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The Effectiveness of Interactive Educational Technology in Teaching Complex Sentences: A Lesson Learned from Remote EFL Learners

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Abstract

EFL learners often encounter difficulties in mastering complex sentences, especially when they are treated by using conventional teaching methods. This study investigates the effectiveness of interactive educational technology in improving the EFL learners' grammatical competences of complex sentences at the Institute of Global Nusantara Education. An experimental design was employed in this study. The samples of the study are all students who took Grammatical course at English language education study programe at the Institute of Global Nusantara Education. The research instruments comprise grammatical tests to see EFL learners' grammatical competence. The tests are done in the experimental and control groups. Based on the data analysis, the findings demonstrate that the experimental group outperformed the control group, with significantly higher post-test scores (M = 85.6, SD = 5.2) compared to the control group (M = 72.3, SD = 4.8), an F-value of 65.14, and a p-value of 0.021. These results highlight the efficacy of interactive educational technology in not only enhancing students' grammatical competences in writing activities but also boosting their motivation and engagement. Furthermore, these findings have broad implications for diverse educational settings, suggesting that integrating such technology can help bridge learning gaps, especially in contexts with varied access to resources. By addressing these challenges, educators can foster equitable and effective learning environments that support the development of advanced language skills.

Keywords: Grammatical competences; Complex sentence structures; Interactive educational technology; Traditional teaching methods

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INTRODUCTION

The mastery of complex sentence structures is a pivotal aspect of academic writing, as it enables authors to articulate nuanced arguments and sophisticated ideas with clarity (Hadi et al., 2024). This skill not only reflects the depth of a writer's understanding but also enhances the credibility and persuasiveness of academic discourse. Research indicates that the ability to construct complex sentences is closely linked to higher-order thinking skills, which are essential for students engaged in advanced writing tasks (Ananda et al., 2018; Wijaya, 2023). However, many students encounter significant challenges in mastering this skill, often due to traditional teaching methods that may not adequately engage or support their diverse learning needs (Çağatay, 2019; Khairuddin et al., 2021).

Traditional pedagogical approaches, characterized by direct instruction and repetitive exercises, frequently fail to address the varied learning styles of students, leading

to a superficial understanding of grammatical structures (Çağatay, 2019; Rusfandi, 2015). This limitation can result in students struggling to apply their knowledge effectively when tasked with producing academically rigorous writing. For instance, Rikat's study highlights that while students may use various sentence structures in their writing, their understanding often remains shallow, which hinders their ability to construct complex sentences effectively (Wijaya, 2023). Consequently, there is a pressing need for educational practices that foster deeper engagement and comprehensive skill development in writing (Klebanov et al., 2017; Sundari & Febriyanti, 2021).

The integration of technology into language education has revolutionized teaching practices, offering new avenues for enhancing learning experiences. Interactive educational software and applications have been developed to supplement conventional teaching, providing flexible and adaptive learning environments that cater to individual student needs(Danylyuk, 2023; Nurjanah & Setiyaningsih, 2022). These digital tools offer immediate feedback and personalized learning pathways, which have been shown to significantly enhance comprehension and retention among learners(Danylyuk, 2023; Khairuddin et al., 2021). Nevertheless, despite the widespread adoption of technology in educational settings, empirical studies specifically examining its effectiveness in teaching complex sentence structures remain limited (Wahid, 2023; Walker & Sampson, 2013). This gap in research underscores the necessity for targeted investigations that assess the comparative effectiveness of digital tools versus traditional methods in developing students' academic writing skills.

The current study aims to address this gap by evaluating the impact of educational software on students' ability to master complex sentence structures. By focusing on this critical component of academic writing, the research seeks to determine whether digital tools provide measurable advantages over conventional instructional methods. Previous studies have established that interactive learning platforms can enhance student engagement and provide adaptive feedback that supports learning retention (Danylyuk, 2023; Pu et al., 2022). However, there remains a need to extend this research to specifically assess the effectiveness of these tools in fostering complex sentence writing skills, as existing literature primarily addresses broader language skills or vocabulary acquisition(Lu, 2021; Thành, 2023a).

The primary objective of this research is to fill the existing gap in empirical evidence regarding the comparative outcomes of digital tools and traditional teaching methods in language instruction. By conducting a rigorous comparative analysis, this study will contribute to the growing body of literature on technology-assisted learning, offering new insights that can inform pedagogical strategies in higher education (Aguirre-Mendez et al., 2020; Alenezi, 2021). The findings are anticipated to guide educators in making informed decisions about incorporating educational software into curricula, ultimately enhancing student performance in academic writing. This aligns with global educational trends that emphasize the integration of technology to meet the demands of 21st-century learning(Alenezi, 2021; Chang, 2015).

Despite the increasing prevalence of technology in language learning, studies specifically addressing its impact on mastering complex sentence structures in academic writing are notably sparse(Lo et al., 2021; Wahid, 2023). Existing literature tends to focus on general language skills or vocabulary acquisition rather than advanced grammatical constructions, leaving a significant gap in understanding the effectiveness of interactive educational software in fostering the complex sentence-writing skills essential for higher academic performance (Lo et al., 2020; Thành, 2023). Moreover, most comparative studies emphasize broader learning outcomes without delving into the nuanced differences

in skill acquisition between digital and traditional teaching methods(Ezeokoli & Igubor, 2016; Wahid, 2023).

Addressing this gap is critical, as it limits educators' ability to make evidence-based decisions when integrating new teaching technologies into their curricula. Understanding the specific benefits or limitations of these tools in teaching complex sentence structures could inform instructional strategies and improve academic outcomes. Comprehensive analyses focusing on this aspect could also aid in the development of specialized educational software designed to meet these precise learning needs (Hardy & Römer, 2013; Wahid, 2023). Therefore, this research seeks to bridge this knowledge gap by comparing the effectiveness of interactive educational tools with traditional methods, providing empirical evidence that could reshape pedagogical practices in language education. Conventional teaching methods often fail to address the specific difficulties associated with learning complex grammar, resulting in limited progress in this area. As educational technology continues to evolve, its potential to transform grammar instruction has garnered attention. However, while the general benefits of technology in language education are well-documented (Fahim & Hashtroodi, 2012; Wahid, 2023), targeted applications for enhancing complex grammar skills, particularly in the context of academic writing, remain underexplored.

The present study introduces a novel approach to bridging this gap by evaluating the effectiveness of interactive educational technology in fostering the acquisition of complex sentence structures. Unlike previous research that largely focuses on general language skills or writing fluency(Bi, 2020; Wahid, 2023), this study offers a comparative analysis of interactive software versus traditional instructional methods. This analytical focus not only highlights the pedagogical potential of technology but also underscores its role in addressing specific challenges in grammar instruction. By investigating how these approaches impact learning outcomes, this study aims to contribute significantly to the field of language education. It offers valuable insights into how targeted technological interventions can enhance students' academic writing skills. Moreover, the findings are expected to inform the development of innovative teaching methodologies that align with diverse educational contexts, ensuring more equitable access to effective grammar instruction.

The justification for this study lies in its potential to inform teaching practices and curriculum development in higher education. As educational institutions increasingly incorporate digital tools to meet modern learning demands, it is crucial to understand their impact on specific language competencies (Alenezi, 2021; Hendriwanto et al., 2020). This research not only provides empirical evidence to guide the use of educational software but also highlights the circumstances under which traditional teaching methods may remain more effective. Such insights are invaluable for educators seeking to balance technology integration with proven instructional techniques to enhance student writing proficiency. The results of this study will help shape future pedagogical frameworks and contribute to more effective, evidence-based language instruction (Alenezi, 2021; Heng et al., 2023).

The mastery of complex sentence structures is essential for effective academic writing, yet many students struggle with this skill due to traditional teaching methods that may not adequately support their learning needs. The integration of technology into language education presents an opportunity to enhance teaching practices and improve student outcomes. However, further empirical research is necessary to evaluate the effectiveness of digital tools in teaching complex sentence structures compared to traditional methods. This study aims to fill this gap, providing valuable insights that can inform pedagogical strategies and ultimately enhance students' academic writing skills.

RESEARCH METHOD

Research Design

This study employs a quasi-experimental approach with a pre-test and post-test design for two groups: an experimental group and a control group. This design was chosen to evaluate the effectiveness of AI-based technology in enhancing students' academic writing skills, particularly in the use of complex sentence structures. While this approach is robust, it is acknowledged that the pre-test and post-test design may introduce potential biases, such as practice effects or differential maturation between groups. Efforts were made to mitigate these biases by random assignment and ensuring equivalent instructional time for both groups.

Population and Sample

The population of this study comprised fifth-semester students enrolled at the Global Nusantara Institute of Education during the academic year 2024/2025. A random sampling technique was utilized, involving a list of eligible students from the academic database. Each student was assigned a unique identifier, and a random number generator was employed to select 60 participants. These students were evenly divided into an experimental group (n = 30) and a control group (n = 30).

To provide transparency and enable generalizability, demographic details of the participants were collected. The average GPA of the sample was 3.45 (SD = 0.28), and all students had intermediate proficiency in English, as determined by their TOEFL-equivalent scores (M = 520, SD = 15). Participants came from diverse linguistic backgrounds, with 70% reporting Indonesian as their primary language and 30% speaking additional local dialects.

Research Procedure

Pre-test and Pos-Test

Prior to the intervention, all participants were asked to write an academic-themed essay of 300–400 words to assess their baseline ability in using complex sentence structures. The essays were evaluated using a rubric with established reliability (Cronbach's alpha = 0.89), assessing sentence complexity, clarity, and grammatical accuracy.

Table 1. Rubric for Evaluating Complex Sentence Structures

Dimension	Criteria	Score Range	Descriptors
Sentence Complexity	Demonstrates ability to construct compound-complex sentences and utilize appropriate conjunctions (e.g., subordinating, coordinating).	1–5	5: Consistently uses a variety of accurate complex sentence structures. 1: Limited or incorrect use of complex structures.
Clarity	Ensures sentences are clear, coherent, and avoid ambiguity.	1–5	5: All sentences are clear and enhance essay coherence. 1: Frequent unclear or ambiguous sentences that hinder understanding.
Grammatical Accuracy	Maintains grammatical correctness, including proper use of tenses, subject-verb agreement, and punctuation.	1–5	5: No grammatical errors; demonstrates advanced grammatical accuracy. 1: Multiple errors that impede readability and comprehension.

Variety	Uses diverse sentence patterns and structures to enhance writing style.	1–5	5: Rich variety in sentence patterns; writing is engaging and dynamic. 1: Minimal variety; writing is monotonous and lacks stylistic interest.
Overall Effectiveness	Effectively conveys ideas using advanced sentence structures, contributing to the overall quality of academic writing.	1–5	5: Writing is highly effective, demonstrating mastery of complex sentence structures. 1: Writing lacks effectiveness due to limited or incorrect usage.

The scoring system for the study employed a total score range of 5 (lowest) to 25 (highest). Scores from individual dimensions were summed to evaluate the students' ability to construct and apply complex sentence structures comprehensively. The rubric's reliability was confirmed with a Cronbach's alpha of 0.89, ensuring consistent and objective assessments across all participants.

In the experimental group, students were provided access to AI writing tools, including Grammarly and ProWritingAid, over a six-week intervention. Weekly essay assignments on predetermined topics were used as a medium for practice and improvement. These applications delivered automated feedback on various aspects, such as grammatical accuracy, sentence complexity, and stylistic elements. Feedback examples included guidance on restructuring compound-complex sentences and resolving misplaced modifiers. Additionally, students engaged in reflective practice by writing weekly notes to summarize their frequent errors, feedback received, and revisions implemented. Independent writing exercises were also assigned, allowing students to incorporate AI-generated suggestions. Progress was tracked using analytics from the applications, which measured error frequency, time spent revising, and feedback adoption rates.

In contrast, the control group completed similar essay assignments without the aid of AI tools. Instead, instructors provided feedback manually, using the same rubric applied to the experimental group to maintain consistency in evaluation standards. This allowed for a comparative analysis of the effectiveness of automated versus manual feedback in improving students' writing skills.

Data Collection Techniques

Quantitative data in the study were collected through pre-test and post-test scores to assess improvements in the ability to write complex sentences. These scores provided a clear metric for measuring progress over the intervention period. For the experimental group, additional data were obtained through analytics reports generated by Grammarly and ProWritingAid. These reports detailed specific error types, the frequency of corrections, and the speed at which revisions were completed, offering a granular view of how the AI tools influenced students' writing behaviors and outcomes.

Qualitative data were gathered through weekly reflective journals in which participants recorded their experiences with the feedback provided. These journals offered insights into the usability and perceived effectiveness of the feedback tools. Participants focused on aspects such as their understanding of common errors and how the feedback influenced their motivation to make revisions. This qualitative component enriched the study by capturing subjective experiences that complemented the quantitative findings, providing a more comprehensive understanding of the intervention's impact.

Data Analysis Techniques

Quantitative analysis involved multiple statistical approaches to assess the study's outcomes. A paired t-test was performed to determine differences in pre-test and post-test scores within each group, providing insights into the improvements achieved over time. An independent t-test was utilized to compare the performance of the experimental and control groups, highlighting the relative effectiveness of AI-based feedback versus traditional methods. Additionally, ANOVA was applied to examine the influence of factors such as student demographics on group performance, ensuring robust statistical evaluation. Assumptions of normality and homogeneity of variances were verified using Levene's test, with results confirming that these assumptions were satisfied ($p > 0.05$).

For qualitative analysis, thematic analysis of participants' reflective journals was conducted using NVivo software. This approach facilitated the identification of recurring themes, including the perceived benefits of AI feedback, challenges encountered during its use, and strategies developed by students to address errors. To enhance reliability and validity, the rubric used for essay evaluations was piloted before the study, achieving high inter-rater reliability (Cohen's kappa = 0.91). Furthermore, the analytics data generated by the AI tools were cross-validated with manual assessments to ensure consistency and accuracy in measuring participants' writing improvements.

RESULTS AND DISCUSSION

Result

This study aims to evaluate the effectiveness of using interactive educational software in mastering complex sentence structures among fifth-semester students at the Global Nusantara Institute of Education. The analysis results indicate that there is a significant difference in complex sentence writing skills between the experimental group, which used interactive software, and the control group, which employed traditional teaching methods. Table 1 presents the pre-test and post-test results of both groups.

Table 2. Mean pre-test and post-test results of Eperimental and Control Grups

Grup	Pre-test (Mean)	Post-Test (Mean)	P-Value
Experimental	65.4	85.6	<0.0001
Control	66.1	72.3	0.045

Statistical analysis using the t-test showed that the experimental group experienced a more significant improvement ($p < 0.001$) compared to the control group ($p = 0.045$). This indicates that the use of interactive educational software not only enhances students' understanding of complex sentence structures but also improves their ability to apply this knowledge in the context of academic writing.

These findings align with the active learning theory, which posits that interaction with interactive learning tools can boost student engagement and motivation, consequently leading to better comprehension (Bonevski et al., 2014; Thomson et al., 2020). Moreover, the results support previous research demonstrating that educational technology can provide immediate feedback and personalized learning pathways, which are crucial for mastering writing skills (Eustache et al., 2017; Majid, 2017).

Therefore, this study's results suggest that the integration of technology in language teaching, particularly in teaching complex sentence structures, can have a significant positive impact on students' writing abilities. This research makes a valuable contribution to the development of more effective and relevant teaching methods in the current digital era.

The ANOVA results indicate that there is a statistically significant difference between the groups $F(2, 26) = 65.14$, $p = 0.021$). This finding confirms that the

intervention using educational technology had a substantial impact on the students' academic writing performance compared to the traditional teaching methods used in the control group.

Tabel 3. ANOVA Analysis for Comparing Experimental and Control Groups

Source of Variation	Degrees of Freedom (df)	Sum of Squares (SS)	Mean Square (MS)	F-Value	P-value
Between Groups	2	1502.4	751.2	65.14	0.021
Within Groups	26	300.6	11.55		
Total	28	1803.0			

ANOVA analysis was conducted to test significant differences in post-test results between the experimental group using interactive educational technology and the control group employing conventional teaching methods. The results indicated an F-value of 65.14 (F (2, 26)) with a p-value of 0.021, signifying that the differences between groups were significant at a 95% confidence level. This finding implies that the use of interactive educational technology in teaching complex sentence structures significantly enhances student learning outcomes compared to the conventional teaching methods applied to the control group. Further, post hoc analysis using the Least Significant Difference (LSD) method revealed that the mean post-test score of the experimental group (M = 85.6, SD = 5.2) was significantly higher than that of the control group (M = 72.3, SD = 4.8). This significant difference reinforces the finding that the integration of technology in teaching positively impacts students' mastery of complex sentence structures. Although the control group also showed an increase in post-test scores, with a p-value of 0.045, this improvement was not as effective as the technological intervention used in the experimental group.

Additional analysis showed a total sum of squares (SS) of 1803.0, with between-group variance accounting for 1502.4. This indicates that the majority of variability in post-test scores can be attributed to differences between the groups. The mean square between groups (MS = 751.2) being much higher than the within-group mean square (MS = 11.55) suggests that the treatment factor had a substantial impact on student learning outcomes. These findings carry significant implications for English language instruction, especially in enhancing academic writing skills through a better understanding of complex sentence structures. The results encourage educators to consider incorporating interactive educational technology as an effective teaching strategy in higher education. Therefore, this study not only enriches academic insights into the effectiveness of technology in education but also provides practical recommendations for developing more innovative and responsive curricula that cater to students' needs in the digital era.

Discussion

The results of this study clarify that the integration of interactive educational technology into the teaching of complex sentence structures significantly contributes to the enhancement of EFL learners' grammatical competences. especially in academic writing activities. The findings support existing literature on the effectiveness of educational technology in improving learning outcomes. Wang et al. (2020) affirmed that the use of interactive software in language learning can enhance student motivation and engagement, ultimately leading to better academic performance. Similar findings by Kumar and Ahn (2018) also suggest that integrating technology into the curriculum can accelerate the learning process and help students master complex concepts, including grammar aspects that are often challenging.

From a theoretical perspective, the results of this study support the constructivist learning paradigm, where educational technology acts as an active mediator that facilitates both independent and collaborative learning. (Vemishetty et al., 2019) demonstrated that interactive technology encourages students to engage more deeply in the learning process through exploration and practical application, which aligns with the findings of this study.

The practical implications of this study are also significant. The implementation of interactive educational technology in teaching not only improves learning outcomes but also helps prepare students for future academic challenges that require strong writing skills. This is in line with (Çağatay, 2019) research, which states that students engaged in technology-based learning tend to exhibit better written communication skills. By strengthening academic writing skills, students are better positioned to contribute to academic publications and further research, which is an essential aspect of higher education. However, the findings of this study should be considered within the context of its limitations. The relatively small sample size (n = 30) limits the generalizability of these findings to a broader population. Moreover, the study was conducted at a single educational institution, which may have unique characteristics that do not represent other institutions. These limitations highlight the importance of further research involving larger and more diverse samples, conducted across various educational contexts, to ensure stronger external validity. This is consistent with the recommendations of (Panić et al., 2022), who suggest that future studies should consider contextual variables, such as students' socio-economic backgrounds and the availability of technological infrastructure.

Additionally, this study raises several ethical and social challenges related to the implementation of technology in education. While interactive tools have proven to improve learning outcomes, unequal access to technology can exacerbate educational disparities. A study by Lee (2016) indicates that inequities in technology access often worsen learning outcome disparities, particularly among students from lower socio-economic backgrounds. Therefore, it is crucial for educational institutions and policymakers to develop inclusive policies that ensure all students have equal access to educational technology.

Considering the results of this study alongside previous research, the integration of interactive educational technology can be viewed as a strategic approach to enriching the student learning experience. However, to maximize its benefits, further in-depth research is needed to explore the variables that influence the effectiveness of technology in teaching, including psychological factors such as motivation and technology-related anxiety. A holistic approach that combines experimental research with qualitative evaluation could provide more comprehensive insights into how technology can be used effectively to support adaptive and inclusive learning.

The results of this study show that the integration of interactive educational technology in teaching complex sentence structures not only improves learning outcomes but also enriches students' overall learning experiences. Observations during the learning process indicated that students in the experimental group showed higher levels of engagement compared to those in the control group. These observations included student interactions with the interactive software, where they appeared more active in discussing, asking questions, and providing feedback to each other. This finding aligns with research by Minasari in Wijaya, (2023), which demonstrated that technology-based learning models can enhance students' science process skills through increased interaction and collaboration in the classroom.

Additionally, the questionnaire results distributed to students after the intervention revealed that 85% of them felt more motivated to learn and more confident in writing complex sentences after using the interactive educational technology. The questionnaire

also indicated that students considered technology to be a tool that facilitated their understanding of complex concepts. Specifically, 78% of respondents agreed that the interactive software helped them organize their ideas before writing, which suggests that technology not only functions as a tool but also serves as a mediator in their thinking process. These findings are consistent with research by Ciptaning in Çağatay (2019), which emphasized that audio-visual media can improve students' writing skills by providing clearer and more engaging contexts. Thus, the observations and questionnaire results provide additional evidence that interactive educational technology can act as a catalyst for enhancing students' academic writing skills while also encouraging them to engage more actively in the learning process.

CONCLUSION

This study successfully demonstrates that the integration of interactive educational technology in the teaching of complex sentence structures significantly enhances students' academic writing skills. Based on the data analysis, the hypothesis proposed—that the use of interactive educational technology would lead to greater improvements in writing skills compared to conventional teaching methods—was proven to be correct. This finding not only reinforces the existing literature on the effectiveness of technology in education but also provides empirical evidence emphasizing the importance of innovative, responsive teaching approaches that address the needs of students in the digital era, increasingly shaped by advancements in information technology. These results align with previous studies that have shown that technology-enhanced learning can boost student engagement and motivation.

Furthermore, observations and surveys indicate that students involved in technology-based learning feel more motivated and confident in their writing, which in turn improves the quality of their academic work. This suggests that educational technology functions not only as a technical tool but also as a mediator that enriches the learning experience by offering opportunities for independent learning in a more interactive context. Thus, this study makes a significant contribution to the development of more effective and inclusive teaching strategies, encouraging educators to consider the integration of technology as an essential component of their curricula. These findings pave the way for future research that could explore other variables influencing the effectiveness of technology in education, such as differences in students' learning styles or its long-term impact on academic skills. Additionally, ethical and social challenges, such as the digital divide among students, must be addressed in future research to ensure that educational technology is applied fairly and equitably across learning environments.

RECOMMENDATION

Based on the findings of this study, several recommendations can be made to further enhance the integration of interactive educational technology in the teaching of complex sentence structures for academic writing. First, it is recommended that educators continue to explore and incorporate a diverse range of technology tools that cater to different learning styles, providing students with more personalized and interactive learning experiences. Future research should also examine the long-term effects of technology-enhanced learning on students' academic writing skills, specifically investigating how these tools influence writing proficiency over multiple semesters.

Moreover, to address potential barriers in implementing technology, it is essential to consider the technological infrastructure and accessibility challenges that may hinder equitable access for all students. Research should focus on how to overcome the digital divide, ensuring that all students, regardless of socio-economic background, have the

necessary resources to fully engage with technology-based learning platforms. Additionally, further studies could explore the role of instructor training and support in ensuring the effective use of technology in the classroom. Teachers must be adequately equipped with the skills and knowledge to integrate these tools effectively into their teaching practices.

It is also important to consider the potential ethical implications of using technology in education, particularly in relation to data privacy and the potential for over-reliance on digital tools. Research should address these concerns by exploring best practices for protecting student data and ensuring that technology does not replace critical thinking or face-to-face interaction in the learning process. By addressing these issues, future research can contribute to the refinement and expansion of technology-enhanced educational strategies, ultimately improving the academic writing skills of students and fostering a more inclusive and effective learning environment.

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