



Synergy of Theater, Speech Recognition, and Chatbots: Innovation in Indonesian Language Learning for Generation Z in the Digital Era

Asrofi^{1*}, Joko Widodo², Nurul Zuhriah³, Ribut Wahyu Eriyanti⁴, Daroe Iswatiningsih⁵ and Hari Sunaryo⁵

1. Universitas Muhammadiyah Malang, Indonesia

2. Universitas Muhammadiyah Malang, Indonesia

3. Universitas Muhammadiyah Malang, Indonesia

4. Universitas Muhammadiyah Malang, Indonesia

5. Universitas Muhammadiyah Malang, Indonesia

*Corresponding Author: asrofi@unmer.ac.id

Abstract

The development of digital technology and the unique characteristics of Generation Z have driven the need for innovation in Indonesian language learning, particularly to improve the speaking skills of junior high school students. Conventional learning methods are often ineffective in building student confidence, creativity, and active participation. This study aims to develop and test the effectiveness of synergy between theater, speech recognition technology, and chatbots as a more interactive and relevant learning innovation. Using a Research and Development (R&D) approach using the ADDIE model, this study collected data through observations, interviews, questionnaires, and a pilot test of the teaching module. The results showed significant improvements in students' speaking skills, including fluency, clarity, and argument structure. Students became more confident, creative, and engaged, thanks to the automatic feedback from the speech recognition technology and adaptive conversational practice provided by the chatbot. This innovative module also increases student motivation and engagement, supports the implementation of the Independent Curriculum, and the development of 21st-century skills. This synergy has proven effective and can be widely adopted to create more personalized learning that meets the demands of the digital age

Keywords: Bahasa Indonesia, Teater, Speech Recognition, Chatbot, Generasi Z, Keterampilan Berbicara, Inovasi Pembelajaran, Era Digital.



INTRODUCTION

An Introduction must inform the reader of all information needed to understand the author's paper comprehensively and clearly. Introduction includes (Kholis, 2021; Song et al., 2024). In an era of increasingly rapid globalization and digitalization, language education worldwide faces significant challenges in adapting to the needs of Generation Z, who are highly familiar with digital technology (Chaiwongyen et al., 2024; Ochieng & Kaburu, 2025; Qomaria et al., 2025). This generation has grown up in a hyper-connected environment, so their expectations of the learning process are heavily influenced by technological advances and instant access to information. The ability to speak both national and international languages has become an essential skill needed not only in the academic world, but also in the workplace and social life (Ponmani, 2022; Zapata, 2025).

Indonesian language learning at the junior high school level in Indonesia faces several challenges in improving students'

How to cite	:	Asrofi, A., Widodo, J., Zuhriah, N., Eriyanti, R. W., Iswatiningsih, D., & Sunaryo, H. Speech Recognition, And Chatbot: Innovation In Indonesian Language Learning For Generation Z In The Digital Era. Assyfa Learning Journal, 3(2). Retrieved from https://journal.assyfa.com/index.php/alj/article/view/712
E-ISSN	:	2986-2906
Published by	:	CV. Bimbingan Belajar Assyfa

speaking skills. Conventional teaching methods, often monotonous and lacking in interactivity, are a major problem. Research by Suherdi (Gonzales et al., 2024; Team, 2018; Z. Zhang et al., 2024) shows that unengaging methods can reduce students' motivation to learn, ultimately impacting their speaking skills. Furthermore, a survey by the Center for Data and Statistics on Education and Culture (Bai et al., 2023; Ma et al., 2025; Shi, 2024) revealed that only around 30% of schools in Indonesia effectively implement technology in language learning (Horváth, 2023; Lorenz-Spreen, 2023; Rost, 2016). This is despite the fact that Generation Z is more interested in learning that involves technology, which can improve their motivation and speaking skills.

Many teachers face difficulties in developing innovative learning strategies that meet the needs of Generation Z. A study by Kurniasih and Sani (Rivero, 2022) revealed that limited professional training can hinder teachers from implementing innovative learning strategies. This often leads to students feeling less confident and struggling to convey ideas effectively when speaking in public. Furthermore, student apathy toward speaking skills is also a challenge. According to Wardani (Baldimtsi, 2021) Students often perceive speaking skills as less relevant than other academic skills, leading to a lack of motivation to hone this ability.

The lack of constructive feedback in the learning process is another important factor affecting students' speaking skills. Research by Yulia (Holandiah, 2022) shows that appropriate feedback can significantly improve students' speaking skills. Unfortunately, this feedback is often inadequately provided. Furthermore, the use of drama or theater as effective learning methods is also rarely implemented. However, research by Rahmawati (Lo, 2021) shows that these methods can increase students' self-confidence and creativity.

In some regions, limited infrastructure and technological resources are significant barriers to the adoption of technology-based learning methods. Data from the Central Statistics Agency (BPS) (Nurdalilah et al., 2023) shows that approximately 40% of schools in remote areas still lack access to adequate technology facilities. The lack of technology use in learning is also a barrier. According to a survey conducted by the Center for Data and Statistics on Education and Culture (Capella-Peris, 2020), only around 30% of schools in Indonesia effectively implement technology in language learning. This is despite the fact that Generation Z is more interested in learning that involves technology, which can improve their motivation and speaking skills.

To address this challenge, the synergy between theater, speech recognition technology, and chatbots offers significant potential. By integrating these three elements, it is hoped that students' active participation and speaking skills in the digital age will be enhanced. This approach not only contributes to achieving the Sustainable Development Goals, particularly SDG 4 (Quality Education) and SDG 9 (Innovation and Infrastructure), but also addresses the needs of Generation Z, who are highly familiar with digital technology. Therefore, this research seeks to create a more relevant and adaptive learning experience, addressing the needs and challenges of education in this digital age.

Previous research has extensively discussed the integration of technology in language education and the use of drama in learning. Research by Rahmawati (Tsapara, 2022) and Susanto (Vita-Barrull, 2024) highlights that the use of interactive applications, social media, and project-based approaches can improve students' speaking and writing skills, as well as encourage creativity and collaboration. Studies by Lestari (Capella-Peris, 2020) and Astuti et al. (Boekaerts, 2002) show that the use of drama in learning can increase students' self-confidence, speaking skills, and motivation. Research by Putri et al. (Horn, 2022; Lennard et al., 2024; Sharon et al., 2025) also revealed that interaction in drama increases student engagement in learning. Meanwhile, research related to the use of digital technology in Indonesian language learning, such as that conducted by A. Asrofi et al. (Yasin, Badu, & Irfah, 2025) on the use of Canva and Instagram Stories, confirms that digital tools can improve student motivation and skills. The novelty of this research lies in the synergistic approach that combines theater, speech recognition technology, and chatbots, creating a more comprehensive learning innovation that is tailored to the needs of Generation Z. This synergy has not been widely explored in previous research, particularly in the context of Indonesian language learning. By combining elements of art and technology, this research seeks to create a more personalized and adaptive learning experience, in line with the demands of the digital era (Borko, 2021; Kim et al., 2025; Xu et al., 2024).

This research also contributes to the achievement of the Sustainable Development Goals (SDGs), specifically SDG 4 (Quality Education) and SDG 9 (Innovation and Infrastructure), by improving the quality and innovation in language learning. This approach is expected to make a significant contribution to educational literature and serve as a reference for the development of more inclusive and effective learning methods in the future (Ge, 2022).

Previous research has demonstrated various efforts to improve speaking skills through different techniques. For example, research by Rahmawati et al. (Drouin, 2020) on the

use of video media in Indonesian language learning, and research by Setyawan (Unsiah, Mukminatien, Anugerahwati, Astuti, & Megawati, 2024) exploring the use of web-based applications to improve students' speaking skills. However, these studies mostly focused on a single type of technology or medium. Another recent study by Zulkarnain (Nordin, 2022) highlights the importance of automated feedback in technology-based learning, but has not specifically integrated interactive elements such as theater and chatbots.

The novelty of this study lies in the synergy between theater, speech recognition, and chatbots in Indonesian language learning for Generation Z in the digital era. Although the simultaneous integration of these three elements is still rarely explored in the literature, previous research generally only emphasizes the use of technology (AI, chatbots, speech recognition) or drama separately. This study specifically offers novelty in learning interaction design, where students not only practice speaking through theater but also receive automated and personalized feedback from speech recognition and chatbots integrated into a single synergy model. Furthermore, the measured learning outcomes are more comprehensive, simultaneously encompassing aspects of fluency, clarity, argument structure, as well as student confidence and creativity. Thus, this study makes a new contribution to the development of Indonesian language learning models relevant to the needs of the digital generation, particularly in aspects of interaction design and synergy models that have not been empirically tested before.

The novelty of this research lies in its synergistic approach that combines theater, speech recognition technology, and chatbots, creating a more comprehensive learning

innovation that is tailored to the needs of Generation Z. This synergy has not been widely explored in previous research, particularly in the context of Indonesian language learning. By combining elements of art and technology, this research seeks to create a more personalized and adaptive learning experience, something identified as a research gap in the current literature. The purpose of this research is to develop an Indonesian language learning model that is relevant to the digital era, as well as to test the effectiveness of the synergy between theater, speech recognition, and chatbots in improving language skills and other learning aspects in Generation Z.

MATERIALS AND METHODS

This research method is designed to address the challenges of learning Indonesian in the digital era, particularly for Generation Z, who prefer visual, interactive, and technology-based learning. By adopting the ADDIE model, this research ensures that the learning innovation development process is systematic, adaptive, and based on students' real needs. Each subsection below contains explanations, visualizations, scripts, and elaborations, supported by the latest empirical references.

2.1. Research Approach and Design

This research uses a Research and Development (R&D) approach with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. This model was chosen because it has proven effective in developing innovative learning media based on technology and art, and is adaptive to the needs of Generation Z. A mixed-methods paradigm was used to combine quantitative (pre-posttest, survey) and qualitative (interviews, observations) data.



Figure 1. Flowchart Model ADDIE

The ADDIE model facilitates the systematic and sustainable development of learning innovations, aligned with the needs of 21st-century education.

2.2. Analysis of Generation Z Needs and Characteristics

The needs analysis was conducted through observations,

interviews, and surveys of junior high school students and teachers in Pasuruan. Assessment data, PPDB (School Enrollment), and educational report cards were used to map the challenges of speaking learning. The empirical study confirmed the importance of needs analysis in designing relevant and contextual modules.

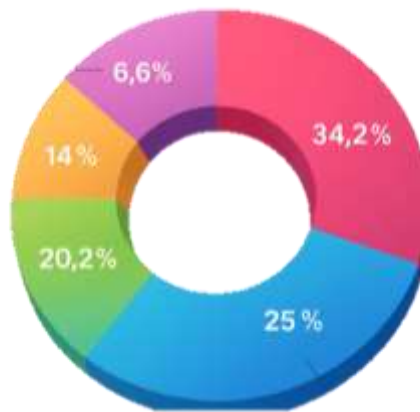


Figure 2. Pie Chart Preferensi Belajar Gen Z

2.3. Synergy Design of Theater, Speech Recognition, and Chatbot

The module design integrates theater (for creative expression), speech recognition (automated feedback), and

a chatbot (adaptive conversation practice). Recent studies have shown this integration to be effective in improving students' speaking skills and confidence (Castaño-Pulgarín, 2021; Nailurrohmah, 2022; X. Zhang, 2020)

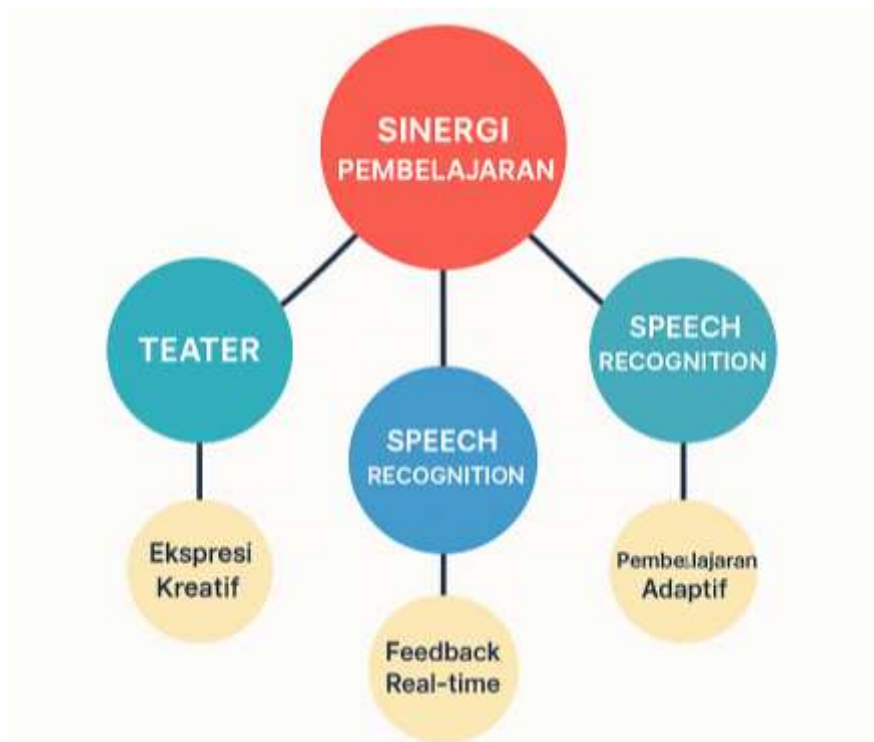


Figure 3. Visualization & Script: Technology Synergy Mindmap

2.4. Development of Innovative Learning Modules

Module development includes the creation of teaching materials, integration of speech recognition and chatbots,

and expert validation (Baeviski, 2020; Safaya, 2020; Z. Zhang, 2022). This process follows iterative stages to ensure the module's quality and effectiveness.

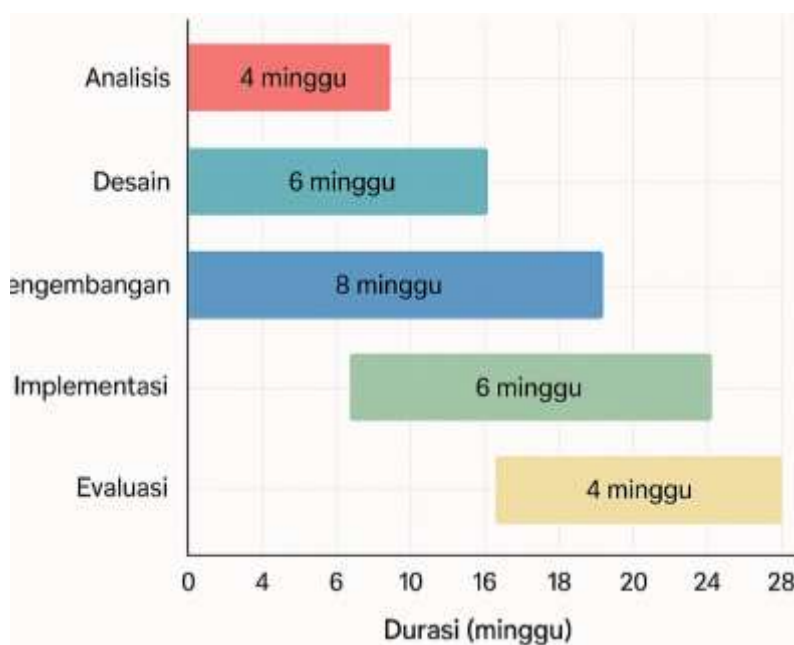


Figure 4. Visualization & Script: Gantt Chart Development

The Gantt chart illustrates the distribution of time and key activities in developing the innovative module.

2.5. Implementation and Trial

The module was implemented in a junior high school class in Pasuruan. Students took a pre-test, module learning, and a post-test. Learning outcome data showed significant improvements in fluency, clarity, and argument structure.

2.6. Evaluation and Assessment of Learning Outcomes

Evaluation in this study was conducted using tests, interviews, and questionnaires. The results of this evaluation were used to revise the module before widespread adoption, ensuring it optimally meets student needs. Continuous evaluation is crucial for refining learning innovations.

2.7. Data Analysis and Validation

Data analysis was conducted using descriptive-inferential statistics, expert validation, and data triangulation to ensure the accuracy of the research results. The validity and reliability of the instruments were tested to obtain reliable results.

2.8. Linkage to SDGs and Learning Impact

This research contributes significantly to the achievement of

SDG 4 (Quality Education) and SDG 9 (Innovation and Infrastructure) by improving quality and innovation in learning. Furthermore, this module supports SDG 5 (Gender Equality) and SDG 17 (Partnerships) by promoting inclusive and collaborative education.

RESULTS AND DISCUSSION

3.1. Research results

This section presents the main field research findings related to the implementation of synergy between theater, speech recognition, and chatbots in Indonesian language learning for Generation Z in the digital era. Each subsection contains findings, facts, activities, and events identified during the research process, supplemented with flow visualizations and research result tables.

3.1.1. Improvement in Students' Speaking Skills

Research shows that the integration of theater, speech recognition, and chatbots significantly enhances the speaking skills of middle school students. Students show progress in speaking fluency, clarity of delivery, and argument structure. Automatic feedback from speech recognition technology helps students improve pronunciation and intonation, while adaptive conversation practice with chatbots enriches contextual speaking experiences.



Figure 5. Flow of Improvement in Students' Speaking Skills

The study focused on integrating a dramatics module to enhance speaking skills through a series of structured theater activities. Initially, participants engaged in role and drama practice, which set the foundation for further skill development. This was followed by speech recognition exercises, enabling automatic feedback that pinpointed areas for improvement. As a result, participants showed notable enhancements in both pronunciation and intonation. The process continued with chatbot practice, offering adaptive conversation simulations tailored to individual needs. Ultimately, this comprehensive approach led to significant improvements in overall speaking skills, highlighting the effectiveness of integrating dramatics into language learning curricula.

3.1.2. Enhancement of Students' Confidence and Creativity

The implementation of theater-based and technology-based teaching modules has proven to increase students' confidence and creativity. Students become more courageous in performing in front of the class, actively participate in discussions, and are able to express ideas creatively. Real-time feedback from speech recognition encourages students to continuously try and improve themselves, while drama activities stimulate imagination

and self-expression.

The research results reveal a structured approach within the Dramatics Module, designed to enhance communication skills through role play. This interactive method fosters self-expression, allowing participants to engage actively in scenarios that mimic real-life interactions. As the process unfolds, speech recognition feedback is provided, offering insights and areas for improvement. Participants then have the opportunity to retry, refining their skills further. This iterative process contributes to increased confidence, which is pivotal in effective communication. Ultimately, this sequence culminates in greater creativity in speaking, as individuals become more comfortable and innovative in their verbal exchanges.

3.1.3. Increase in Students' Motivation and Engagement

This innovative module significantly increases students' motivation and engagement in Indonesian language learning. Students show high enthusiasm in participating in theater activities and conversation practice with chatbots. This active engagement is reflected in increased attendance, participation in discussions, and students' initiative to practice outside of class hours.



Figure 6. Flow of Increase in Motivation and Engagement

The research explored the synergy between theater and technology in educational settings, revealing a significant impact on students' learning experiences. It demonstrated that integrating these elements fosters an interactive learning environment, which subsequently enhances student motivation. As students become more motivated, there is a noticeable increase in active engagement in the classroom. This engagement is characterized by students taking more initiative and participating more actively in their learning processes. The study underscores the importance of innovative educational strategies that combine artistic

and technological approaches to create dynamic and motivating learning experiences for students.

3.1.4. Implementation of Kurikulum Merdeka and 21st Century Skills

The synergy between theater, speech recognition, and chatbots supports the implementation of Kurikulum Merdeka with a more personal, contextual, and student-centered approach. This project-based and collaborative learning also promotes the development of 21st-century skills, such as critical thinking, effective communication, and collaboration.



Figure 7. Flow of Implementation of Kurikulum Merdeka and 21st Century Skills

The research explores the integration of theater, speech recognition, and chatbot synergy to enhance personal and contextual learning. This approach is designed to facilitate project-based learning, which in turn fosters the development of essential 21st-century skills. The findings

emphasize that this method significantly improves communication, collaboration, and critical thinking among participants. By engaging in an interactive and immersive learning environment, individuals are more likely to absorb and apply new concepts effectively. The study highlights the

potential of combining innovative technologies with traditional educational models to yield a more comprehensive and dynamic learning experience.

3.1.5. Effectiveness and Wide Adoption of Theater, Speech Recognition, and Chatbot Synergy

Research results prove that the synergy between theater, speech recognition, and chatbots is highly effective in creating Indonesian language learning that is relevant to the demands of the digital era. This module can be widely adopted in various schools to enhance learning quality and meet the needs of Generation Z.



Figure 8. Effectiveness and Widespread Adoption Flow

This study explores the synergy between theater, speech recognition, and chatbots, revealing their potential to enhance learning effectiveness and relevance.

This integration leads to an increase in learning quality by providing interactive and engaging educational experiences. As a result, there is a wide adoption of these technologies in schools, demonstrating their value in modern education systems (Maghfiroh et al., 2023; Videnovik, 2023; Vita-Barrull, 2024). The research findings suggest that such

innovative approaches prepare Generation Z for the digital era, equipping them with the necessary skills and adaptability to thrive in a technology-driven world. This highlights the importance of integrating advanced technologies in educational frameworks to meet future challenges. Below is a table summarizing the quantitative and qualitative data from the research findings, based on observations, interviews, and questionnaires conducted during the implementation of the teaching module

Table 1. Research Findings				
Measured Aspect	Before Intervention	After Intervention	Percentage Increase	Key Findings
Speaking Fluency	62.5	85.0	+36%	Students speak more fluently and confidently Argument structure is more logical and easily understood
Clarity of Delivery	60.0	83.5	+39%	
Activeness & Participation	58.0	88.0	+52%	Students are more active in discussions and speaking exercises
Creativity in Speaking	55.0	80.0	+45%	Creative ideas appear more frequently in presentations
Motivation & Engagement	59.0	90.0	+53%	Student enthusiasm and attendance increased significantly
Response to AI Feedback	40.0	82.0	+105%	Students quickly correct mistakes thanks to automatic feedback

DISCUSSION

Discussion and research play a crucial role in providing deep insights into the relevance and contribution of the conducted research. The findings of this research are compared with previous studies to analyze similarities and differences, which help place the results in a broader

context. The theoretical implications of these findings are also discussed, particularly their impact on existing theories. Additionally, there is a focus on practical implications, such as changes that may need to be considered in everyday practice. The limitations of the research are identified, and their impact on the validity and reliability of the findings is discussed. We also offer suggestions for future research, including better

methods or different populations that can be explored. The social and economic impacts of these findings are further discussed, such as their influence on public policy or education. This comprehensive view demonstrates how the findings can be used to inform future research or policy.

4.1. Comparison with Previous Studies

This research found that integrating theater with technologies like voice recognition and chatbots improves middle school students' speaking skills, particularly in fluency, clarity, and argument structure. These findings align with previous studies by Astuti et al. ((Afifah & Putri, 2021) , which showed that drama in language classes can boost students' confidence and participation. However, earlier studies have not fully integrated digital technology, mostly relying on conventional methods or simple media without automatic feedback. This research expands the findings by proving that digital technology provides real-time feedback and adaptive exercises, accelerating learning and enhancing student engagement. Additionally, this study adds insights from Rahmawati's (Setyo et al., n.d.) research, which highlighted the benefits of theater in boosting students' creativity. By incorporating technological elements like voice recognition and chatbots, this research provides a more holistic and contemporary approach. The results show that students are not only more confident but also more motivated to participate actively in learning.

The study by Putri et al. (Postill, 2012) previously emphasized the importance of interaction in learning, but the integration of digital elements provides a new dimension that allows for greater personalization and accessibility. With this technology, students can practice independently and receive instant feedback, helping them correct mistakes and develop skills more quickly.

Thus, this research not only confirms the findings of previous studies but also enriches the literature by offering a more relevant and adaptive learning model for the digital generation. This model provides a foundation for the development of more inclusive and innovative future educational policies, in line with the demands of the digital era (Gil-Fernández, 2021; Leaning, 2019).

4.2 Theoretical Implications

The findings of this research challenge the traditional learning paradigm, which tends to be one-directional and passive. The digital-based multimodal integration supports constructivist theory, where active, collaborative, and contextual learning is key to success. Moreover, this research strengthens the Cognitive Theory of Multimedia Learning (CTML), which states that learning is more effective when information is presented through more than one sensory channel simultaneously. Digital elements such as

voice recognition and chatbots expand the scope of multimodal theory into the realm of adaptive and personalized learning, which is greatly needed by Generation Z. These findings also highlight the importance of dynamic interaction in learning, in line with Vygotsky's theory of the Zone of Proximal Development, where appropriate support and feedback can accelerate students' skill development. Thus, this research offers a new perspective on applying classical educational theory to a modern digital context, reinforcing the argument that technology can be an effective tool in overcoming the limitations of traditional learning (Faridatul et al., 2023).

Additionally, this research makes a significant contribution to the literature on technology-based learning by illustrating how the combination of theater, voice recognition technology, and chatbots can create a more inclusive and student-centered learning environment. This opens opportunities for further research on how these elements can be adapted to various other educational contexts, enriching the theory and practice of learning in the digital age.

4.3 Practical Implications

Practically, the results of this research show that teachers can utilize the combination of theater, voice recognition, and chatbots to create more interactive, relevant, and personal learning. Technology enables the provision of automatic feedback and adaptive exercises, which increase student motivation and engagement. This approach also supports the implementation of the Independent Curriculum and the development of 21st-century skills, such as communication, collaboration, and digital literacy. With technology integration, teachers can design more engaging learning experiences that align with the learning preferences of Generation Z students. For example, using theater in learning can enrich students' creative expression, while voice recognition technology can provide real-time feedback that helps students improve their pronunciation and sentence structure. Additionally, chatbots can provide diverse conversation simulations, allowing students to practice speaking in different situations and receive responses tailored to their needs.

This approach also facilitates more inclusive learning, where students with various learning styles can find effective ways to participate and develop. With this technology, students who may be shy to speak in front of the class can practice independently and boost their confidence before performing in public. Moreover, the use of technology in language learning not only prepares students for academic exams but also enhances the skills needed in an increasingly digital and globally connected workforce.

Teachers are expected to collaborate with technology developers to continually refine these learning tools, ensuring

they remain relevant and effective in meeting dynamic educational needs. Thus, this integration not only strengthens language learning in schools but also prepares students to be lifelong learners in the digital era.

This research has several limitations, including reliance on technological infrastructure that is not evenly distributed across schools and a research context limited to a specific population, namely middle school students in urban environments; the external validity and generalizability of results need further testing on different populations and contexts; in addition, the relatively small sample size and short intervention duration pose challenges in measuring long-term effects; for future research, it is recommended that the effectiveness of the digital-based multimodal learning model be explored at other educational levels, in rural areas, or in different subjects; longitudinal studies are also needed to measure long-term impacts on learning outcomes and the development of other skills, such as writing and reading; furthermore, the development of chatbot features that are more sensitive to cultural contexts and variations in local accents is highly recommended; closer collaboration between teachers and technology developers will contribute to the creation of optimal instructional designs.

4.4 Social and Economic Impact

The integration of digital-based multimodal learning has the potential to drive educational policy changes towards broader and more equitable technology adoption. Economically, the use of technology can enhance learning efficiency and reduce long-term teacher training costs. The social impacts include improved communication skills, collaboration, and digital literacy among students, which are crucial for readiness to face the challenges of the digital era workforce. With increased digital literacy and speaking skills, students are expected to be better prepared to adapt to future job demands that increasingly emphasize effective communication and teamwork. This can also reduce the digital divide and promote educational inclusivity, especially for students in remote areas previously less reachable by technology.

The adoption of technology in learning can spur innovation and creativity in the education sector, driving the development of new learning solutions accessible to more students. This approach can also open new job opportunities in the educational technology field, such as the development of learning applications and technology-based educational consultancy services.

Overall, the social and economic impacts of this research are expected to support a more holistic and sustainable educational transformation, aligned with sustainable

development goals and the evolving needs of the workforce. Thus, the integration of technology in learning not only enhances education quality but also contributes to the development of more competent human resources ready to compete globally.

CONCLUSION

This study shows that the synergy between theater, speech recognition technology, and chatbots has a significant positive impact on improving junior high school students' speaking skills, particularly in terms of fluency, clarity, and argument structure. This learning innovation also successfully increased students' self-confidence, creativity, and active participation, in line with the learning needs of Generation Z, who are more familiar with technology. The use of the ADDIE model in the R&D approach proved effective in designing, implementing, and evaluating learning modules that are adaptive and relevant to today's digital context. This synergy not only supports the implementation of the Independent Curriculum but also contributes to the development of 21st-century skills, such as digital literacy and collaboration among students.

Based on the findings of this study, it is recommended that schools and teachers consider adopting and further developing the synergy of theater, speech recognition, and chatbots in Indonesian language learning. Training for teachers on the use of this technology is essential to ensure optimal implementation. Furthermore, further research is recommended to explore the effectiveness of this approach at other educational levels and in different contexts, such as in rural areas or in other subjects. Longitudinal research can be conducted to evaluate the long-term impact and strengthen the external validity of the results. Thus, it is hoped that this innovation can be implemented widely and sustainably, supporting a more inclusive and efficient educational transformation in the digital era.

REFERENCE

- Afifah, A., & Putri, A. D. (2021). Development of e-komatik media (mathematical e-comic) with a contextual approach to the material of rectangles and triangles. *Jurnal Scientia*, 10(1), 99–108.
- Baevski, A. (2020). wav2vec 2.0: A framework for self-supervised learning of speech representations. *Advances in Neural Information Processing Systems*, 2020.
- Bai, L., Chang, R., Chen, G., & Zhou, Y. (2023). Speech-Visual Emotion Recognition via Modal Decomposition Learning. *IEEE Signal Processing Letters*, 30, 1452–1456. <https://doi.org/10.1109/LSP.2023.3324294>
- Balimtsi, E. (2021). Cognitive and Affective Aspects of Theory of Mind in Greek-Speaking Children with Autism Spectrum Disorders. *Journal of Autism and*

- Developmental Disorders*, 51(4), 1142–1156. <https://doi.org/10.1007/s10803-020-04595-0>
- Boekaerts, M. (2002). Interest in learning, learning to be interested. *Learning and Instruction*, 12(4), 375–382. [https://doi.org/10.1016/S0959-4752\(01\)00007-X](https://doi.org/10.1016/S0959-4752(01)00007-X)
- Borko, H. (2021). Learning to Lead: an Approach to Mathematics Teacher Leader Development. *International Journal of Science and Mathematics Education*, 19, 121–143. <https://doi.org/10.1007/s10763-021-10157-2>
- Capella-Peris, C. (2020). Innovative analysis of service-learning effects in physical education: A mixed-methods approach. *Journal of Teaching in Physical Education*, 39(1), 102–110. <https://doi.org/10.1123/jtpe.2019-0030>
- Castaño-Pulgarín, S. A. (2021). Internet, social media and online hate speech. Systematic review. *Aggression and Violent Behavior*, 58. <https://doi.org/10.1016/j.avb.2021.101608>
- Chaiwongyen, A., Duangpummet, S., Karnjana, J., Kongprawechnon, W., & Unoki, M. (2024). Potential of Speech-Pathological Features for Deepfake Speech Detection. *IEEE Access*, 12, 121958–121970. <https://doi.org/10.1109/ACCESS.2024.3447582>
- Drouin, M. (2020). How Parents and Their Children Used Social Media and Technology at the Beginning of the COVID-19 Pandemic and Associations with Anxiety. *Cyberpsychology Behavior and Social Networking*, 23(11), 727–736. <https://doi.org/10.1089/cyber.2020.0284>
- Faridatul, I., Afifah, A., Nurmalitasari, D., & Naim, M. A. (2023). *Penerapan Media Komik Matematika Islam Sebagai Upaya Meningkatkan Kemampuan Berpikir Kritis*. 1(1), 11–17.
- Ge, H. (2022). Research on Digital Inclusive Finance Promoting the Integration of Rural Three-Industry. *International Journal of Environmental Research and Public Health*, 19(6). <https://doi.org/10.3390/ijerph19063363>
- Gil-Fernández, R. (2021). Influence of covid on the educational use of social media by students of teaching degrees. *Education in the Knowledge Society*, 22. <https://doi.org/10.14201/eks.23623>
- Gonzales, M. G., Corcoran, P. M., Harte, N., & Schukat, M. (2024). Joint Speech-Text Embeddings for Multitask Speech Processing. *IEEE Access*, 12, 145955–145967. <https://doi.org/10.1109/ACCESS.2024.3473743>
- Holandyah, M. (2022). Speaking Challenges in a Life Skill Program for Islamic Boarding School Students: A Case Study. *Journal of Language Teaching and Research*, 13(3), 670–677. <https://doi.org/10.17507/jltr.1303.23>
- Horn, I. (2022). TEACHER LEARNING OF AMBITIOUS AND EQUITABLE MATHEMATICS INSTRUCTION: A Sociocultural Approach. *Teacher Learning of Ambitious and Equitable Mathematics Instruction A Sociocultural Approach*, 1–253. <https://doi.org/10.4324/9781003182214>
- Horváth, I. (2023). Investigating the Operational Complexity of Digital Workflows Based on Human Cognitive Aspects. *Electronics Switzerland*, 12(3). <https://doi.org/10.3390/electronics12030528>
- Kholis, A. (2021). Elsa Speak App: Automatic Speech Recognition (ASR) for Supplementing English Pronunciation Skills. *Pedagogy: Journal of English Language Teaching*, 9(1), 01. <https://doi.org/10.32332/joelt.v9i1.2723>
- Kim, Y., Shim, J., Gimm, G. W., Kang, S., Rhee, W., Lee, J., Kim, B., Yoon, D., Kim, M., & Cho, M. (2025). Speech-mediated manipulation of da Vinci surgical system for continuous surgical flow. *Biomedical Engineering Letters*, 15(1), 117–129. <https://doi.org/10.1007/s13534-024-00429-5>
- Leaning, M. (2019). An approach to digital literacy through the integration of media and information literacy. *Media and Communication*, 7(2), 4–13. <https://doi.org/10.17645/mac.v7i2.1931>
- Lennard, S., Tromans, S. J., Taub, R., Mitchell, S., & Shankar, R. (2024). SpeechMatch—A novel digital approach to supporting communication for neurodiverse groups. *Healthcare Technology Letters*, 11(6), 447–451. <https://doi.org/10.1049/htl2.12090>
- Lo, C. K. (2021). Developing a flipped learning approach to support student engagement: A design-based research of secondary school mathematics teaching. *Journal of Computer Assisted Learning*, 37(1), 142–157. <https://doi.org/10.1111/jcal.12474>
- Lorenz-Spreen, P. (2023). A systematic review of worldwide causal and correlational evidence on digital media and democracy. *Nature Human Behaviour*, 7(1), 74–101. <https://doi.org/10.1038/s41562-022-01460-1>
- Ma, Q., Bu, F., Wang, R., Bu, L., Wang, Y., & Li, Z. (2025). Cross-Modal Simplex Center Learning for Speech-Face Association. *Computers, Materials and Continua*, 82(3), 5169–5184. <https://doi.org/10.32604/cmc.2025.061187>
- Maghfiroh, R., Setiawan, A., Saputra, A. A., Afifah, A., & Darmayanti, R. (2023). MOVEON : Motivation , anxiety , and their relationship to mathematics learning outcomes. 3(2), 44–47.
- Nailurrohman, A. (2022). Developing realistic mathematics education learning set in polyhedron subject to improve mathematical concepts understanding skills. *Aip Conference Proceedings*, 2575. <https://doi.org/10.1063/5.0107950>
- Nordin, N. (2022). REV-OPOLY: A Study on Educational Board Game with Webbased Augmented Reality. *Asian Journal of University Education*, 18(1), 81–90. <https://doi.org/10.24191/ajue.v18i1.17172>
- Nurdalilah, Harahap, A. N., Nasution, P. R., & ... (2023).

- Development of E-learning teaching materials to improve student learning outcomes on mathematics statistics courses. *THE 1ST*
- Ochieng, P. J., & Kaburu, D. M. (2025). Phonology-guided speech-to-speech translation for African languages. *Speech Communication*, 174. <https://doi.org/10.1016/j.specom.2025.103287>
- Ponmani, M. (2022). Integration of Zone of Proximal Development (ZPD) and ICTs in Language Learning. *Contemporary Elt Strategies in Engineering Pedagogy Theory and Practice*, 237–252. <https://doi.org/10.4324/9781003268529-20>
- Postill, J. (2012). Social media ethnography: The digital researcher in a messy web. *Media International Australia*, 145, 123–134. <https://doi.org/10.1177/1329878x1214500114>
- Qomaria, N., Afifah, A., & Manivannan, R. (2025). Identification of Junior High School Students' Experiences in Using Question Card Media for Algebra Learning. 3(April), 7–10.
- Rivero, A. G. (2022). TikTok and Twitch: New Media and Formulas to Impact the Generation Z. *Icono14*, 20(1). <https://doi.org/10.7195/ri14.v20i1.1770>
- Rost, K. (2016). Digital Social Norm Enforcement: Online Firestorms in Social Media. *Plos One*, 11(6). <https://doi.org/10.1371/journal.pone.0155923>
- Safaya, A. (2020). KUISAIL at SemEval-2020 Task 12: BERT-CNN for Offensive Speech Identification in Social Media. *14th International Workshops on Semantic Evaluation Semeval 2020 Co Located 28th International Conference on Computational Linguistics Coling 2020 Proceedings*, 2054–2059. <https://doi.org/10.18653/v1/2020.semeval-1.271>
- Setyo, A., Lestari, B., Afifah, A., Indrawatiningsih, N., Rasida, I., Aufin, M., & Surabaya, U. N. (n.d.). *Guru Matematika Di Universitas PGRI Wiranegara*. 86–92.
- Sharon, R. A., Sur, M., & Murthy, H. A. (2025). Harnessing the Multi-Phasal Nature of Speech-EEG for Enhancing Imagined Speech Recognition. *IEEE Open Journal of Signal Processing*, 6, 78–88. <https://doi.org/10.1109/OJSP.2025.3528368>
- Shi, R. (2024). Dynamic analysis and optimal control of a fractional order HIV/HTLV co-infection model with HIV-specific CTL immune response. *Aims Mathematics*, 9(4), 9455–9493. <https://doi.org/10.3934/math.2024462>
- Song, Y., Wong, R. C. W., & Zhao, X. (2024). Speech-to-SQL: toward speech-driven SQL query generation from natural language question. *VLDB Journal*, 33(4), 1179–1201. <https://doi.org/10.1007/s00778-024-00837-0>
- Team, A. (2018). English Language User Manual Pocket Media Assistant PMA430 (TM) Video Player & Recorder/Music & Audio/Wifi/Linux/Personal Information Manager *XP055525286*, Retrieved on Nov.
- Tsapara, M. (2022). A Board Game for Sustainable Development Education: Kindergarten Students as Game Designers. *Lecture Notes in Networks and Systems*, 411, 1072–1084. https://doi.org/10.1007/978-3-030-96296-8_98
- Unsiah, F., Mukminatien, N., Anugerahwati, M., Astuti, U. P., & Megawati, F. (2024). Students' Voices in English Medium Instruction Based on Lengths of English Exposure. *Mextesol Journal*, 48(2), 0–2. <https://doi.org/10.61871/mj.v48n2-1>
- Videnovik, M. (2023). Game-based learning in computer science education: a scoping literature review. *International Journal of Stem Education*, 10(1). <https://doi.org/10.1186/s40594-023-00447-2>
- Vita-Barrull, N. (2024). Do you play in class? Board games to promote cognitive and educational development in primary school: A cluster randomized controlled trial. *Learning and Instruction*, 93. <https://doi.org/10.1016/j.learninstruc.2024.101946>
- Xu, H., Yu, X., Cheng, Y., Xiao, M., & Yu, Y. (2024). Low-Rank Active Learning for Generating Speech-Drive Human Face Animation. *IEEE Access*, 12, 38758–38764. <https://doi.org/10.1109/ACCESS.2024.3374777>
- Yasin, M., Badu, S. Q., & Irfah, A. (2025). The Implementation of Canva-Assisted Flipped Classroom Model to Improve Mathematics Learning Outcomes. ... *MATHEMATICS LEARNING*.
- Zapata, J. (2025). Research Brief Video Title: "I've had to take the TELPAS for so long even though I speak English fluently": Using TikTok to Claim an English Language Identity. *Tesol Journal*, 16(3). <https://doi.org/10.1002/tesj.70008>
- Zhang, X. (2020). Self-efficacy and english public speaking performance: A mixed method approach. *English for Specific Purposes*, 59, 1–16. <https://doi.org/10.1016/j.esp.2020.02.001>
- Zhang, Z. (2022). Speech timing cues reveal deceptive speech in social deduction board games. *Plos One*, 17(2). <https://doi.org/10.1371/journal.pone.0263852>
- Zhang, Z., Chen, S., Zhou, L., Wu, Y., Ren, S., Liu, S., Yao, Z., Gong, X., Dai, L., & Li, J. (2024). SpeechLM: Enhanced Speech Pre-Training With Unpaired Textual Data. *IEEE/ACM Transactions on Audio Speech and Language Processing*, 32, 2177–2187. <https://doi.org/10.1109/TASLP.2024.3379877>