtual learning environment and our methodological approach to public speaking skill development. Then, we present the results of our systematic review. Finally, we discuss the results of the three aspects mentioned above.

**Pedagogical Agent in a Virtual Learning Environment**

Pedagogical agents (PAs) are computer-controlled on-screen characters designed to facilitate instruction (Craig & Schroeder, 2018). They have been used to present information, increase motivational support, and provide conversation with learners (Siegle, Schroeder, Lane, & Craig, 2023). Many studies have shown students' positive satisfaction and improvement after learning with pedagogical agents (Kim & Baylor, 2016; Zeitlhofer, Zumbach, & Aigner, 2023). Kim and Baylor (2016) found that the design features of pedagogical agents, including realism and instructional roles, positively influenced learning outcomes and engagement. Pedagogical agents in digital learning environments can enhance knowledge acquisition and improve self-regulated learning, suggesting an impact on cognitive and communication skills (Zeitlhofer, Zumbach, & Aigner, 2023).

A pedagogical agent can be related to cognitive theory and sociocultural learning theory, as on-screen agents have the potential to enhance learning environments by adding a social component and increasing interactivity in ways that can help the learner engage with the lesson in more meaningful ways (Craig & Schroeder, 2018). Pedagogical agents are more beneficial in learning engagement. The agent can be designed to facilitate learning in different roles, for example, providing instruction or supporting engagement, and can be used for conveying information in a variety of learning environments, e.g., narrated videos, intelligent tutoring systems, and educational games (Craig & Schroeder, 2018; Kim & Baylor, 2016). Other authors argue that learning through pedagogical agents motivates and increases task relevance perceptions and self - efficacy beliefs (van der Meij, van der Meij, & Harmsen, 2015).

In the classroom context, numerous methodologies exist whereby pedagogical agents can integrate into the teaching and learning processes. For example, an intelligent tutoring system can support self-regulated learning by offering interactivity between the learner and the system, as well as adaptivity through individualized instruction, scaffolding, and feedback based on the learner's actions, interactions, and performance (Dever et al., 2023). The pedagogical agent is constituted by an intelligent tutoring system that makes a diagnosis adapted to the needs of students to improve the learning process. This is achieved by dynamic interaction on a system with a collaborative and distributed interaction facility, in which the agent is conceived as an educational tool (Laureano - Cruces et al., 2014). Besides, pedagogical agents engage in various activities, such as helping learners solve problems (as tutors often do), asking and answering questions, providing encouragement, or even role-playing as fellow learners (Lane, 2016). The learning activities can be adjusted from face - to - face classroom activities and then applied by adding learning platforms and plug-ins to the lessons.

The principles of pedagogical agents simulate the classroom environment as much as possible (Liew, Mat Zin, & Sahari, 2017). Some features include setting, roles of students and teachers, materials, lesson plans, and exercises. Recent multimedia technology allows facilitators to develop pedagogical agent lessons,

materials, and activities as desired (Liew, Mat Zin, & Sahari, 2017). Furthermore, an avatar or digital representation may be determined by several factors, including user preferences, social norms, experiences within the environment, and technical affordances or constraints of the system (Nowak & Fox, 2018). These features can encourage learners to get involved in any learning activity without being embarrassed by tiny issues that, in real life, make decisions difficult. The characteristics may include appearance, traits, abilities, or behaviors that reflect human capacities and norms to complete the fantasy (Nowak & Fox, 2018).

Pedagogical agents can benefit learners in many corroborative activities, such as group discussions, brainstorming, conferences, and more (Zeitlhofer, Zumbach, & Aigner, 2023). There are more communication options, both chatting and messaging. Pedagogical agents significantly enhance learning by being culturally responsive and inclusive, accommodating diverse learner backgrounds, languages, and cultural contexts. Designing PAs with culturally relevant content that reflects the learners' backgrounds, using diverse avatars and voices, can create an environment that makes learning more engaging and relatable (Nowak & Fox, 2018). Additionally, implementing multilingual support and real-time translation features ensures that language barriers do not hinder understanding and engagement, thus catering to a broader range of learners. Moreover, adaptive learning technologies can tailor the learning experience based on individual learner profiles, adjusting content, pacing, and feedback to meet specific needs. Customization options for the pedagogical agents' appearance and interaction style can enhance learner connection and engagement (Kim & Baylor, 2016). However, the inclusive interaction design genuinely respects and considers diverse learning styles and abilities, making learning more engaging and effective for diverse learners (Liew, Mat Zin, & Sahari, 2017).

**Speaking Practice through Agents**

McNatt (2019) discusses various approaches to improving public speaking through virtual reality and pedagogical agents, highlighting techniques such as feedback on nonverbal communication and avatars to simulate audience reactions. Virtual Reality (VR) for reflection-based training in public speaking provided realistic practice scenarios and personalized feedback, aiding in self-awareness and skill development (Zhou, Fujimoto, Kanbara, & Kato, 2021). Using pedagogical agents in this context helps students critically engage with their speech content and delivery (Putman, 2019). Pedagogical agents can be designed to foster positive learning experiences, including reducing anxiety and enhancing engagement in public speaking training (Lane, 2016). Pedagogical agents can be used in public speaking training because they can provide personalized, interactive, and immediate feedback in a controlled environment that is less intimidating than real audiences (Schneider, Börner, Van Rosmalen, & Specht, 2014). This facilitates repeated practice and mastery of speaking skills. Pedagogical agents can simulate various audience reactions and dynamics, helping learners adapt their communication strategies effectively (Grivokostopoulou, Kovas, & Perikos, 2020). For example, the Virtual Orator software provides an immersive public speaking training platform where virtual audiences simulate realistic reactions. This tool allows users to practice their public speaking skills in various scenarios, enhancing their ability to handle different audiences and situations, thus improving their communication strategies. The VR-based model employed pedagogical agents that provide feedback on nonverbal communication (Zhou, Fujimoto, Kanbara, & Kato, 2021). Therefore, it enhanced public speaking skills by guiding learners on speech clarity, pacing, and body language, enhancing their overall public speaking competence. Although most public speaking practice is usually conducted through one-on-one training with a coach and self-practice, it is challenging to integrate into a modern, demanding teaching environment regarding cost control, time consumption, difficulty standardization, and increased pressure in the learning environment. However, effective instructional methods that can encourage students to participate in public speaking are still in need.

Many people feel afraid and conscious of judgment in these scenarios, often resulting in an overwhelming, uncomfortable, and stressful speaking experience (Tanveer, Lin, & Hoque, 2015). A study of undergraduate students in the US found that 64% reported a fear of public speaking (Marinho, de Medeiros, Gama, & Teixeira, 2017). in comparison, 61% of college students rank second in the top three concerns behind death and financial problems (Dwyer & Davidson, 2021). According to a survey of students from two UK universities, 80% of students reported that oral presentations were a source of social anxiety impacting learning and well-being (Dwyer & Davidson, 2021). Pedagogical agents in virtual learning environments challenge public speaking practice as they reduce the

pressure of confrontation and the limitation of educational opportunities, not only in the classroom.

Hixon and So (2009) compared virtual field experiences to traditional field experiences. The virtual field experiences exposed a wider variety of teaching and learning environments, allowed peers to have shared experiences, promoted reflectivity, and allowed students to prepare cognitively for their upcoming real-life field experience. A social skills training application simulates a virtual social situation in training that mimics real-world communication. For example, virtualspeech.com, a presentation training program developed through wearing VR glasses. Virtual reality technology creates scenarios for learners to practice speaking as if they were in a real place (Hoque, Courgeon, Martin, Mutlu, & Picard, 2013). With 3D models in a virtual environment, users can develop their presentation skills as much as they want without worrying about feedback from others (Kampmann et al., 2016). The benefit of this method can be developed for individual and holistic learners. This creates more widespread educational change and socio-economic, cultural, and economic variations that may affect learners' behavior and perceptions. Using Avatars is the basis for teaching that supports the idea that representative inclusion helps learners feel engaged, positive, and motivated to endure challenging content (Kim & Baylor, 2016). Developing and implementing pedagogical agents involves significant technical challenges, including high costs for development and maintenance, the need for robust technological infrastructure, and potential technical issues such as software bugs and system crashes. Addressing these challenges is crucial for understanding the feasibility of widespread adoption. For instance, Hixon and So (2009) highlighted that virtual field experiences, despite their benefits in exposing learners to diverse environments and promoting cognitive preparation, require substantial investment in VR technology and infrastructure, as seen in applications like VirtualSpeech.com which uses VR glasses for presentation training. These technologies can adjust content, pacing, and feedback according to the learner's abilities and preferences, providing a more tailored and effective learning environment. For example, features such as customizable avatars and interactive elements can enhance engagement and motivation, making learning more accessible and inclusive for all students (Kim & Baylor, 2016).

In public speaking training, most practices are based on real situations; for example, the master of ceremony training has to follow the event sequence, or some product presentation has to outline the content order. People with public speaking anxiety tend to avoid watching video recordings because they are reluctant to substantiate their negative performance. These presenters tend to be more aware of their appearance than their presentation (Karl & Kopf, 1993). Agents or digital representations are now used in communication to promote interactions through the virtual learning environment. This representation can be presented as a character that allows users to control, use, and interact with the avatars in various contexts. Instructors may encourage students to develop their speeches through online practice. A primary method an instructor may enable to help students further develop their speeches is through practice. However, this practice often does not mimic the natural speech environment (i.e., audience and context). Emerging technology, such as virtual reality, can change how students practice their speeches and provide a new method for replicating the final speech context for students' practice sessions. (Frisby, Kaufmann, Vallade, Frey, & Martin, 2020). Virtual humans have been used within teacher training simulations to provide guided practice and skill-building (Bradley & Kendall, 2014). Comparative studies that evaluate the effectiveness of pedagogical agents against traditional instructional methods or other technological interventions are crucial to understanding their specific advantages and disadvantages. For example, Hixon and So (2009) found that virtual field experiences facilitated by PAs exposed learners to a wider variety of teaching environments and promoted cognitive preparation more effectively than traditional methods. Such comparisons can highlight how PAs may enhance engagement, adaptability, and personalized learning while identifying potential drawbacks like the high costs and technological requirements (Hoque, Courgeon, Martin, Mutlu, & Picard, 2013).

Data privacy is a significant concern, as PAs often collect and process sensitive information about students, necessitating robust data protection measures to prevent unauthorized access and misuse. Additionally, obtaining informed consent from students and parents is essential to address privacy and ethical issues related to data collection and usage (Mabanza & de Wet, 2014). There is also the risk of over-reliance on technology, which can diminish critical interpersonal skills and reduce face - to - face interaction between students and teachers (Hoque, Courgeon, Martin, Mutlu, & Picard, 2013).

Addressing these ethical issues is vital for balancing the benefits of PAs with the potential risks, ensuring they contribute positively to the educational experience (Kim & Baylor, 2016).

Understanding these aspects is crucial for informing the design and implementation of more effective PAs. Student perspectives can reveal specific features and functionalities that enhance engagement, motivation, and learning outcomes, as well as highlight areas for improvement. For instance, insights into how students from diverse backgrounds interact with and respond to PAs can guide the development of culturally responsive and personalized learning experiences (Kim & Baylor, 2016; Nowak & Fox, 2018). Additionally, feedback from students with special educational needs or disabilities can help tailor PAs to support inclusive education better (Mabanza & de Wet, 2014). By addressing these gaps, the review could provide a more comprehensive and nuanced understanding of the role and potential of PAs in virtual learning environments.

## Research methodology

This systematic educational research review analyzes how pedagogical agents in virtual learning environments can improve public speaking skills. We retrieved several articles using specified keywords and identified inclusion and exclusion criteria from databases like Scopus, ScienceDirect, SAGE Publication, and Wiley. The preliminary search focused on studies published in English between 2012 and 2023, using keywords related to pedagogical agents and virtual learning environments. Exclusion criteria included PowerPoint presentations, publications with only abstracts, articles where agent roles were not established, and those unrelated to the communication approach.

Table 1 summarizes the search terms with two domain-specific strings: ‘Pedagogical Agents’ OR 'Mediated Representation’ OR ‘Simulated-based Training’ OR ‘Avatar - based Learning’ AND ‘Virtual Learning Environment’ OR ‘Virtual Reality.’ Included sources comprise journal articles, complete dissertations, and conference papers.

**Table 1** Final search terms used for each topic

| Topic | Search terms |
|---|---|
| Pedagogical agents | ‘Pedagogical Agents’ OR‘Mediated Representation’ OR ‘Simulated-based Training’ OR ‘Avatar-based Learning’ |
| Virtual learning environment | Virtual learning environment’ OR ‘Virtual Reality’ |

This study was a joint negotiation process involving all three authors of this paper. This process was very intensive and was carried out by the researchers in detail. This means that every study included was considered together and done after all three researchers' agreement. Different priorities were set to answer the research question in the best possible way. First, the pedagogical agent's educational purpose was extracted from an instructional design perspective.

The search initially resulted in 1,121 references, of which 539 were first excluded because they were unrelated to educational research. Of the remaining sources, 652 titles and abstracts were initially screened based on the inclusion and exclusion criteria by the first and the second. In 90% of the studies, agreement was found on including or excluding the survey. If it needed to be clarified whether an article should be included, the abstract was read together again, and a decision was made collectively. After this process, 99 sources remained for full-text screening, resulting in 42 publications containing meta-analysis studies, which were included in the review.

The selection process adhered to the PRISMA guidelines. Studies were screened based on the inclusion and exclusion criteria. The selection involved multiple

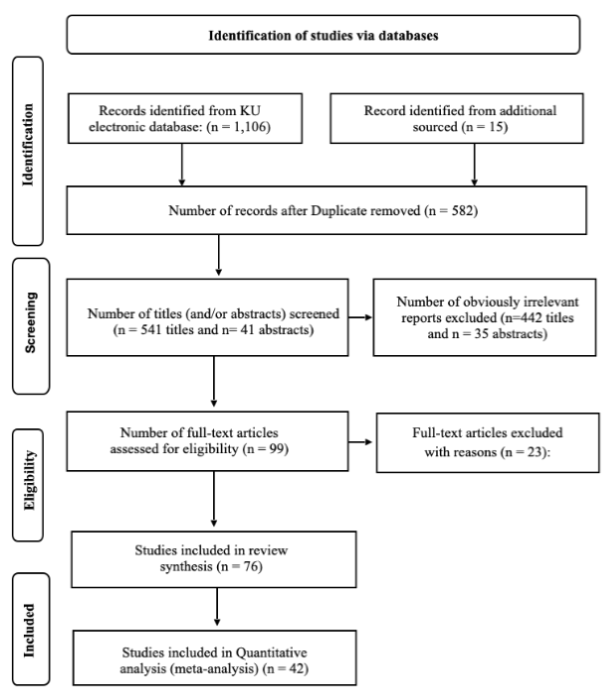


**Figure 1** PRISMA flow chart

stages: initial screening of titles and abstracts, followed by full-text review. Data were extracted using a standardized form to capture study characteristics, participant details, intervention specifics, and outcome measures. Quality assessment was performed using the Cochrane Risk of Bias tool and the Newcastle-Ottawa Scale. A random-effects model was applied for the meta-analysis. The review process involved collaboration among multiple reviewers to ensure consistency and reliability. Discrepancies were resolved through discussion and consensus. Decisions regarding study inclusion, data extraction, and analysis were made collaboratively.

Furthermore, the research types used to explore the relationship between pedagogical agents and public speaking practice were examined. Table 2 provides an overview of the virtual learning environment and pedagogical agent content analysis. This study gathered the components of a virtual learning environment, such as information and social space, explicitly presented interaction, distance, and presence education, and integrated multiple tools into the virtual physical environment.

**Table 2** Studied of Pedagogical Agent in Virtual Learning Environment Used in Public Speaking Practice

| Components | Researchers | | | | |
|---|---|---|---|---|---|
| | Kampmann et al. (2016) | Frisby et al. (2020) | McNatt (2019) | Putman (2019) | Zhou et al. (2021) |
| Interactive Feedback | | ✓ | ✓ | ✓ | ✓ |
| Personalization | ✓ | ✓ | ✓ | ✓ | ✓ |
| Practice Scenarios | ✓ | ✓ | ✓ | ✓ | ✓ |
| Multimodal Interaction | ✓ | ✓ | ✓ | ✓ | ✓ |
| Engagement and Motivation | ✓ | ✓ | ✓ | ✓ | ✓ |
| Content Delivery | ✓ | ✓ | ✓ | ✓ | ✓ |
| Collaboration and Social Learning | | ✓ | ✓ | ✓ | ✓ |
| Assessment and Reporting | | ✓ | ✓ | | ✓ |

The virtual learning environment is a centralized hub, similar to physical educational spaces, where learners can access various resources and engage in interactive activities. In this environment, pedagogical agents act as human-like interfaces facilitating interaction between learners and educational content. These agents can provide personalized feedback, guidance, and support, making the learning experience more dynamic and responsive. Table 2 outlines the components of these agents, specifically in the context of public speaking training. By incorporating VR technology, these components create an immersive and interactive learning experience that enhances technical public speaking skills and empowers students to tackle social justice issues confidently. This innovative approach ensures that learners are well - equipped to communicate effectively in diverse, challenging real - world situations.

## Results

In this section, we outline results from the analyzed studies by providing a representation of the research questions.

**RQ 1: What components of pedagogical agents in virtual learning environments can be applied in public speaking skill training?**

Several components of pedagogical agents can be effectively utilized for public speaking skill training in virtual learning environments. Incorporating several vital components, mainly summarized in Figure 2, can significantly enhance public speaking skill training.

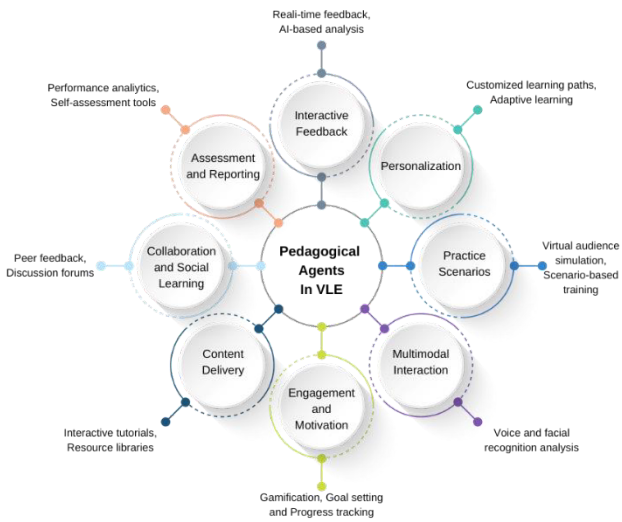


**Figure 2** Components of virtual learning environments and pedagogical agents

These components include interactive feedback, where pedagogical agents can provide immediate real-time feedback on various aspects of a speech, such as tone, pace, volume, and body language. AI is also utilized to analyze and provide suggestions for improvement in word choice, speech structure, and engagement strategies. Besides, a virtual learning environment can customize learning paths by personalizing content and exercises based on the learner's proficiency level and progress. It enhances adaptive learning by adjusting the difficulty and type of practice sessions based on performance data. The virtual audience

simulation creates realistic audiences with diverse reactions to simulate different public speaking environments (e.g., supportive, critical, indifferent). These scenario - based trainings provide specific scenarios such as business presentations, speeches, or impromptu speaking situations to practice relevant skills.

Regarding multimodal interaction, voice and facial recognition are used to analyze speech delivery and monitor facial expressions and eye contact to provide feedback on non-verbal communication. In addition, incorporating game-like elements such as points, badges, and leaderboards creates learning to be engaging and motivating. Learners can set goals and track their progress over time. The interactive tutorials offer lessons on public speaking techniques, such as structuring a speech, using rhetorical devices, and managing anxiety. Instructors can provide resource libraries, including sample speeches, videos, and articles on effective public speaking.

In collaboration and social learning, learners could have opportunities to practice with peers and provide constructive feedback for both chatting and discussion forums. Performance analytics can be reported on metrics such as speech clarity, emotional tone, and audience engagement, as well as self - assessment tools that enable learners to evaluate their performance and identify areas for improvement. By integrating these components, pedagogical agents in virtual learning environments can create a comprehensive and supportive environment for improving public speaking skills, catering to each learner's unique needs and progress.

**RQ 2: Which innovations and features in pedagogical agents can improve public speaking skills and apply them to real-life performance?**

Several features and innovations in pedagogical agents can significantly enhance public speaking skills for real-life applications, as shown in Table 3.

Recent research employing platforms such as Orai, Yoodli, Speeko, Toastmasters International, and VirtualSpeech has demonstrated significant advancements in real-time feedback and analysis in public speaking training (Frisby, Kaufmann, Vallade, Frey, & Martin, 2020). These platforms utilize advanced speech recognition and natural language processing technologies to provide immediate feedback on critical verbal elements, including clarity, pacing, intonation, and pronunciation (Wang & Ruiz, 2021). Additionally, sophisticated computer vision algorithms analyze nonverbal communication cues such as gestures, posture, and eye contact, offering corrective suggestions to enhance overall speaker effectiveness. Adaptive learning and personalization tailor training programs to individual strengths, weaknesses, and progress, dynamically adjusting task difficulty in real time to ensure continuous challenge and growth. Virtual and augmented reality create immersive practice environments and provide augmented

**Table 3** Innovation and Features for Public Speaking Practice

| Innovation | Features | Platforms |
|---|---|---|
| Real - Time Feedback and Analysis | Instant Speech Evaluation<br>Body Language Analysis | Orai, Yoodli, Speeko, Toastmasters International, and VirtualSpeech |
| Adaptive Learning and Personalization | Customized Training Programs<br>Dynamic Difficulty Adjustment | Orai, Yoodli, VirtualSpeech, Prezi Video and Eloquent |
| Virtual Reality (VR) and Augmented Reality (AR) | Immersive Practice Environments<br>Augmented Feedback | VirtualSpeech, Ovation, Speech Center VR, Public Speaking VR, and Engage VR |
| Artificial Intelligence and Machine Learning | Predictive Analytics<br>Natural Language Generation | Yoodli, Orai, VirtualSpeech, Speeko, and Eloquent |
| Emotional and Psychological Support | Anxiety Detection<br>Confidence-Building Exercises: Incorporate | Orai, Yoodli, VirtualSpeech, Speeko, and Public Speaking VR |
| Multimodal Interaction | Voice and Gesture Control<br>Haptic Feedback | VirtualSpeech, Ovation, Speech Center VR, and Engage VR: |
| Collaborative and Social Learning | Peer Review and Feedback<br>Role-Playing Scenarios | Toastmasters Online, VirtualSpeech, Prezi Video, Yoodli, and Speech Center VR |
| Advanced Content Delivery | Interactive Simulations<br>Scenario-Based Learning | VirtualSpeech, Prezi Video, Speech Center VR, Orai, and Yoodli |
| Assessment and Reporting | Comprehensive Analytics Dashboard<br>Benchmarking | Orai, Yoodli, VirtualSpeech, Speeko, and Speech Center VR |
| Gamification and Motivation | Gamified Elements<br>Achievement Tracking | Orai, Yoodli, Speeko, VirtualSpeech, and Eloquent |

feedback by overlaying real-time improvement areas (Frisby, Kaufmann, Vallade, Frey, & Martin, 2020). Artificial Intelligence and machine learning enhance learning through predictive analytics, identifying potential struggle areas and generating realistic audience questions for practice. Emotional and psychological support uses physiological sensors to detect anxiety, offering real-time calming techniques and confidence-building exercises that gradually increase the difficulty of speaking settings. Multimodal interaction enhances learning by allowing learners to use voice commands and gestures for more intuitive and natural interactions with the pedagogical agent. At the same time, haptic feedback devices simulate real - world sensations, increasing practice session realism (Wang & Ruiz, 2021).

Collaborative and social learning fosters a cooperative environment through peer review sessions and role-playing scenarios, enabling learners to present to and receive feedback from peers while assuming different roles to gain varied perspectives. Advanced content delivery includes interactive simulations and scenario-based modules, focusing on specific public speaking skills such as persuasive speaking and storytelling. Assessment and reporting offer a comprehensive analytics dashboard with detailed performance metrics, enabling progress tracking and benchmarking against public speaking standards. Gamification and motivation incorporate points, badges, and leaderboards to engage learners, with achievement tracking highlighting milestones to encourage continuous effort (Kolb, 2014). These advanced features and innovations create highly effective and engaging training programs, significantly improving public speaking skills and preparing learners for real - life performances.

**RQ 3: How could instructors integrate teaching and learning theories with pedagogical agents in a virtual learning environment to develop classroom public speaking skills?**

Instructors can integrate various teaching and learning theories with pedagogical agents in a virtual learning environment to effectively develop public speaking skills. Here are some fundamental theories and how they can be applied:

**Constructivist and Social Learning Theories**

Active learning encourages students to construct their understanding and knowledge of public speaking through experiences and reflection (Deslauriers, McCarty, Miller, Callaghan, & Kestin, 2019). Using pedagogical agents with scaffolded learning can offer support and guidance at various stages, gradually reducing assistance as students become more proficient (Munshi et al., 2023). The study evaluates an adaptive scaffolding framework within a virtual learning environment, highlighting its effectiveness in helping students develop self - regulated learning skills. Instructors can design public speaking tasks under problem-based learning that require students to solve real-world problems, promoting deeper engagement and practical application of skills.

Tomaszewski et al. (2022) studied how pedagogical agents can demonstrate public speaking skills, providing precise models for students to emulate, which enhances student engagement and learning outcomes. Social learning theory enhances social interaction and facilitates opportunities for students to practice and receive feedback from the pedagogical agent and their peers (Bandura, 1991). Observational learning allows students to watch recordings of effective speeches and analyze what makes them successful.

Public speaking skills design activities incorporate the four stages of Kolb's experiential learning cycle: concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb, 2014). Additionally, encourage students to engage in reflective practice by reviewing their speaking experiences, identifying areas for improvement, and applying new strategies in future performances. This combined approach ensures continuous skill development and practical learning.

Situated Learning Theory emphasizes contextual learning, which involves placing public speaking practice within authentic contexts that mimic real-life scenarios. It also promotes a community of practice, where students can learn from each other through shared experiences and collaborative practice, enhancing their skills in a supportive, real - world environment (Lave & Wenger, 1991).

**Cognitive and Cognitive Load Theories**

In cognitive load theory, learning content can be broken down into smaller, manageable components, chunking information to prevent cognitive overload. Instructors can use worked examples to provide step-by-step demonstrations of effective strategies, which helps reduce cognitive load during learning. Students start with substantial guidance and gradually move towards independent practice as they build confidence and competence (Sweller, 2011).

The cognitive theory of multimedia learning

suggests utilizing multimedia elements such as videos, animations, and interactive simulations to enhance understanding and retention of public speaking concepts through multimodal learning. Information should be presented in segments to allow students to process one concept before moving to the next, adhering to the segmented learning approach. Additionally, the redundancy principle advises against presenting redundant information to avoid overloading students' cognitive capacities, ensuring a more efficient learning experience (Mayer, 2005).

**Behaviorist Theory**

Lipnevich and Panadero (2021) explored using immediate feedback and reinforcement to encourage desired behaviors, such as proper posture and precise articulation. It also emphasizes the importance of repetitive practice opportunities to help students effectively develop and reinforce public speaking skills.

**Motivational and Self-Determination Theories**

Self-determination theory emphasizes three core components to enhance learning: autonomy, competence, and relatedness (Deci & Ryan, 2012). Allowing students to choose topics or types of speeches that interest them fosters a sense of autonomy, making them more invested in their learning process. Providing constructive feedback helps students feel competent, promoting a sense of mastery. Creating a supportive learning environment where students feel connected to their peers and instructor strengthens relatedness, motivating them to engage and succeed in their public speaking endeavors.

The ARCS model of motivational design emphasizes four key elements to enhance student motivation (Keller, 1987). First, capture and maintain students' attention using engaging and interactive elements. Second, make learning activities relevant by connecting them to students' goals and interests. Third, build students' confidence by designing challenging yet achievable tasks and providing opportunities for success. Finally, students should be ensured that the learning process is satisfying by offering positive feedback and recognizing their progress.

This study has analyzed studies investigating different pedagogical agent tools that may affect public speaking skills during training. Our sample of studies found the following types of virtual learning applications in online platforms. Nowadays, instructors do not need the knowledge of coding specialists and software engineers to design their classes; some programs are made accessible to the public with user-friendly interfaces. In this table, these platforms have allowed educators to create a functional and fully conversational pedagogical agent. There are more opportunities for instructors to apply this technology in their lessons.

## Conclusion

Practicing public speaking through a pedagogical agent in a virtual learning environment supports 21st-century skills effectively. Virtual environments enable students to access a vast network of people and information, transcending cultural and geographical barriers. This study affirms the research questions posed, demonstrating the significant potential of pedagogical agents in enhancing public speaking skills.

**RQ1: Effective Components in Public Speaking Training**

Adaptive feedback, emotional support, and immersive simulations are crucial components and a comprehensive approach to public speaking training. Adaptive feedback highlights areas of strength, reinforcing positive behaviors and boosting confidence. Emotional support addresses psychological barriers, such as anxiety, helping learners build resilience and self-assurance. Immersive simulations provide realistic practice environments that mirror real-world speaking scenarios. This comprehensive approach reassures educators and professionals about the effectiveness of the training, allowing learners to practice in various settings, adapt to different audience sizes, and build practical skills and confidence.

**RQ2: Innovative Features of Pedagogical Agents**

Pedagogical agents leverage advanced technologies such as AI - driven speech analysis, VR - based immersive practice, and AR - enhanced feedback to provide personalized and adaptive learning experiences. AI - driven speech analysis offers detailed tone, pitch, pacing, and word choice feedback, enabling immediate, objective evaluations. This immediate feedback instills confidence in educators and professionals about the impact of technology on learning. VR - based immersive practice helps learners rehearse in lifelike settings, desensitizing them to real - life speaking pressures. AR - enhanced feedback overlays real - time suggestions, providing contextually relevant guidance. These technologies ensure that skills developed are directly transferable to actual public speaking situations, making the learning process more engaging and effective.

**RQ3: Integrating Learning Theories with Pedagogical Agents**

Integrating teaching and learning theories with pedagogical agents provides a robust framework for developing public speaking skills. Constructivist theories, emphasizing active engagement and personal experience, are particularly effective in virtual public speaking training. Pedagogical agents create scenarios that allow students to construct knowledge by practicing speeches in realistic, immersive environments. Cognitive learning theories, focusing on mental processes such as attention, memory, and problem-solving, are supported by AI - driven analysis and feedback. Social learning theories, highlighting observation, imitation, and social interaction, are seamlessly integrated, allowing learners to engage in peer feedback sessions and audience interactions.

This synergy between theory and technology fosters a holistic learning experience, enabling students to refine their public speaking abilities in a supportive and interactive setting. The virtual learning experience allows flexible scheduling, enabling learners to effectively balance education, professional development, and personal life. In conclusion, pedagogical agents in virtual learning environments offer a comprehensive, practical approach to public speaking training, significantly improving learners' confidence, proficiency, and real-world performance.

**Discussion**

This study's findings highlight the transformative potential of pedagogical agents in virtual public speaking training. Critical components like adaptive feedback, emotional support, and immersive simulations create a dynamic, supportive learning environment that mirrors real-world scenarios. Adaptive feedback is particularly impactful, offering immediate, personalized insights that help learners make real-time adjustments. This builds competence and confidence, which are essential for effective public speaking. Emotional support addresses psychological barriers such as anxiety and lack of confidence. Features like stress management exercises and anxiety detection help learners build resilience and self-assurance, leading to more confident speakers (Kampmann et al., 2016; Frisby, Kaufmann, Vallade, Frey, & Martin, 2020; McNatt, 2019; Putman, 2019; Zhou, Fujimoto, Kanbara, & Kato, 2021).

Immersive simulations enhance the realism of training by replicating various speaking scenarios. This allows learners to adapt their skills to different contexts, increasing their confidence and effectiveness. Practicing in a risk - free environment enables learners to experiment and refine techniques without fear of real-world consequences, fostering more profound understanding and skill acquisition (Apoki, Hussein, Al-Chalabi, Badica, & Mocanu, 2022; Bradley & Kendall, 2014; Craig & Schroeder, 2018).

Innovative features of pedagogical agents significantly enhance learning and improve real-life public speaking performance. AI - driven speech analysis provides detailed, objective feedback on aspects of speech delivery, such as tone, pitch, pacing, and word choice. VR - based immersive practice offers interactive learning experiences, simulating real-world speaking situations. AR - enhanced feedback provides real-time, contextually relevant guidance, helping learners make immediate improvements during practice sessions (Frisby, Kaufmann, Vallade, Frey, & Martin, 2020).

Integrating teaching and learning theories with pedagogical agents in virtual environments creates a robust framework for developing public speaking skills. Constructivist theories emphasize learning through active engagement and personal experience. Cognitive learning theories focus on mental processes like attention, memory, and problem-solving, supported by AI - driven analysis and feedback. Social learning theories highlight observation, imitation, and social interaction, enabling peer feedback and audience interactions within the virtual environment (Deslauriers, McCarty, Miller, Callaghan, & Kestin, 2019; Munshi et al., 2023; Tomaszewski et al., 2022).

The synergy between theory and technology fosters a comprehensive learning experience. Leveraging constructivist, cognitive, and social learning theories, instructors can create engaging and effective training programs addressing both technical and psychological aspects of public speaking. This integrated approach ensures learners can acquire the necessary skills and better understand practical communication principles. These virtual environments' supportive and interactive nature helps learners refine their public speaking abilities engagingly and effectively. Advanced technological tools and pedagogical agents in public speaking training can significantly improve learners' confidence, proficiency, and real - world performance (Mayer, 2005; Sweller, 2011; Kolb, 2014).

## Suggestions

Overall, this literature review has expanded the evidence base for using pedagogical agents in virtual learning environments, demonstrating the potential for university students to enhance their skills through this technology when integrated with various teaching and learning methods. However, this study primarily identifies theoretical benefits and advantages of this technology without addressing potential adverse effects on students' experiences. The conclusions drawn are preliminary and serve as a foundation for future experimental research.

Future research should focus on student retention after practice and applying learned skills in real-world contexts, particularly in public speaking courses embedded within the curriculum. Additionally, since most studies reviewed were conducted in Western contexts, future investigations should consider cultural factors in Asian settings. Onsite outcomes could reveal learners' improvements, suggesting that this technology could benefit millions of individuals who fear public speaking. Moreover, including emotional and psychological support mechanisms, such as anxiety management tools and motivational strategies, could further enhance the effectiveness of pedagogical agents in reducing public speaking anxiety and boosting students' confidence.

## References


Al-Kaisi, A., Arkhangelskaya, A., Rudenko-Morgun, O., & Lopanova, E. (2020). Pedagogical agents in teaching language: types and implementation opportunities. *IJAEDU-International E-Journal of Advances in Education, 5*(15), 275–285.

Apoki, U. C., Hussein, A. M. A., Al-Chalabi, H. K. M., Badica, C., & Mocanu, M. L. (2022). The role of pedagogical agents in personalized adaptive learning: A review. *Sustainability, 14*(11), 6442.

Bandura, A. (1991). Social cognitive theory of self-regulation. *Organizational behavior and human decision processes, 50*(2), 248–287.

Bradley, E. G., & Kendall, B. (2014). A review of computer simulations in teacher education. *Journal of Educational Technology Systems, 43*(1), 3–12.

Craig, S. D., & Schroeder, N. L. (2018). *Design principles for virtual humans in educational technology environments.* Oxfordshire, UK: Routledge.

Deci, E. L., & Ryan, R. M. (2012). Self-determination theory. *Handbook of Theories of Social Psychology, 1*(20), 416–436.

Deslauriers, L., McCarty, L. S., Miller, K., Callaghan, K., & Kestin, G. (2019). Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom. *Proceedings of the National Academy of Sciences, 116*(39), 19251–19257.

Dever, D. A., Sonnenfeld, N. A., Wiedbusch, M. D., Chmorrow, G., Amon, M. J., & Azevedo, R. (2023). A complex systems approach to analyzing pedagogical agents' scaffolding of self-regulated learning within an intelligent tutoring system. *Metacognition and Learning, 18,* 659–691.

Dwyer, K. K., & Davidson, M. (2021). Take a Public Speaking Course and Conquer the Fear. *Journal of Education and Educational Development, 8*(2), 255–269.

Frisby, B. N., Kaufmann, R., Vallade, J. I., Frey, T. K., & Martin, J. C. (2020). Using Virtual Reality for Speech Rehearsals: An Innovative Instructor Approach to Enhance Student Public Speaking Efficacy. *Basic Communication Course Annual, 32*(6).

Grivokostopoulou, F., Kovas, K., & Perikos, I. (2020). The effectiveness of embodied pedagogical agentsand their impact on students learning in virtual worlds. *Applied Sciences, 10*(5), 1739.

Hixon, E., & So, H. (2009). Technology's Role in Field Experiences for Preservice Teacher Training. *Educational Technology & Society, 12*(4), 294–304.

Hoque, M., Courgeon, M., Martin, J. C., Mutlu, B., & Picard, R. W. (2013). Mach: My automated conversation coach. In *Proceedings of the 2013 ACM International Joint Conference on Pervasive and Ubiquitous Computing* (pp. 697–706). New York, NY: ACM.

Karl, K. A., & Kopf, J. M. (1993). Guidelines for Using Videotaped Feedback Effectively. *Human resource development quarterly, 4*(3), 243-256.

Kampmann, I. L., Emmelkamp, P. M., Hartanto, D., Brinkman, W. P., Zijlstra, B. J., & Morina, N. (2016). Exposure to virtual social interactions in the treatment of social anxiety disorder: A randomized controlled trial. *Behaviour Research and Therapy, 77,* 47–156.

Keller, J. M. (1987). Development and use of the ARCS model of instructional design. *Journal of Instructional Development, 10*(3), 2–10.

Kim, Y., & Baylor, A. L. (2016). Research-based design of pedagogical agent roles: a review, progress, and recommendations. *International Journal of Artificial Intelligence in Education, 26*(1), 160–169.

Kolb, D. A. (2014). *Experiential learning: Experience as the source of learning and development.* Upper Saddle River, NJ: FT Press.

Lane, H. C. (2016). Pedagogical Agents and Affect: Molding Positive Learning Interactions. *Emotions and Technology,* 47–62.

Laureano-Cruces, A. L., Acuña-Garduño, E., Sánchez-Guerrero, L., Ramírez-Rodríguez, J., Mora-Torres, M., & Silva-López, B. R. (2014). A Pedagogical Agent as an Interface of an Intelligent Tutoring System to Assist Collaborative Learning. *Scientific Research, 5*(8), 619–629.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, England: Cambridge University Press.

Liew, T. W., Mat Zin, N. A., & Sahari, N. (2017). Exploring the affective, motivational and cognitive effects of pedagogical agent enthusiasm in a multimedia learning environment. *Human-centric Computing and Information Sciences, 7,* 1–21.

Lipnevich, A. A., & Panadero, E. (2021). A review of feedback models and theories: Descriptions, definitions, and conclusions. In *Frontiers in Education* (Vol. 6, p. 720195). Lausanne, Switzerland: Frontiers

Mabanza, N., & de Wet, L. (2014). Determining the usability effect of pedagogical interface agents on adult computer literacy training. *E-Learning Paradigms and Applications: Agent-based Approach,* 145–183.

Marinho, A. C. F., de Medeiros, A. M., Gama, A. C. C., & Teixeira, L. C. (2017). Fear of public speaking: Perception of college students and correlates. *Journal of Voice, 31*(1), 127.e7.

Martha, A. S. D., Santoso, H. B., Junus, K., & Suhartanto, H. (2023). The effect of the integration of metacognitive and motivation scaffolding through a pedagogical agent on self-and co-regulation learning. *IEEE Transactions on Learning Technologies, 16*(4), 573–584.

Mayer, R. E. (2005). Cognitive theory of multimedia learning. *The Cambridge handbook of multimedia learning, 41,* 31–48.

McNatt, D. B. (2019). Enhancing public speaking confidence, skills, and performance: An experiment of service-learning. *The international journal of management education, 17*(2), 276–285.

van der Meij, H., van der Meij, J., & Harmsen, R. (2015). Animated pedagogical agents effects on enhancing student motivation and learning in a science inquiry learning environment. *Educational technology research and development, 63,* 381–403.

Munshi, A., Biswas, G., Baker, R., Ocumpaugh, J., Hutt, S., & Paquette, L. (2023). Analysing adaptive scaffolds that help students develop self-regulated learning behaviours. *Journal of Computer Assisted Learning, 39*(2), 351–368.

Nowak, K. L., & Fox, J. (2018). Avatar and Computer-Mediated Communication: A Review of the Definitions, Uses, and Effects of Digital Representation. *Review of Communication Research, 6,* 30–53.

Putman, A. L. (2019). Reflections on a pedagogical shift: A public speaking for social justice model. *Journal of Communication Pedagogy, 2,* 83–89.

Schneider, J., Börner, D., Van Rosmalen, P., & Specht, M. (2014). Presentation trainer: A toolkit for learning non-verbal public speaking skills. In *Open Learning and Teaching in Educational Communities: 9th European Conference on Technology Enhanced Learning, EC-TEL 2014, Graz, Austria, September* 16–19, 2014, *Proceedings 9* (pp. 522–525). Cham, Switzerland: Springer International Publishing.

Siegle, R. F., Schroeder, N. L., Lane, H. C., & Craig, S. D. (2023). Twenty-five years of learning with pedagogical agents: History, barriers, and opportunities. *TechTrends, 67*(5), 851–864.

Sweller, J. (2011). Cognitive load theory. In *Psychology of learning and motivation* (Vol. 55, pp. 37–76). Cambridge, Massachusetts: Academic Press.

Tanveer, M. I., Lin, E., & Hoque, M. E. (2015). Rhema: A Real-Time In-Situ Intelligent Interface to Help People with Public Speaking. In *IUI '15: Proceedings of the 20th International Conference on Intelligent User Interfaces* (pp.286 – 295). New York, NY: ACM.

Tomaszewski, W., Xiang, N., Huang, Y., Western, M., McCourt, B., & McCarthy, I. (2022). The impact of effective teaching practices on academic achievement when mediated by student engagement: Evidence from Australian high schools. *Education Sciences, 12*(5), 358.

Wang, I., & Ruiz, J. (2021). Examining the use of nonverbal communication in virtual agents. *International Journal of Human–Computer Interaction, 37*(17), 1648–1673.

Zeitlhofer, I., Zumbach, J., & Aigner, V. (2023). Effects of Pedagogical Agents on Learners' Know Environments. *Knowledge, 3*(1), 53–67.

Zhou, H., Fujimoto, Y., Kanbara, M., & Kato, H. (2021). Virtual reality as a reflection technique for public speaking training. *Applied Sciences, 11*(9), 3988.