

PERMA-Based Learning with AI Assistance for Argumentative Speaking: A Pilot Project

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<https://doi.org/10.17977/um065.v6.i9.2026.8>

Article history

Submitted: 26 April 2026

Revised: 8 June 2026

Accepted: 9 June 2026

Published: 14 June 2026

Keywords

AI-assisted learning

Argumentative speaking

PERMA-based learning

Abstract

Pre-service teachers in non-English-major programs often experience anxiety when using English as a medium of instruction, particularly in argumentative speaking tasks. This challenge is relevant for Indonesian Language Education students who may need to use English in future teaching contexts. This paper reports a pilot project within a larger planned study on PERMA-based learning integrated with AI assistance in Speaking for Academic Purposes. The project involved third-year students enrolled in English for Learning and explored the potential of this approach to support argumentative speaking and readiness to use English in instructional settings. This study employed a qualitative design using data triangulation through classroom observations, student reflections, and speaking performance records. At the beginning of the program, many participants reported anxiety and low confidence because English was rarely used in their daily communication. During the intervention, students appeared to become more comfortable participating in speaking activities due to supportive interactions with the lecturer and peers. They also used AI tools to prepare arguments, clarify language use, and practice pronunciation before class sessions, followed by reflective summaries uploaded to Google Classroom. The findings suggest gradual improvements in confidence, pronunciation, fluency, and engagement in argumentative speaking activities. This pilot study provides preliminary evidence that integrating PERMA-based learning with AI-assisted preparation may support students' confidence and participation in argumentative speaking. The findings indicate the feasibility of this approach and warrant further investigation through larger-scale studies in Speaking for Academic Purposes.

1. Introduction

In many EFL contexts, speaking remains one of the most challenging language skills because learners frequently experience anxiety, low confidence, limited vocabulary, fear of making mistakes, and insufficient opportunities for authentic oral practice (Namsaeng & Thuratham, 2025; Ölmez & İltar, 2025). These challenges are particularly relevant for pre-service teachers in non-English majors, who may later be required to use English as a medium of instruction or professional communication despite limited oral proficiency. Recent studies have shown that supportive pedagogical approaches grounded in Positive Psychology, such as the PERMA model, can reduce anxiety and improve learners' wellbeing, motivation, and speaking performance (Esmaeilee et al., 2025; Ly & Nguyen, 2024, 2025). At the same time, AI-supported learning tools have created new opportunities for immediate feedback, self-paced practice, and personalized support in speaking development through automated evaluation and interactive practice (Darmawansah et al., 2025; Huang et al., 2025). However, limited research has explored the integration of PERMA-based learning with AI assistance for argumentative speaking among pre-service teachers outside English departments, particularly in the Indonesian higher education context.

Although numerous studies have examined methods for improving EFL speaking, much of the literature has focused on communicative fluency, pronunciation practice, and general oral interaction through approaches such as vlog projects, debate techniques, blended instruction, and task-based activities (Chunliu & Guangsheng, 2025; Deliana & Ganie, 2025; Wang et al., 2024; Zhan et al., 2025). However, many university learners still experience hesitation, low confidence, and limited readiness to express ideas in more demanding academic speaking tasks, particularly those requiring critical reasoning and structured argumentation (Beyene et al., 2024; Hougham et al., 2024; Leeming et al., 2024). In addition, recent innovations have shown that digital tools such as automated speech feedback, voice analytics, and intelligent learning systems can support speaking development through more immediate and personalized practice opportunities (Espiritu & Buaraphan, 2024; Kang et al., 2024; Qian et al., 2025). Separately, wellbeing-oriented pedagogies have highlighted the importance of positive emotion, engagement, relationships, meaning, and accomplishment in creating supportive learning environments that sustain learner motivation and resilience (Criado-Del Rey et al., 2024; Martín-Antón et al.,

2024; Reize et al., 2025). Nevertheless, limited studies have combined these technological and psychological perspectives into a single instructional model for academic speaking development.

Recent studies on EFL speaking instruction can be grouped into three major trends. First, many researchers have focused on technology-enhanced speaking learning through mobile applications, blended learning, virtual platforms, and automated feedback systems. These approaches have generally improved learners' fluency, pronunciation, and engagement by providing flexible and interactive practice opportunities (Fansury et al., 2025; Jia & Lu, 2025; Prabakaran et al., 2025; Yassin, 2024). Second, another body of literature has emphasized communicative and task-based pedagogies, including role-play, flipped classrooms, presentations, debate, and project-based learning. Findings indicate that authentic speaking tasks and collaborative interaction can strengthen learners' confidence, oral complexity, and real-world communication skills (Amir et al., 2025; Dawilai et al., 2024; Imbernón-Pérez & Solís-Becerra, 2024; Zheng et al., 2025). Third, recent studies have increasingly examined affective dimensions of speaking, showing that anxiety, low self-efficacy, and fear of negative evaluation remain major barriers, while supportive instruction can foster motivation and willingness to communicate (Almohammadi, 2024; López-Medina & Casado, 2024; Messerli & Locher, 2024; Moodie & Greenier, 2024). Despite these developments, prior studies have often treated technology, pedagogy, and learner wellbeing as separate areas of inquiry.

Conceptually, this study positions argumentative speaking development as both a cognitive and affective process that requires learners to generate claims, provide evidence, respond to counterarguments, and communicate ideas confidently in English. The PERMA framework offers a psychological foundation for supporting this process by fostering Positive Emotion, Engagement, Relationships, Meaning, and Accomplishment, which are associated with increased motivation, resilience, and willingness to communicate. At the same time, AI-assisted learning provides practical mechanisms through which these PERMA dimensions can be enacted in speaking instruction. For example, AI-generated feedback may reduce anxiety and promote Positive Emotion by providing non-judgmental practice opportunities; interactive speaking tasks can enhance Engagement through immediate responses and personalized challenges; AI-supported collaboration and discussion activities may strengthen Relationships; authentic argumentation tasks can increase Meaning by connecting speaking activities with future professional roles; and continuous performance feedback can foster a sense of Accomplishment through visible progress. Therefore, rather than functioning as separate constructs, PERMA and AI assistance are viewed in this study as complementary components that jointly support the development of argumentative speaking competence among pre-service teachers.

While numerous studies have examined speaking improvement through mobile learning, task-based instruction, flipped classrooms, and blended environments, these studies have mainly concentrated on general speaking fluency, pronunciation, or everyday communication rather than argumentative speaking for academic purposes (Kopzhassarova & Izotova, 2024; Usman & Mahmud, 2024; Xiong & Eng, 2024; Zakarneh et al., 2025). Other scholars have investigated learner anxiety, motivation, and communicative confidence, confirming that affective factors strongly influence oral performance; however, such studies often stop at identifying problems instead of designing integrated pedagogical solutions (Kim et al., 2024; Vázquez-Sánchez et al., 2023; Villar-Guevara et al., 2024). In addition, emerging research on AI and intelligent systems has demonstrated the potential of automated feedback, voice recognition, and personalized learning support, yet these innovations are frequently oriented toward technical efficiency rather than learner wellbeing or classroom emotional climate (Kang et al., 2024; Mirzoyeva et al., 2024; Qian et al., 2025). Furthermore, studies involving pre-service teachers have commonly focused on bilingual education, practicum readiness, or general pedagogical competence rather than preparing non-English majors to use English for argumentative classroom communication (Buser, 2025; Gardiner-Hyland & Hoven, 2025; Yang et al., 2024). To date, no pilot study has specifically examined PERMA-based learning integrated with AI assistance for argumentative speaking among Indonesian pre-service teachers in non-English majors. Therefore, this study seeks to address that gap.

The objective of this study is to investigate the implementation of PERMA-based learning with AI assistance in developing argumentative speaking among pre-service teachers in the Indonesian Language Education program. Specifically, this study aims to examine how the integration of positive psychology principles and AI-supported speaking practice can reduce learners' anxiety, enhance self-confidence, improve fluency and pronunciation, and strengthen their ability to construct academic arguments in English. In addition, the study seeks to explore students' readiness to use English as a medium of instruction in future classroom contexts.

2. Method

2.1. Study Design

This study employed a qualitative case study design to explore the implementation of PERMA-based learning with AI assistance in improving students' argumentative speaking skills. A case study design was selected because it allows an in-depth investigation of a specific educational context and provides rich insights

into participants' experiences, perceptions, and behavioral changes during the intervention. The qualitative approach was considered appropriate because the study aimed to understand students' speaking development, confidence, and emotional responses rather than to measure causal relationships statistically.

2.2. Participants

The participants were 24 third-year students enrolled in the Indonesian Language Education Study Program. Among them, 4 were male students and 20 were female students. They belonged to a non-regular weekend class, as most participants were employed as teachers, educational staff, or professionals during weekdays while pursuing their undergraduate studies. This context was particularly relevant because the students represented adult learners who balanced academic, professional, and personal responsibilities, conditions that often limit opportunities for continuous English practice. As future educators, they were expected to communicate ideas clearly and confidently in educational settings, yet many had limited experience using English for academic discussion and argumentation. Consequently, they constituted a meaningful group for examining how PERMA-based learning and AI assistance could support speaking development under authentic educational constraints.

2.3. Target Population and Sampling Technique

The broader target population consisted of pre-service teachers enrolled in language education programs who may be required to use English for professional communication, classroom interaction, or continuing professional development. Purposive sampling was employed because the study sought participants who possessed characteristics directly relevant to the research objectives. The selected students were considered information-rich cases due to their dual roles as university students and future educators, their limited exposure to English speaking activities, and their demonstrated need for confidence-building and emotional support in oral communication.

Furthermore, the sampling strategy was aligned with the exploratory nature of this pilot study. Pilot studies are designed to evaluate the feasibility, practicality, and preliminary effectiveness of an instructional intervention before its implementation on a larger scale. Therefore, rather than seeking statistical representativeness, the study prioritized participants who could provide detailed feedback regarding the integration of PERMA-based learning and AI-assisted speaking practice. The weekend-class cohort was particularly suitable because their diverse professional experiences, constrained study time, and varying levels of English proficiency allowed the researcher to examine whether the intervention could function effectively in a realistic and challenging educational environment. Findings from this pilot study are expected to inform future large-scale investigations involving broader populations of pre-service teachers and language learners.

2.4. Instruments

Several instruments were used to collect data: (1) classroom observation sheets, (2) students' assignments submitted through Google Classroom, and (3) semi-structured interviews exploring students' perceptions of the learning process. Sample interview questions included: How did AI tools help your speaking preparation? and How did PERMA-based learning affect your confidence? Content validity of the instruments was reviewed by the researcher's academic supervisors as language education experts.

2.5. Measurement Tools

Students' speaking performance was assessed using an observation rubric focusing on pronunciation, fluency, confidence, argument structure, and engagement in PERMA-based learning activities. The rubric also considered students' ability to use AI tools meaningfully before classroom participation. Scores and descriptive notes were recorded during each session.

2.6. Research Procedures and Timeline

The study was conducted online for four weeks and consisted of three phases: planning, implementation, and assessment. The four-week duration was considered appropriate for a pilot study because its primary purpose was to examine the feasibility and initial implementation of the instructional model rather than to measure long-term learning outcomes. During the planning phase, learning materials, AI-supported speaking tasks, and PERMA-based activities were developed and adapted to the characteristics of working adult learners. During implementation, students engaged in AI-assisted preparation prior to synchronous online meetings and subsequently participated in argumentative speaking activities designed to promote positive emotions, engagement, collaborative interaction, meaningful communication, and a sense of accomplishment. During the assessment phase, students submitted reflective learning summaries through Google Classroom and participated in semi-structured interviews to evaluate their experiences with the intervention.

2.7. Data Analysis Strategy

Data were analyzed using thematic analysis. Observation notes, interview transcripts, and student submissions were coded to identify recurring themes related to anxiety reduction, confidence growth, pronunciation improvement, and speaking performance. Triangulation across multiple data sources was conducted to enhance trustworthiness and credibility of the findings.

3. Results and Discussion

3.1. Results

The study commenced on 6 March 2026 with the implementation of PERMA-based learning integrated with AI-assisted speaking preparation. During the orientation stage, students were informed that speaking performance would be evaluated based on individual progress rather than comparison with classmates. The lecturer emphasized psychological safety, supportive participation, and continuous improvement throughout the learning process. Classroom observations indicated that the lecturer consistently adopted a patient and encouraging approach, helping students feel comfortable participating in English-speaking activities without fear of embarrassment or negative judgment.

To prepare students for argumentative speaking tasks, the lecturer introduced key principles of academic argumentation, including expressing opinions, providing reasons, presenting evidence, and responding to opposing viewpoints. Students were also familiarized with the Toulmin Argument Model, consisting of claim, data, warrant, backing, rebuttal, and qualifier, to support the development of more structured and logical arguments. In addition, useful sentence patterns and academic expressions were explicitly modeled before students engaged in speaking activities. Figure 1 illustrates the lecturer's introduction of useful expressions for presenting opinions and supporting arguments during classroom instruction.



Figure 1. The Lecturer Introduces Useful Expressions for Giving Opinions and Reasons in Argumentative Speaking

Following the instructional stage, students engaged in AI-assisted preparation before participating in classroom speaking activities. Several students used ChatGPT and Gemini to generate ideas, develop supporting reasons, and refine academic expressions for their presentations. Students reported that these tools helped them organize arguments and increase their confidence before speaking. In addition, YouGlish was frequently used to practice pronunciation through authentic British and American English models, while Duolingo supported vocabulary development and sentence construction. Some students also joined English-speaking communities through Telegram groups to gain additional opportunities for informal communication and speaking practice outside scheduled class meetings.

After completing their preparation, students participated in simulated academic speaking sessions. They presented viewpoints on educational and social issues, justified their positions using Toulmin-based argument structures, and responded to questions from classmates. During these interactions, peers were encouraged to challenge arguments, request clarification, and offer alternative perspectives. Students were therefore required not only to express opinions but also to defend and elaborate on their reasoning. Figure 2 presents an example of a classroom speaking session in which a student delivers an argumentative presentation while receiving reinforcement from the lecturer and feedback from peers.

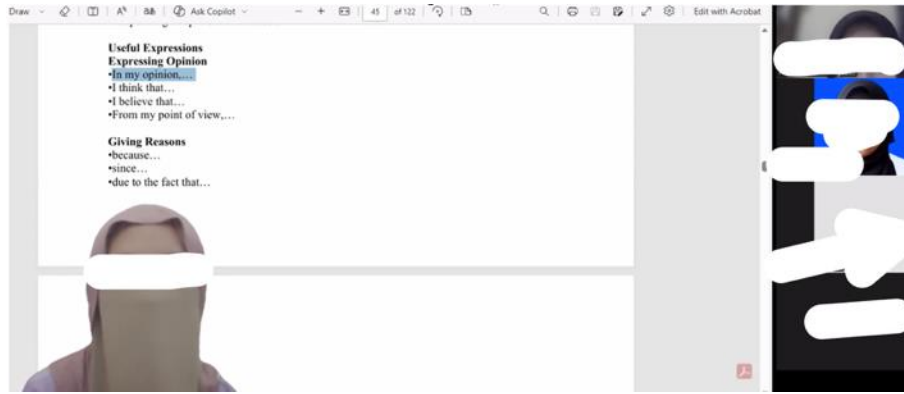


Figure 2. A Student Delivers an Argumentative Speaking Presentation While the Lecturer Provides Reinforcement and Classmates Observe

Across the four-week implementation, observation records indicated gradual increases in students' participation and willingness to speak. Students who were initially reluctant to contribute became more willing to volunteer responses and complete speaking tasks. Speaking performance records further suggested improvements in pronunciation clarity, fluency, and the organization of arguments through the use of claims, supporting evidence, and rebuttals. Moreover, reflective summaries submitted through Google Classroom demonstrated growing awareness of learning strategies, speaking challenges, and personal progress. Collectively, these findings suggest that the combination of PERMA-based learning, AI-assisted preparation, and structured argumentative speaking activities contributed to a more supportive and engaging environment for English oral communication.

Table 1 summarizes the major changes observed during the four-week intervention. At the beginning of the program, many students showed low confidence, hesitation, and anxiety, which often led them to avoid speaking activities. The classroom atmosphere was initially influenced by fear of making mistakes, and student participation tended to be passive with limited responses. In terms of speaking performance, pronunciation was often unclear, fluency was interrupted by frequent pauses, and argumentative speaking was characterized by limited reasoning and insufficient supporting examples. Academic interaction was also minimal, as students rarely asked questions or responded to others' ideas. After the intervention, noticeable improvements were observed across all aspects. Students became more confident and willing to speak, while the classroom climate developed into a supportive and appreciative environment. Participation increased significantly, pronunciation became clearer, and speech delivery became smoother. In addition, students demonstrated stronger argumentative speaking through better use of claims, evidence, and rebuttals, while classroom interaction became more dynamic through active questioning and the ability to defend arguments.

Table 1. Aspect Observed

No	Aspect Observed	Initial Condition	Condition After Intervention
1	Confidence	Hesitant, anxious, avoided speaking	More confident and willing to speak
2	Classroom Climate	Fear of mistakes	Supportive and appreciative
3	Participation	Passive and limited responses	More active participation
4	Pronunciation	Unclear and uncertain	More accurate and clearer
5	Fluency	Frequent pauses	Smoother delivery
6	Argumentative Speaking	Limited reasoning and examples	Better use of claims, evidence, rebuttals
7	Academic Interaction	Rarely asked or answered questions	More active questioning and defending arguments

Data gathered from students' assignments submitted through Google Classroom also revealed consistent engagement in out-of-class preparation. Each week, students uploaded personal learning notes documenting what they had learned before and after classroom sessions. Interestingly, many participants preferred to write their notes by hand, photograph the pages, and submit them online (see Figure 3). The uploaded notes commonly included useful vocabulary, argumentative expressions, sentence patterns, pronunciation reminders, and reflections on strategies they intended to use during speaking performances. This activity enabled the lecturer to recognize and appreciate students' small but meaningful learning efforts, not only their final speaking performance.

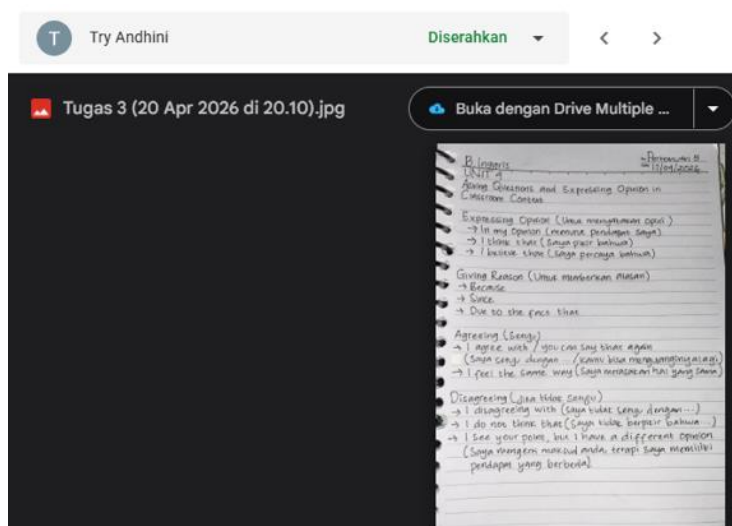


Figure 3. A Student's Handwritten Notes Uploaded to Google Classroom, Containing Useful Expressions for Argumentative Speaking Preparation

Findings from the semi-structured interviews further indicated positive student perceptions of the learning process. Many participants stated that AI tools such as ChatGPT, Gemini, and YouGlish helped them prepare ideas, improve sentence choices, and practice pronunciation before class. Students also reported that the PERMA-based learning atmosphere increased their confidence because they felt supported by both the lecturer and classmates. Several participants emphasized that they felt more comfortable participating because they were not compared with one another, which reduced anxiety and strengthened their sense of belonging to the class community.

3.2. Discussion

One of the most prominent findings of this study is that students became more willing to speak when they perceived the classroom as a psychologically safe environment. Observation notes and interview responses consistently showed that students were less afraid of making mistakes because the lecturer avoided public comparison, emphasized encouragement rather than criticism, and treated errors as part of the learning process. This suggests that students' improvement in argumentative speaking was closely related to changes in their emotional state rather than linguistic practice alone. For many participants, especially those from a non-English-major background, anxiety had previously prevented them from expressing ideas even when they understood the content. The PERMA-based approach appeared to reduce this emotional barrier by creating a learning atmosphere in which students felt accepted and supported. As a result, students became more willing to participate, ask questions, and defend their arguments during classroom discussions. This finding supports previous research indicating that supportive learning environments can enhance confidence, participation, and willingness to communicate in EFL contexts (Ji et al., 2025; López-Medina & Casado, 2024; Namsaeng & Thuratham, 2025; Ölmez & İter, 2025). However, the present study demonstrates that these benefits were achieved not merely through positive classroom interaction but through the deliberate integration of PERMA principles into speaking instruction.

Another important finding is that students primarily used AI tools as preparation partners rather than as assessment technologies. Although AI is often discussed in terms of automated feedback and performance evaluation, participants in this study relied on ChatGPT, Gemini, YouGlish, and Duolingo mainly to generate ideas, explore vocabulary, rehearse arguments, and check pronunciation before speaking in front of others. This pattern indicates that AI functioned as a confidence-building scaffold that reduced uncertainty during speaking preparation. Students reported feeling more prepared because they could organize ideas and rehearse language privately before entering public discussion. Consequently, AI appeared to support not only linguistic development but also emotional readiness for argumentative speaking. This finding extends previous studies on AI-assisted language learning, which have primarily emphasized feedback efficiency, personalization, and language accuracy (Huang et al., 2025; Kang et al., 2024; Qian et al., 2025). The current study suggests that the value of AI may lie equally in its ability to increase learners' confidence and willingness to participate in challenging speaking tasks.

The findings further reveal that students' speaking development was characterized by improvements in the way they organized and defended ideas rather than by fluency gains alone. Throughout the intervention, students were required to formulate claims, provide supporting evidence, respond to questions, and justify their positions using Toulmin-based argumentation elements. Observation data showed that students gradually moved beyond short personal opinions and began constructing more structured responses supported by

reasons and examples. This suggests that argumentative speaking developed because students repeatedly practiced reasoning aloud within authentic classroom interactions. The findings therefore indicate that academic speaking should be viewed as a process of argument construction rather than merely oral language production. While previous studies have highlighted the benefits of debate, authentic communication, and task-based interaction (Correia, 2025; Deliana & Ganie, 2025; Zheng et al., 2025), the present study demonstrates how explicit argumentation scaffolds can help non-English-major pre-service teachers develop more academically oriented speaking performance.

A final finding concerns the role of handwritten reflective notes submitted through Google Classroom. Students frequently described these reflections as opportunities to document new vocabulary, evaluate their speaking performance, and recognize personal progress. Rather than serving merely as an assessment requirement, the reflective activity encouraged students to remain engaged with learning between class meetings. The findings suggest that reflection strengthened students' sense of ownership over their learning process and reinforced the accomplishment dimension of PERMA. Importantly, students appeared to value recognition of small achievements, such as learning new expressions or successfully answering a question, which contributed to sustained motivation throughout the intervention. While previous studies have reported positive effects of reflective and process-oriented learning activities (Asrobi et al., 2025; Ke & Zhou, 2024; Mandasari et al., 2024), the present findings show that reflection can function as a connecting mechanism between AI-assisted preparation, classroom participation, and emotional wellbeing. Together, these elements formed an integrated learning experience that supported the development of argumentative speaking among Indonesian pre-service teachers.

3.3. Implications

The findings of this pilot study offer several pedagogical, theoretical, and practical implications for English language teaching, particularly in contexts involving non-English-major pre-service teachers. First, the study suggests that speaking instruction should address emotional readiness alongside linguistic competence. The positive changes observed in students' confidence and participation indicate that reducing anxiety and fostering psychological safety are not peripheral concerns but central conditions for successful argumentative speaking development. Therefore, language educators may benefit from incorporating PERMA-based principles into speaking instruction by creating supportive learning environments, recognizing students' progress, and encouraging risk-taking without fear of negative evaluation. Such practices may be particularly valuable for learners who have limited prior exposure to English communication and who often perceive speaking activities as threatening or intimidating.

3.4. Limitations

Several limitations should be acknowledged in interpreting the findings of this study. First, this research was conducted as a pilot project involving only 24 third-year students from one Indonesian Language Education program in a non-regular weekend class. Therefore, the findings may not be generalizable to students from other universities, disciplines, age groups, or learning contexts. A larger and more diverse sample would be needed to confirm the broader applicability of the results.

Second, the study employed a qualitative case study design, which aimed to provide in-depth understanding rather than statistical generalization. Although data triangulation was conducted through classroom observations, student assignments, and semi-structured interviews, the findings relied primarily on descriptive interpretation of students' experiences and classroom development. Future studies may strengthen the evidence by incorporating mixed-method or experimental designs with pre-test and post-test comparisons.

Third, the intervention lasted only four weeks, which limits conclusions regarding the long-term sustainability of students' speaking improvement, confidence growth, and continued use of AI-assisted learning tools. Longer interventions are needed to examine whether the observed gains can be maintained over time.

Fourth, students used different digital tools such as ChatGPT, Gemini, YouGlish, Duolingo, and Telegram groups based on personal preference. While this flexibility supported learner autonomy, it also created variation in learning experiences that was not systematically controlled or measured. Future research may compare the relative effectiveness of specific AI tools or digital platforms for argumentative speaking development.

Finally, the study focused primarily on students' confidence, fluency, pronunciation, and argumentative participation in classroom contexts. More detailed measurement of linguistic complexity, accuracy, critical thinking quality, and transferability to real teaching practice was beyond the scope of the present pilot study. These aspects remain important directions for future research.

4. Conclusion

This pilot study explored the implementation of PERMA-based learning integrated with AI assistance in supporting the argumentative speaking development of pre-service teachers from a non-English-major program. The findings suggest that the combination of positive psychology principles, supportive classroom practices, and AI-assisted preparation was associated with students' reported increases in confidence, engagement, and readiness to participate in argumentative speaking activities. Participants also appeared to benefit from opportunities to rehearse ideas, receive support during preparation, and engage in structured academic discussions. The study further indicates that supportive assessment practices, collaborative classroom interaction, and reflective learning activities may contribute to creating a learning environment in which students feel more comfortable expressing and defending their ideas in English. Rather than demonstrating effectiveness in a causal sense, the findings provide preliminary evidence that integrating psychological wellbeing and AI-supported learning may offer a feasible and potentially valuable approach to argumentative speaking instruction for this particular group of learners. Given the exploratory nature and limited scale of the study, the findings should be interpreted cautiously and cannot be generalized to broader populations or educational contexts. Nevertheless, the study contributes initial insights into how PERMA-based learning and AI assistance can be combined within speaking instruction and identifies several areas worthy of further investigation. Future research involving larger and more diverse participant groups, longer intervention periods, and comparative or mixed-methods designs is recommended to examine the transferability, sustainability, and potential impact of this instructional approach across different teacher education contexts.

Author Contributions

Rasi Yugafiati: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Project administration, Validation, Writing – Original draft preparation, Writing – Review & Editing. Issy Yuliasri: Supervision, Methodology, Validation, Writing – Review & Editing. Widhiyanto: Resources, Visualization, Formal analysis, Writing – Review & Editing. All authors have equal contributions to the paper. All the authors have read and approved the final manuscript.

Funding

This research received no external funding from any public, commercial, or not-for-profit funding agency. The study was independently conducted by the authors. No sponsor had any role in the study design; data collection, analysis, or interpretation; manuscript preparation; or the decision to submit the article for publication.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/ or publication of this article.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request. The shared materials may include anonymized classroom observation notes, processed student assignment data, interview summaries or transcripts, and supporting analytical documents relevant to the study findings. Data are not publicly available in an open repository because they involve student participants and contain information subject to privacy and ethical considerations. All data shared upon request will be appropriately anonymized to protect participants' identities.

Declaration on AI Use

AI were used only to improve readability and language under strict human oversight; no content, ideas, analyses, or conclusions were generated by AI.

Acknowledgement

The authors would like to express sincere gratitude to the academic supervisors and colleagues who provided valuable feedback during the development of this study. Appreciation is also extended to the students of the Indonesian Language Education Study Program who voluntarily participated in the pilot project and contributed their time, reflections, and learning experiences. The authors are grateful to all individuals who offered academic encouragement, technical assistance, and constructive suggestions throughout the research and manuscript preparation process.

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