

Evaluating the Impact of AI Tools on Grammar Mastery: A Comparative Study of Learning Outcomes

¹James Edward Lalira, ¹Yopie A. T. Pangemanan, ¹Jane E. Scipio, ¹Sjerly Lumi, ¹Theo Ch. Merentek, ²Vivi Nansy Tumuju

¹Universitas Kristen Indonesia Tomohon, Indonesia

²Universitas Sam Ratulangi, Indonesia

***Correspondence:**

jameslalira@gmail.com

Submission History:

Submitted: October 19, 2024

Revised: December 16, 2024

Accepted: December 17, 2024



This article is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License.

Abstract

Artificial Intelligence (AI) tools are increasingly integrated into education, offering innovative solutions to enhance learning, particularly in language acquisition. In grammar instruction, tools like Grammarly and ChatGPT provide real-time feedback, error correction, and personalized learning experiences. This study investigates the impact of these AI-assisted learning tools on grammar proficiency among students from diverse academic programs in two higher education institutions in Indonesia. A quasi-experimental design was employed, comparing pre-test and post-test grammar scores to evaluate the effectiveness of these tools. A total of 150 students participated, representing programs such as Nursing, Pharmacy, Health Administration, Economics Education, and English Education. The findings revealed significant improvements in grammar scores, particularly among students in non-language-focused programs, with an average increase of 15%. Students in the English Education program showed smaller gains (5%), attributed to their higher baseline proficiency. While the results demonstrate the potential of AI tools in enhancing grammar accuracy, concerns were raised about over-reliance on technology and the need for transparent integration in educational contexts. The absence of qualitative insights and long-term retention data are acknowledged as limitations. This study highlights the importance of using AI as a supplementary resource to support meaningful grammar learning, especially for students with limited exposure to formal language instruction.

Keywords: Artificial intelligence, education, grammar proficiency, learning media, learning outcome.

INTRODUCTION

The rapid advancement of artificial intelligence (AI) has profoundly impacted various facets of modern life, leveraging advanced computing and information processing techniques to simulate human-like behaviors such as reasoning, decision-making, and language comprehension (Tien, 2017; Riedl, 2019; Shrestha et al., 2019; Dazeley et al., 2021;

Zhang & Lu, 2021; Wei, 2023). AI encompasses a range of technologies, including machine learning, deep learning, and natural language processing, which enable computers to perform tasks traditionally associated with human intelligence (Sarker, 2022; Rashid & Kausik, 2024). These capabilities have led to AI's integration into diverse domains, such as visual recognition, automated translation, and robotics, where it provides intelligent services with remarkable efficiency (Hwang et al., 2020; Ahmed et al., 2022; Licardo et al., 2024). The pervasiveness of AI continues to grow, driven by technological innovation and societal needs, as seen during the COVID-19 pandemic, which accelerated the adoption of AI solutions in numerous industries (Amankwah-Amoah et al., 2021; Agarwal et al., 2022). As AI continues to evolve, its transformative potential presents both unprecedented opportunities and significant challenges, shaping the ways individuals, organizations, and communities operate in an increasingly digital world.

In the field of education, AI has emerged as a powerful tool for enhancing teaching and learning experiences (Popenici & Kerr, 2017; Chen et al., 2020; Baidoo-Anu & Ansah, 2023; Abulibdeh et al., 2024; Wang et al., 2024). One of its most notable contributions is the ability to provide personalized learning tailored to individual students' needs, preferences, and learning behaviors. Research emphasized by Lin et al. (2023) and Kabudi et al. (2021) highlights that AI-powered systems can function as intelligent tutors by integrating educators' expertise to provide targeted feedback, adaptive instruction, and tailored support for learners. Beyond personalization, Liu et al. (2021) and Lamerias and Arnab (2021) argue that AI in education facilitates deeper learning by promoting conceptual understanding over rote memorization. It allows students to advance at their own pace while encouraging curiosity, creativity, and collaboration (Habib et al., 2023). Furthermore, as higher education increasingly embraces AI, its integration offers opportunities to improve access, quality, and equity in education, reshaping the traditional classroom and empowering learners worldwide.

As these advancements reshape education more broadly, their impact on specific disciplines, such as English language learning, warrants closer examination to understand how AI can support and transform language acquisition and instruction. Artificial intelligence (AI) supports the development of language-specific skills, such as reading comprehension, vocabulary building, and pronunciation accuracy, by providing personalized and interactive learning experiences. For instance, AI-powered applications like Duolingo and Babbel enable learners to engage in gamified exercises that build vocabulary and enhance sentence construction through repetition and reinforcement (Zainuddin et al., 2020; Kessler et al., 2023). Similarly, tools such as Google's Speech-to-Text and ELSA Speak provide real-time pronunciation feedback, helping learners fine-tune their accent and intonation by comparing their speech to native speakers' (Kholis, 2021; Sun, 2023). In grammar instruction, platforms like Grammarly and Write & Improve automatically detect errors in sentence structure and offer suggestions for improvement, enabling students to practice self-editing skills (Koltovskaia, 2020; Barrot, 2021; Almusharraf & Alotaibi, 2022). Additionally, AI-driven adaptive learning platforms, such as Knewton adjust content difficulty based on students' progress, ensuring that learners work at an appropriate pace (Dutta et al., 2024). These tools not only create tailored learning

environments but also promote autonomy and continuous engagement, addressing individual learners' unique needs and challenges in English language acquisition.

In the context of English grammar instruction, AI has shown significant potential to address specific challenges learners face. Intelligent tutoring systems, for example, can identify grammatical errors in real-time and provide detailed explanations to help students understand the underlying rules (Ni & Cheung, 2023). Automated marking systems streamline the assessment process, allowing educators to focus on deeper instructional tasks while students benefit from immediate, consistent evaluations (Yesilyurt, 2023). However, while AI effectively assists in correcting errors and reinforcing grammar concepts, it also raises questions about students' dependency on technology and their ability to internalize these rules for independent application. As AI continues to reshape English language education, it is essential to explore how these tools can balance technological efficiency with the development of critical thinking and a deeper understanding of grammar.

Artificial Intelligence (AI) has increasingly transformed education, particularly in the context of English as a Foreign Language (EFL) teaching and learning. Research by Marzuki et al. (2023) highlights the role of various AI-powered tools, such as Quillbot, WordTune, and ChatGPT, in improving the content and organization of students' writing. EFL teachers from three universities in Indonesia observed significant benefits, particularly in enhancing students' ability to structure their ideas more effectively. Similarly, Jiang (2022) identifies diverse applications of AI in EFL education, including Intelligent Tutoring Systems (ITSs), Automatic Evaluation Systems, and Neural Machine Translation tools, which support personalized learning experiences. However, Jiang emphasizes the need for further exploration of the pedagogical and ethical implications of AI in EFL contexts. Meanwhile, Alshumaimeri and Alshememry (2023) focus on summarizing the challenges and perceptions surrounding AI's integration into language learning, emphasizing its potential to develop English skills despite skepticism among educators.

In the specific area of grammar learning, studies demonstrate AI's effectiveness in enhancing students' grammatical accuracy and understanding. For instance, Kim (2019) explored the use of AI chatbots in a Korean university, finding that students engaging in chatbot-based grammar practice outperformed those interacting with human partners, highlighting the unique benefits of AI-driven interaction. Similarly, Chang et al. (2021) observed significant improvements in grammar and writing performance when EFL students used Grammarly for automated feedback and revision. Schmidt-Fajlik (2023) compared ChatGPT with Grammarly and ProWritingAid, concluding that ChatGPT offers more comprehensive grammar support for Japanese English learners.

Artificial intelligence (AI) tools are increasingly being integrated into language education, yet there is limited research that focuses specifically on their impact on grammar mastery in structured learning environments. While AI applications are widely recognized for their potential to enhance language learning, most studies have not isolated grammar as a distinct skill, nor have they utilized objective measures such as grammar test performance to evaluate their effectiveness. This study addresses this gap by evaluating the influence of AI tools, such as Grammarly and ChatGPT on grammar proficiency in an EFL context. By analyzing grammar test results before and after exposure to AI-assisted learning, it aims to provide empirical evidence of how these tools enhance grammar accuracy. The findings will

contribute to a deeper understanding of the benefits and limitations of AI in grammar instruction, informing educators and policymakers about strategies for integrating AI to improve language learning outcomes.

METHOD

This study utilized a quasi-experimental design to evaluate the impact of AI-assisted learning tools on students' grammar mastery by comparing their grammar test results before and after the intervention. This design is appropriate for measuring the effect of an intervention in the absence of a control group, as it allows researchers to track changes in the same group of participants over time (Gopalan et al., 2020; Creswell & Creswell, 2018). The study aimed to measure improvements in grammar accuracy resulting from the use of AI tools such as Grammarly, ChatGPT, and ProWritingAid during a structured learning intervention. This approach focused on analyzing the progression of students' grammar proficiency over the study period. A total of 150 students from two higher education institutions in Indonesia, Universitas Kristen Indonesia Tomohon (UKIT) and Sekolah Tinggi Ilmu Kesehatan Bethesda (STIKES Bethesda) Tomohon, participated in the study. The participants represented various academic programs, including 60 students from the Nursing Diploma Program, 12 from the English Education Program, 18 from the Economics Education Program, 40 from the Pharmacy Program, and 10 from the Health Administration Program. Students were selected based on their enrollment in English classes to ensure diverse representation in the study sample. Purposive sampling, as described by Campbell et al. (2020), was employed to ensure that the selected participants met the criteria necessary for meaningful analysis.

The research design consisted of two key phases: a pre-test to assess students' baseline grammar proficiency and a post-test to evaluate their performance after the intervention. According to Sanders (2019), pre-test and post-test evaluations enable immediate assessment of an intervention, such as a simulation session, and provide valuable insights for refining instructional techniques or intervention methods. This approach allowed the researcher to measure changes in grammar skills resulting from the use of AI tools. The intervention phase involved students using AI-assisted tools to practice grammar, receive real-time feedback, and correct errors, enabling tailored and interactive learning experiences. The pre-test and post-test results were analyzed descriptively to compare the students' performance before and after the intervention. Descriptive analysis is commonly used in quasi-experimental studies to identify trends and measure the extent of improvement without relying on inferential statistics (Cohen et al., 2018). This study provides empirical insights into the practical benefits of AI-assisted tools for grammar instruction, offering valuable implications for integrating AI into EFL teaching practices.

FINDING AND DISCUSSION

The study's findings reveal the impact of artificial intelligence (AI) tools on students' grammar performance, providing a comparative perspective on their effectiveness. By analyzing grammar test results completed under two distinct conditions—without and with the use of AI tools—the study offers a nuanced understanding of how AI influences students' ability to complete grammar tasks.

Two grammar tests were conducted as part of the study, following a structured approach. In the first test, students completed a grammar task without the use of AI tools such as Grammarly or ChatGPT. This initial test aimed to assess the students' baseline grammar proficiency and their ability to independently complete grammar-related tasks. For the second test, students were given the same grammar task; however, they were permitted to utilize AI tools if they chose to do so. This test was designed to evaluate the influence of AI on the quality and accuracy of the students' grammar output. The comparison of results from these tests provides empirical evidence of the extent to which AI tools enhance grammar performance and supports a deeper understanding of their role in language learning.

Table 1. Grammar test results

No	Study Program	Pre-test mean score	Post-test mean score	Improvement (%)
1	Bachelor's in English Education	85	90	5%
2	Bachelor's in Economics Education	65	78	13%
3	Bachelor's in Pharmacy	60	75	15%
4	Bachelor's in Health Administration	62	77	15%
5	Diploma in Nursing	58	73	15%

The findings of this study highlight the pivotal role of artificial intelligence (AI) tools, such as Grammarly and ChatGPT, in improving grammar proficiency across diverse academic programs. The integration of AI tools in education is increasingly recognized for its ability to provide personalized feedback, automate error detection, and offer detailed explanations for language-related tasks, making them indispensable in language learning (Jiang, 2022; Alshumaimeri & Alshememry, 2023). This study demonstrates that using these tools during grammar-focused interventions significantly enhanced students' performance, with marked improvements in post-test scores for non-language-focused programs such as Nursing, Pharmacy, and Health Administration.

Grammarly played a crucial role in the intervention by enabling students to identify and correct grammar errors in real time. As a tool designed for precision, Grammarly not only highlights mistakes but also provides concise explanations, allowing students to understand the rules underlying the corrections. This aligns with findings from Chang et al. (2021), who observed that students using Grammarly achieved notable improvements in writing performance due to its instant and structured feedback. For students with minimal exposure to formal grammar instruction, such as those in Nursing and Pharmacy programs, Grammarly served as an effective substitute for traditional language instruction, addressing individual learning gaps and promoting self-directed improvement (Calma et al., 2022). For example, instructors can address grammar and convention errors to ensure correctness (Fitria, 2022), emphasize conciseness and the use of active voice to improve clarity (Zinkevich & Ledeneva, 2021), guide students on word choice and variety to make their

writing more engaging, and stress the importance of maintaining an appropriate academic tone to meet formality standards (Getchell et al., 2022).

Similarly, ChatGPT proved valuable in complementing Grammarly's functionalities by engaging students in interactive grammar exercises. As noted by Zebua and Katemba (2024) and Xiao and Zhi (2023), ChatGPT, as an AI chatbot, enables students to ask grammar-related questions, receive detailed explanations, and practice constructing sentences in real time. The tool's conversational approach reduces intimidation, making grammar practice more accessible and engaging, particularly for students who may lack confidence in their language skills (Essel et al., 2023; Zou et al., 2024). These capabilities reflect the findings of Schmidt-Fajlik (2023), who noted ChatGPT's effectiveness in addressing complex grammar issues and providing comprehensive support compared to other AI tools. In this study, ChatGPT's ability to contextualize grammatical rules and offer examples tailored to students' input significantly contributed to the observed improvements in grammar test scores (Qu & Wu, 2024).

The combination of Grammarly and ChatGPT during the intervention created a robust learning environment tailored to students' diverse grammatical needs. Grammarly focused on detecting grammatical errors and providing rule-based corrections, while ChatGPT offered a broader platform for exploration and deeper understanding of grammar concepts. According to Shloul et al. (2024), the integration of ChatGPT introduces innovative opportunities for interactive learning and individualized support, fostering students' mastery of grammar. Similarly, De Andrade Pereira et al. (2024) emphasize Grammarly's ability to enhance grammatical accuracy through precise feedback and corrective guidance. This dual approach allowed students to benefit from both automated precision and interactive problem-solving, thereby addressing a wider range of grammar challenges. These findings support the argument that integrating multiple AI tools enhances the overall effectiveness of interventions by leveraging their complementary strengths (Kim, 2019; Marzuki et al., 2023).

The smaller improvement (5%) observed among English Education students highlights an important consideration: AI tools may have a more pronounced impact on learners with weaker foundational skills. English Education students, with their higher baseline proficiency, likely relied less on AI tools for foundational grammar corrections and instead focused on refining more advanced aspects of their grammar skills. This aligns with previous studies suggesting that AI tools are most effective for addressing learning gaps rather than advancing already proficient learners (Chang et al., 2021; Zhao, 2024).

Despite these successes, the study raises concerns about the potential over-reliance on AI tools. While Grammarly and ChatGPT effectively enhance grammar accuracy, excessive use may inadvertently hinder students from developing independent problem-solving skills. Urlaub and Dessein (2022) argue that the use of AI can, at times, be unproductive, disruptive, and even perceived as a form of academic dishonesty. This highlights the importance of promoting balanced and ethical usage of AI in educational contexts. Educators must ensure that these tools are used to supplement, rather than replace, traditional learning approaches. Transparency in the implementation of AI tools is also critical, particularly in academic assessments, to maintain the validity and fairness of evaluations (Selwyn, 2021; Jiang, 2022).

The necessity of clear educational policies regarding the application of AI in academic settings is a critical outcome of this research. (Chan, 2023; Kamalov et al., 2023). Educational institutions must establish guidelines on how and when students should utilize AI, alongside strategies for lecturers to adapt assessments accordingly (Zhai et al., 2021). Transparent integration of AI into curricula and evaluation processes is essential to ensure that assessments accurately reflect students' efforts and abilities. These findings emphasize the need for more comprehensive assessment methodologies in environments where AI is increasingly prevalent. Lecturers should consider incorporating evaluation strategies that focus not only on task outcomes but also on the learning process and deeper comprehension of concepts. Alternative assessment methods, such as reflective discussions, process-based evaluations, or rubrics that account for technology use, can help ensure fairness and accuracy in academic evaluations (Pinheiro, 2022). To address existing gaps in research and practice, assessments must go beyond quantitative results to evaluate students' critical thinking and qualitative understanding of grammar concepts. Comprehensive assessment strategies provide a more accurate representation of students' capabilities and ensure that the quality of their learning is not diminished by over-reliance on AI. Lecturers must take proactive measures to maintain objective evaluations while fostering deeper, meaningful comprehension.

This study has a few limitations worth mentioning. First, it focused only on two specific AI tools, Grammarly and ChatGPT, which might not fully represent the wide variety of AI applications available for learning grammar. As a result, the findings might not apply to other tools with different features. Second, the study used a quasi-experimental approach without a control group, making it harder to compare AI-assisted grammar learning with more traditional teaching methods. Third, the duration of the intervention was quite short, so it's unclear how well students might retain the grammar skills they learned over the long term. Lastly, the study mainly relied on grammar test scores to measure progress, which might not fully capture how well students understand and use grammar in everyday situations.

Future research should aim to overcome these limitations to better understand how AI tools contribute to grammar instruction. Studies with control groups could provide clearer comparisons between AI-assisted learning and traditional teaching methods, while longitudinal research could explore the long-term retention of grammar skills and the lasting impact of AI on language learning. Expanding the focus to include other AI tools, such as adaptive learning platforms or grammar-specific applications, could reveal how different technologies perform in various contexts. Adding qualitative approaches, like interviews or think-aloud activities, could offer richer insights into how students engage with AI, their learning processes, and how these tools influence critical thinking in grammar use. Additionally, examining the ethical implications of AI in education—such as its effects on independent learning and academic integrity—could help ensure its responsible and effective integration into classrooms.

CONCLUSION

This study examined the role of AI-assisted learning tools, specifically Grammarly and ChatGPT, in improving grammar proficiency among students from various academic programs. The findings showed improvements in grammar test scores, particularly among students in non-language-focused programs such as Nursing, Pharmacy, and Health Administration. These results indicate that AI tools can be effective in addressing foundational grammar challenges for learners who may have limited exposure to formal language instruction. Meanwhile, students in language-focused programs, such as English Education, demonstrated smaller improvements, likely due to their higher baseline proficiency. While the outcomes suggest the potential of AI tools in enhancing grammar learning, the study also highlights concerns about over-reliance on these technologies, which could impede the development of independent problem-solving and critical thinking skills. Additionally, the use of AI in assessments raises questions about the need for transparency and ethical considerations in educational contexts.

ACKNOWLEDGMENTS

I am sincerely appreciative of the critical feedback provided by Dr. Daniel Sondakh, MT and John Kutu, MM on the content of this research, which played a significant role in its development. Additionally, I am profoundly appreciative of the unwavering assistance provided by my colleagues at the English Education Study Program, Faculty of Lectures Training and Education, Universitas Kristen Indonesia Tomohon, during the course of this research. I am particularly grateful to the informants whose invaluable information provided critical insights that significantly enhanced this research

REFERENCES

- Abulibdeh, A., Zaidan, E., & Abulibdeh, R. (2024). Navigating the confluence of artificial intelligence and education for sustainable development in the era of industry 4.0: Challenges, opportunities, and ethical dimensions. *Journal of Cleaner Production*, 437, 140527. <https://doi.org/10.1016/j.jclepro.2023.140527>
- Agarwal, P., Swami, S., & Malhotra, S. K. (2022). Artificial intelligence adoption in the post covid-19 new-normal and role of smart technologies in transforming business: A review. *Journal of Science and Technology Policy Management*, 15(3), 506–529. <https://doi.org/10.1108/jstpm-08-2021-0122>
- Ahmed, I., Jeon, G., & Piccialli, F. (2022). From artificial intelligence to explainable artificial intelligence in industry 4.0: A survey on what, how, and where. *IEEE Transactions on Industrial Informatics*, 18(8), 5031–5042. <https://doi.org/10.1109/tii.2022.3146552>
- Almusharraf, N., & Alotaibi, H. (2022). An error-analysis study from an EFL writing context: Human and automated essay scoring approaches. *Technology Knowledge and Learning*, 28(3), 1015–1031. <https://doi.org/10.1007/s10758-022-09592-z>
- Alshumaimeri, Y. A., & Alshememry, A. K. (2023). The extent of AI applications in EFL learning and teaching. *IEEE Transactions on Learning Technologies*, 17, 653–663. <https://doi.org/10.1109/tlt.2023.3322128>

- Amankwah-Amoah, J., Khan, Z., Wood, G., & Knight, G. (2021). COVID-19 and digitalization: The great acceleration. *Journal of Business Research*, 136, 602–611. <https://doi.org/10.1016/j.jbusres.2021.08.011>
- Baidoo-Anu, D., & Ansah, L. O. (2023). Education in the era of generative Artificial Intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning. *Journal of AI*, 7(1), 52–62. <https://doi.org/10.61969/jai.1337500>
- Barrot, J. S. (2021). Using automated written corrective feedback in the writing classrooms: Effects on L2 writing accuracy. *Computer Assisted Language Learning*, 36(4), 584–607. <https://doi.org/10.1080/09588221.2021.1936071>
- Calma, A., Cotronei-Baird, V., & Chia, A. (2022). Grammarly: An instructional intervention for writing enhancement in management education. *The International Journal of Management Education*, 20(3), 100704. <https://doi.org/10.1016/j.ijme.2022.100704>
- Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D., & Walker, K. (2020). Purposive sampling: Complex or simple? Research case examples. *Journal of Research in Nursing*, 25(8), 652–661. <https://doi.org/10.1177/1744987120927206>
- Chan, C. K. Y. (2023). A comprehensive AI policy education framework for university teaching and learning. *International Journal of Educational Technology in Higher Education*, 20(1). <https://doi.org/10.1186/s41239-023-00408-3>
- Chang, T., Li, Y., Huang, H., & Whitfield, B. (2021). Exploring EFL students' writing performance and their acceptance of AI-based automated writing feedback. *ICEDS '21: Proceedings of the 2021 2nd International Conference on Education Development and Studies*. <https://doi.org/10.1145/3459043.3459065>
- Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access*, 8, 75264–75278. <https://doi.org/10.1109/access.2020.2988510>
- Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education* (8th ed.). Routledge. <https://doi.org/10.4324/9781315456539>
- Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches*. SAGE Publications.
- Dazeley, R., Vamplew, P., Foale, C., Young, C., Aryal, S., & Cruz, F. (2021). Levels of explainable artificial intelligence for human-aligned conversational explanations. *Artificial Intelligence*, 299, 103525. <https://doi.org/10.1016/j.artint.2021.103525>
- De Andrade Pereira, F., Paul, L., Pritoni, M., Casillas, A., Prakash, A., Huang, W., Shaw, C., Martin-Toral, S., Finn, D., & Donnell, J. O. (2024). Enabling portable demand flexibility control applications in virtual and real buildings. *Journal of Building Engineering*, 86, 108645. <https://doi.org/10.1016/j.jobee.2024.108645>
- Dutta, S., Ranjan, S., Mishra, S., Sharma, V., Hewage, P., & Iwendi, C. (2024). Enhancing educational adaptability: A review and analysis of AI-Driven adaptive learning platforms. *2024 4th International Conference on Innovative Practices in Technology and Management (ICIPTM)* (pp. 1–5). <https://doi.org/10.1109/iciptm59628.2024.10563448>
- Essel, H. B., Vlachopoulos, D., Essuman, A. B., & Amankwa, J. O. (2023). ChatGPT effects on cognitive skills of undergraduate students: Receiving instant responses from AI-based

- conversational large language models (LLMs). *Computers and Education Artificial Intelligence*, 6, 100198. <https://doi.org/10.1016/j.caeai.2023.100198>
- Fitria, T. N. (2022). Identifying grammatical and mechanical errors of students' writing: Using "Grammarly" as an online assessment. *Lingua Didaktika Jurnal Bahasa Dan Pembelajaran Bahasa*, 16(2), 169. <https://doi.org/10.24036/ld.v16i2.116824>
- Getchell, K. M., Carradini, S., Cardon, P. W., Fleischmann, C., Ma, H., Aritz, J., & Stapp, J. (2022). Artificial intelligence in business communication: The changing landscape of research and teaching. *Business and Professional Communication Quarterly*, 85(1), 7–33. <https://doi.org/10.1177/23294906221074311>
- Gopalan, M., Rosinger, K., & Ahn, J. B. (2020). Use of quasi-experimental research designs in education research: Growth, promise, and challenges. *Review of Research in Education*, 44(1), 218–243. <https://doi.org/10.3102/0091732x2090330>
- Habib, S., Vogel, T., Anli, X., & Thorne, E. (2023). How does generative artificial intelligence impact student creativity? *Journal of Creativity*, 34(1), 100072. <https://doi.org/10.1016/j.yjoc.2023.100072>
- Hwang, G., Xie, H., Wah, B. W., & Gašević, D. (2020). Vision, challenges, roles and research issues of Artificial Intelligence in Education. *Computers and Education Artificial Intelligence*, 1, 100001. <https://doi.org/10.1016/j.caeai.2020.100001>
- Jeon, J. (2022). Exploring AI chatbot affordances in the EFL classroom: young learners' experiences and perspectives. *Computer Assisted Language Learning*, 37(1–2), 1–26. <https://doi.org/10.1080/09588221.2021.2021241>
- Jiang, R. (2022). How does artificial intelligence empower EFL teaching and learning nowadays? A review on artificial intelligence in the EFL context. *Frontiers in Psychology*, 13. <https://doi.org/10.3389/fpsyg.2022.1049401>
- Kabudi, T., Pappas, I., & Olsen, D. H. (2021). AI-enabled adaptive learning systems: A systematic mapping of the literature. *Computers and Education Artificial Intelligence*, 2, 100017. <https://doi.org/10.1016/j.caeai.2021.100017>
- Kamalov, F., Calonge, D. S., & Gurrib, I. (2023). New era of artificial intelligence in education: Towards a sustainable multifaceted revolution. *Sustainability*, 15(16), 12451. <https://doi.org/10.3390/su151612451>
- Kessler, M., Loewen, S., & Gönülal, T. (2023). Mobile-assisted language learning with Babbel and Duolingo: Comparing L2 learning gains and user experience. *Computer Assisted Language Learning*, 1–25. <https://doi.org/10.1080/09588221.2023.2215294>
- 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, N. (2019). A study on the use of artificial intelligence chatbots for improving English grammar skills. *Journal of Digital Convergence*, 17(8), 37–46. <https://doi.org/10.14400/jdc.2019.17.8.037>
- Koltovskaia, S. (2020). Student engagement with automated written corrective feedback (AWCF) provided by Grammarly: A multiple case study. *Assessing Writing*, 44, 100450. <https://doi.org/10.1016/j.asw.2020.100450>

- Lameras, P., & Arnab, S. (2021). Power to the teachers: An exploratory review on artificial intelligence in education. *Information*, 13(1), 14. <https://doi.org/10.3390/info13010014>
- Licardo, J. T., Domjan, M., & Orehovački, T. (2024). Intelligent robotics—A systematic review of emerging technologies and trends. *Electronics*, 13(3), 542. <https://doi.org/10.3390/electronics13030542>
- Lin, C., Huang, A. Y. Q., & Lu, O. H. T. (2023). Artificial intelligence in intelligent tutoring systems toward sustainable education: A systematic review. *Smart Learning Environments*, 10(1). <https://doi.org/10.1186/s40561-023-00260-y>
- Liu, Y., Saleh, S., & Huang, J. (2021). Artificial intelligence in promoting teaching and learning transformation in schools. *International Journal of Innovation, Creativity and Change*, 891–902. <https://doi.org/10.53333/ijicc2013/15369>
- Marzuki, Widiati, U., Rusdin, D., Darwin, & Indrawati, I. (2023). The impact of AI writing tools on the content and organization of students' writing: EFL teachers' perspective. *Cogent Education*, 10(2). <https://doi.org/10.1080/2331186x.2023.2236469>
- Ni, A., & Cheung, A. (2022). Understanding secondary students' continuance intention to adopt AI-powered intelligent tutoring system for English learning. *Education and Information Technologies*, 28(3), 3191–3216. <https://doi.org/10.1007/s10639-022-11305-z>
- Pinheiro, C. M. S. (2022). The use of alternative methods of assessment in higher education: a study of university teachers and students.
- Popenici, S. a. D., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. *Research and Practice in Technology Enhanced Learning*, 12(1). <https://doi.org/10.1186/s41039-017-0062-8>
- Qu, K., & Wu, X. (2024). ChatGPT as a CALL tool in language education: A study of hedonic motivation adoption models in English learning environments. *Education and Information Technologies*. <https://doi.org/10.1007/s10639-024-12598-y>
- Rashid, A. B., & Kausik, M. a. K. (2024). AI revolutionizing industries worldwide: A Comprehensive overview of its diverse applications. *Hybrid Advances*, 7, 100277. <https://doi.org/10.1016/j.hybadv.2024.100277>
- Riedl, M. O. (2019). Human-centered artificial intelligence and machine learning. *Human Behavior and Emerging Technologies*, 1(1), 33–36. <https://doi.org/10.1002/hbe2.117>
- Sanders, S. (2019). *A brief guide to selecting and using Pre-Post assessments*. The National Technical Assistance Center for the Education of Neglected or Delinquent Children and Youth.
- Sarker, I. H. (2022). AI-based modeling: Techniques, applications and research issues towards automation, intelligent and smart systems. *SN Computer Science*, 3(2). <https://doi.org/10.1007/s42979-022-01043-x>
- Schmidt-Fajlik, R. (2023). ChatGPT as a grammar checker for Japanese English language learners: A comparison with Grammarly and ProWritingAid. *AsiaCALL Online Journal*, 14(1), 105–119. <https://doi.org/10.54855/acoj.231417>
- Selwyn, N. (2022). The future of AI and education: Some cautionary notes. *European Journal of Education*, 57(4), 620-631. <https://doi.org/10.1111/ejed.12532>

- Shloul, T. A., Mazhar, T., Abbas, Q., Iqbal, M., Ghadi, Y. Y., Shahzad, T., Mallek, F., & Hamam, H. (2024). Role of activity-based learning and ChatGPT on students' performance in education. *Computers and Education Artificial Intelligence*, 6, 100219. <https://doi.org/10.1016/j.caeai.2024.100219>
- Shrestha, Y. R., Ben-Menahem, S. M., & Von Krogh, G. (2019). Organizational decision-making structures in the age of artificial intelligence. *California Management Review*, 61(4), 66–83. <https://doi.org/10.1177/0008125619862257>
- Sun, W. (2023). The impact of automatic speech recognition technology on second language pronunciation and speaking skills of EFL learners: a mixed methods investigation. *Frontiers in Psychology*, 14. <https://doi.org/10.3389/fpsyg.2023.1210187>
- Tien, J. M. (2017). Internet of things, real-time decision making, and artificial intelligence. *Annals of Data Science*, 4(2), 149–178. <https://doi.org/10.1007/s40745-017-0112-5>
- Urlaub, P., & Dessen, E. (2022). Machine translation and foreign language education. *Frontiers in Artificial Intelligence*, 5. <https://doi.org/10.3389/frai.2022.936111>
- Wang, S., Wang, F., Zhu, Z., Wang, J., Tran, T., & Du, Z. (2024). Artificial intelligence in education: A systematic literature review. *Expert Systems With Applications*, 252, 124167. <https://doi.org/10.1016/j.eswa.2024.124167>
- Wei, L. (2023). Artificial intelligence in language instruction: Impact on English learning achievement, L2 motivation, and self-regulated learning. *Frontiers in Psychology*, 14. <https://doi.org/10.3389/fpsyg.2023.1261955>
- Xiao, Y., & Zhi, Y. (2023). An exploratory study of EFL learners' use of ChatGPT for language learning tasks: Experience and perceptions. *Languages*, 8(3), 212. <https://doi.org/10.3390/languages8030212>
- Yesilyurt, Y. E. (2023). AI-enabled assessment and feedback mechanisms for language learning. In Kartal, G. (Eds.). *Transforming the language teaching experience in the age of AI*. (pp. 25–43). IGI Global. <https://doi.org/10.4018/978-1-6684-9893-4.ch002>
- Zainuddin, Z., Chu, S. K. W., Shujahat, M., & Perera, C. J. (2020). The impact of gamification on learning and instruction: A systematic review of empirical evidence. *Educational Research Review*, 30, 100326. <https://doi.org/10.1016/j.edurev.2020.100326>
- Zebua, J. a. Z., & Katemba, C. V. (2024). Students' perceptions of using the OpenAI ChatGPT application in improving writing skills. *Journal of Language and Literature Studies*, 4(1), 110–123. <https://doi.org/10.36312/jolls.v4i1.1805>
- Zhai, X., Chu, X., Chai, C. S., Jong, M. S. Y., Istenic, A., Spector, M., ... & Li, Y. (2021). A Review of Artificial Intelligence (AI) in Education from 2010 to 2020. *Complexity*, 2021(1), 8812542. <https://doi.org/10.1155/2021/8812542>
- Zhang, C., & Lu, Y. (2021). Study on artificial intelligence: The state of the art and future prospects. *Journal of Industrial Information Integration*, 23, 100224. <https://doi.org/10.1016/j.jii.2021.100224>
- Zhao, D. (2024). The impact of AI-enhanced natural language processing tools on writing proficiency: an analysis of language precision, content summarization, and creative writing facilitation. *Education and Information Technologies*, 1-32. <https://doi.org/10.1007/s10639-024-13145-5>

- Zinkevich, N. A., & Ledeneva, T. V. (2021). Using grammarly to enhance students' academic writing skills. *Professional Discourse & Communication*, 3(4), 51–63. <https://doi.org/10.24833/2687-0126-2021-3-4-51-63>
- Zou, B., Wang, C., Yan, Y., Du, X., & Ji, Y. (2024). Exploring English as a foreign language learners' adoption and utilisation of ChatGPT for Speaking practice through an extended technology acceptance model. *International Journal of Applied Linguistics*. <https://doi.org/10.1111/ijal.12658>