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Gamification with natural language processing: A pathway to improved English speaking for EFL students

Shella Gherina Saptiany[1*], C Susmono Widagdo[2], Abel Julia Istifary[3], Aruf Mustofa[4]
[1*,3,4] Department of Tourism, Sekolah Tinggi Ilmu Ekonomi Pariwisata Indonesia, Semarang, Indonesia
[2] Department of Management, Sekolah Tinggi Ilmu Ekonomi Pariwisata Indonesia, Semarang, Indonesia
*Corresponding author: shellagherina@stiepari.ac.id

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ABSTRACT

Advances in artificial intelligence and gamification have transformed language learning by offering interactive, feedback-rich, and engaging environments that go beyond traditional instruction. In this context, this study investigates the impact of Natural Language Processing (NLP)-based gamification applications on the English speaking performance of students learning English as a Foreign Language (EFL). Using a quasi-experimental design, 90 tourism students were divided into three groups: two experimental groups using ELSA Speak and Duolingo, and a control group following conventional learning methods. Speaking tests were administered before and after a ten-session intervention, and the results were analyzed using Quantitative. The findings revealed substantial improvements in the speaking skills of students using NLP-based gamification applications. Both ELSA and Duolingo produced significant gains in pronunciation, fluency, and overall speaking performance compared to the control group, with Duolingo demonstrating slightly more consistent improvements. Large effect sizes confirmed the practical significance of these results, while the negligible changes in the control group underscored the effectiveness of technology-based interventions.

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INTRODUCTION

English has become the global lingua franca, serving as the primary medium of communication in international business, education, science, and technology. (Zrekat & Al-Sohbani, 2022) stated that the ability to speak English fluently is therefore considered one of the most important skills for learners of English as a Foreign Language (EFL). For EFL students, developing speaking competence is not only a key to academic success but also a prerequisite for professional advancement and global participation. Despite its importance, speaking is often regarded as the most challenging skill to acquire due to its complexity (Lestari et al., 2024; Masuram & Sripada, 2020), which involves pronunciation, vocabulary, grammar, fluency, and the ability to interact spontaneously in real-time communication.

Speaking competence in English is an essential skill for English as a Foreign Language (EFL) students (Riadil, 2020). EFL learners are individuals who study English as a foreign language, usually in countries where English is not the dominant language in everyday life. They learn English primarily for academic, professional, or international communication purposes rather than as a language used in their daily social environment. However, many EFL students face various challenges in improving their speaking abilities (Omar, 2023). Major obstacles include limited vocabulary, frequent pronunciation errors, lack of fluency, and anxiety when speaking in a foreign language. Moreover, conventional teaching methods that focus heavily on grammar (Schurz & Coumel, 2023) and rote memorization are often less effective in fostering speaking competence due to the lack of active interaction and immediate feedback.

With the rapid advancement of educational technology, innovative approaches are increasingly being adopted to overcome these challenges (Dewi et al., 2025). One promising approach is the integration of gamification and Natural Language Processing (NLP) in language learning applications. NLP, a subfield of Artificial Intelligence (AI), focuses on enabling computers to understand, process, and generate human language (Mishra & Kumar, 2021). It allows language learning applications to provide personalized feedback by analyzing learners' speech, pronunciation, and fluency. When embedded into interactive platforms, NLP can transform speaking practice into an engaging and adaptive learning experience (Sheriffdeen, 2025), making it more effective than traditional drill-based methods.

Gamification, on the other hand, incorporates game-like elements such as points, badges, levels, and challenges to foster motivation and engagement among learners (Saptiany et al., 2024). The integration of gamification with NLP creates an interactive and dynamic learning environment where students can practice speaking while receiving instant feedback and rewards. For instance, applications such as *ELSA* Speak utilize NLP to provide AI-driven pronunciation correction (Akhter, 2025), while

Duolingo combines gamified elements with NLP-powered speaking exercises (Sadigzade, 2025). These features not only increase student motivation but also provide individualized learning pathways, catering to different levels of proficiency and learning styles.

Previous studies have demonstrated that gamification can significantly enhance learner motivation, engagement, and language performance in EFL contexts (Al-Khresheh, 2025; Azizbek Tursunbayevich, 2024; Tayeh et al., 2024). Gamified environments provide immediate feedback, clear goals, and reward systems that encourage active participation and sustained learning behaviors (Dehghanzadeh et al., 2024; Hellín et al., 2023; Saleem et al., 2022). In parallel, Natural Language Processing (NLP)-based technologies have been shown to facilitate pronunciation improvement, speech fluency, and real-time corrective feedback through intelligent speech recognition systems (Dehghanzadeh et al., 2024; Saleem et al., 2022). For instance, AI-powered language learning tools employing NLP algorithms have enabled students to practice spoken English more autonomously and receive personalized feedback, thus supporting self-regulated learning (Wei, 2023).

However, despite the growing popularity of gamified NLP-based applications, there remains a limited number of empirical studies focusing specifically on their effectiveness in improving speaking skills among EFL students. Previous studies have largely emphasized the benefits of gamification in general language learning or the role of NLP in speech recognition (Celaj & Jani, 2024; Markad et al., 2025), but the combined impact of both elements on EFL speaking performance has not been thoroughly investigated. This presents a critical gap in the literature, particularly in contexts where learners face persistent challenges in achieving oral proficiency through conventional classroom instruction.

In response to this gap, the present study aims to explore the impact of NLP-based gamification applications on the speaking skills of EFL students. Specifically, it seeks to examine whether such applications can significantly enhance learners' oral communication compared to traditional teaching methods. Based on this objective, the study addresses the following research questions:

1. How do students' speaking skills change after the implementation of NLP-based gamification applications?
2. To what extent do NLP-based gamification applications enhance the English speaking performance of EFL students?
3. Is there a significant difference in the improvement of speaking skills between students who use NLP-based gamification applications and those who follow conventional learning methods?

Therefore, this study contributes both theoretically and practically by enriching the understanding of how NLP-based gamification can be effectively utilized to improve EFL students' oral proficiency and by offering insights for educators integrating AI-driven tools into language instruction.

RESEARCH METHODOLOGY

Research design

This study employs a quantitative approach with a quasi-experimental design (Creswell, 2007) to measure the effect of an NLP-based gamification application on improving EFL students' speaking skills. The quantitative approach was chosen because it allows for an objective measurement of changes in speaking skills before and after the intervention. The quasi-experimental design was used to compare the results between two experimental groups and one control group (Grimshaw et al., 2000), enabling statistical analysis to determine whether there are significant differences in the improvement of students' speaking skills after using the NLP-based gamification application.

The population in this study consists of tourism students who are learning English as a foreign language (EFL). This population was chosen because tourism students require strong English-speaking skills to communicate effectively in the tourism industry, both with international tourists and in professional workplace settings. The research sample comprises 90 tourism students, selected through purposive sampling based on specific criteria, such as having a relatively similar level of English proficiency and no prior intensive use of NLP-based gamification applications. The sample was divided into three groups:

1. Experimental Group 1 (30 students) – used the ELSA Speak application, which is NLP-based and focuses on pronunciation and speaking practice.
2. Experimental Group 2 (30 students) – used the Duolingo application, which also integrates NLP but emphasizes interactive quiz-based practice.
3. Control Group (30 students) – learned using conventional methods without the aid of NLP-based gamification applications.

Research instrument

The research instruments used include speaking test and application usage log. Speaking test conducted in two stages: a pre-test before the intervention and a post-test after the intervention. This test aimed to assess students' speaking skills in various aspects using Brown's (2004) speaking assessment rubric. Application usage data (e.g., practice duration, number of practice sessions, and achievement scores within

the application) were collected to examine the relationship between the intensity of application use and the improvement of speaking skills.

Data collection

In this study, the data collection techniques used were as follows:

- **Pre-test (Initial Test)**

  Students took a speaking test using Brown's Speaking Assessment rubric, which was recorded and assessed by independent examiners.

- **Treatment with NLP-based Gamification Applications**

  After the pre-test, the treatment groups received an intervention using two NLP-based gamification applications over 10 sessions. The experimental groups used the NLP-based gamification applications, with their activities and progress monitored through activity logs and automatic scores. The control group learned using conventional methods.

- **Post-test (Final Test)**

  After the treatment period was completed, a post-test was conducted using the same format as the pre-test. The results were then compared using statistical tests to measure improvements in speaking skills.

Data analysis

The analysis technique used is Descriptive Analysis, which presents an initial overview of students' speaking skills before and after the treatment based on the average pre-test and post-test scores using Brown's Speaking Assessment rubric. Normality and Homogeneity Tests were conducted to ensure the data met statistical assumptions. A Paired Sample t-Test was applied to measure significant differences within each group (Experimental 1, Experimental 2, and Control) before and after treatment. An Independent Sample t-Test was used to compare post-test results between the experimental groups and the control group, as well as between the two experimental groups, to examine the effectiveness of each application. Finally, an additional test was conducted to measure the effect size of the NLP-based gamification applications on students' speaking skill improvement, ensuring the practical significance of the research findings.

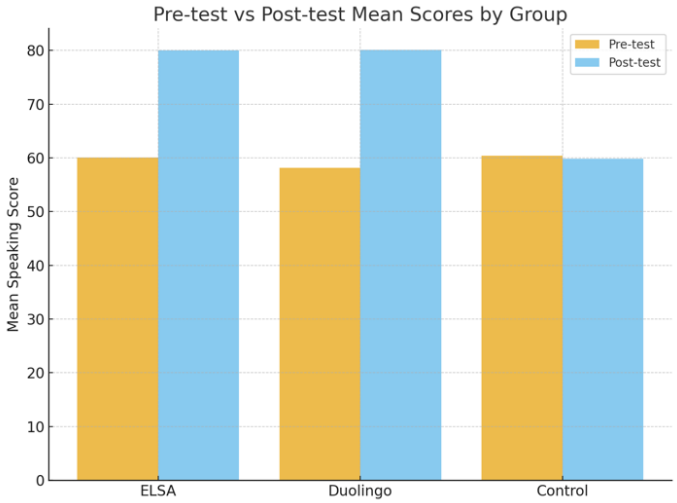
RESULTS

How do students' speaking skills change after the implementation of NLP-based gamification applications?

Table 1. Pre-test and post-test speaking scores across groups

Group	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	t-value	p-value	Effect Size (d)
ELSA	60,1	12,08	79,97	5,15	-8,079	0	1,47
Duolingo	58,13	5,75	80,13	3,2	-18,137	0	3,31
Control	60,4	7,01	59,8	4,11	0,438	0,664	0,08

Figure 1. Comparison of pre-test and post-test mean speaking scores by group



The paired-samples t-test results showed marked improvements in students' speaking skills following the implementation of NLP-based gamification applications. In the ELSA group, scores rose from 60.10 on the pre-test to 79.97 on the post-test, a significant gain of 19.87 points ($t = -8.079$, $p < .001$). The Duolingo group also improved substantially, from 58.13 to 80.13, an increase of 22 points ($t = -18.137$, $p < .001$). These results indicate that both applications provided strong and consistent support for developing students' speaking skills. By contrast, the control group showed no meaningful change (M = 60.40 to 59.80; $t = .438$, $p = .664$), aligning with its non-significant t-test result and confirming that no substantial improvement occurred without an NLP-based gamification application.

Effect size calculations further confirmed the strength of these findings. The ELSA group achieved a large effect size ($d = 1.47$), while Duolingo demonstrated an even greater impact ($d = 3.31$), reflecting exceptionally large and uniform gains in speaking

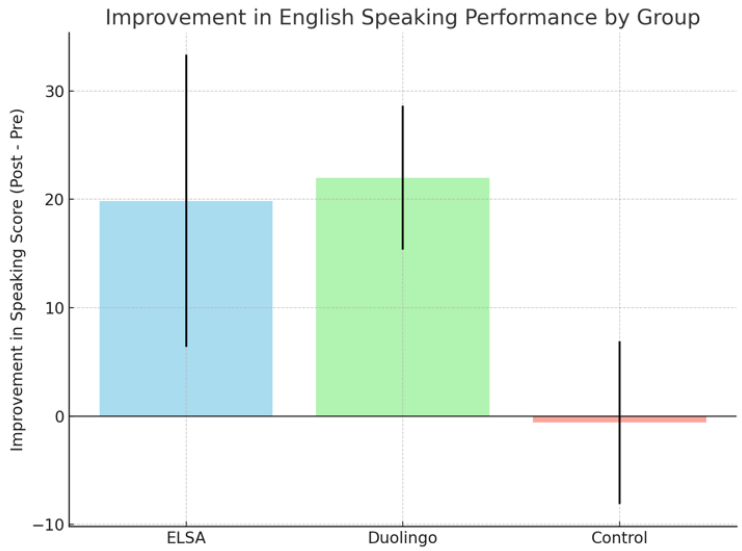
performance. In comparison, the control group's effect size was negligible (d = 0.08). Taken together, these results clearly demonstrate the substantial benefits of NLP-based gamification applications for improving students' speaking skills and underscore the practical value of integrating AI-powered, gamified tools into EFL learning environments.

To what extent do NLP-based gamification applications enhance the English speaking performance of EFL students?

Table 2. One-way ANOVA results for improvement in speaking performance across groups

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	9341.956	2	4670.978	49.724	.000
Within Groups	8172.667	87	93.939		
Total	17514.622	89			

Figure 2. Example of image information



The results of the one-way ANOVA revealed a significant difference in the extent of speaking performance improvement across the three groups, $F(2, 87) = 49.724$, $p < .001$. Students who used NLP-based gamification applications showed far greater gains in speaking performance than those in the control group. The Duolingo group achieved the highest average improvement ($M = 22.00$, $SD = 6.64$), followed by the ELSA group ($M = 19.87$, $SD = 13.47$), while the control group demonstrated no improvement ($M = –0.60$, $SD = 7.50$). These results indicate that NLP-based gamification applications substantially enhanced the English speaking performance of EFL students compared to traditional learning methods.

Overall, the ANOVA results indicate that NLP-based gamification applications constitute an effective approach to enhancing English speaking skills among EFL students. Both Duolingo and ELSA produced statistically significant and meaningful gains. Duolingo demonstrated the most consistent improvement across participants. In contrast, the negligible change observed in the control group underscores the efficacy of technology-based interventions and their potential to transform language learning outcomes.

Is there a significant difference in the improvement of speaking skills between students who use NLP-based gamification applications and those who follow conventional learning methods?

Table 3. Two-way ANOVA and Post Hoc results for speaking skill improvement across groups

Source (Between-Subjects)	Type III Sum of Squares	df	Mean Square	F	Sig.
Class (Pre vs Post)	8,514.689	1	8,514.689	181.195	< .001
Group	3,621.644	2	1,810.822	38.535	< .001
Class × Group	4,670.978	2	2,335.489	49.700	< .001
Error	8,176.600	174	46.992		

Note. Significant interaction effects show differences between ELSA, Duolingo, and Control groups across pre-test and post-test.

Tabel 4. Post Hoc comparisons (Mean Differences)

Comparison (I–J)	Mean Difference	Sig.
ELSA vs Control	+9.93	< .001
Duolingo vs Control	+9.03	< .001
ELSA vs Duolingo	+0.90	.473

Note. Both ELSA and Duolingo groups scored significantly higher than the control group; there was no significant difference between ELSA and Duolingo.

The two-way ANOVA results revealed significant main effects of testing session (pre-test vs. post-test), $F(1,174) = 181.195$, $p < .001$, and group (ELSA, Duolingo, Control), $F(2,174) = 38.535$, $p < .001$, as well as a significant interaction between session and

group, F(2,174) = 49.700, p < .001 (see Table 3). These results indicate that students who used NLP-based gamification applications achieved greater improvements in speaking skills compared to those in the control group following conventional learning methods.

Post hoc comparisons using the LSD test showed that both ELSA (M difference = +9.93, p < .001) and Duolingo (M difference = +9.03, p < .001) significantly outperformed the control group in terms of speaking skill improvement. However, no significant difference emerged between ELSA and Duolingo (M difference = +0.90, p = .473), indicating that both applications were similarly effective in enhancing students' speaking performance.

Figure 3. Pre-test and post-test mean speaking scores by group

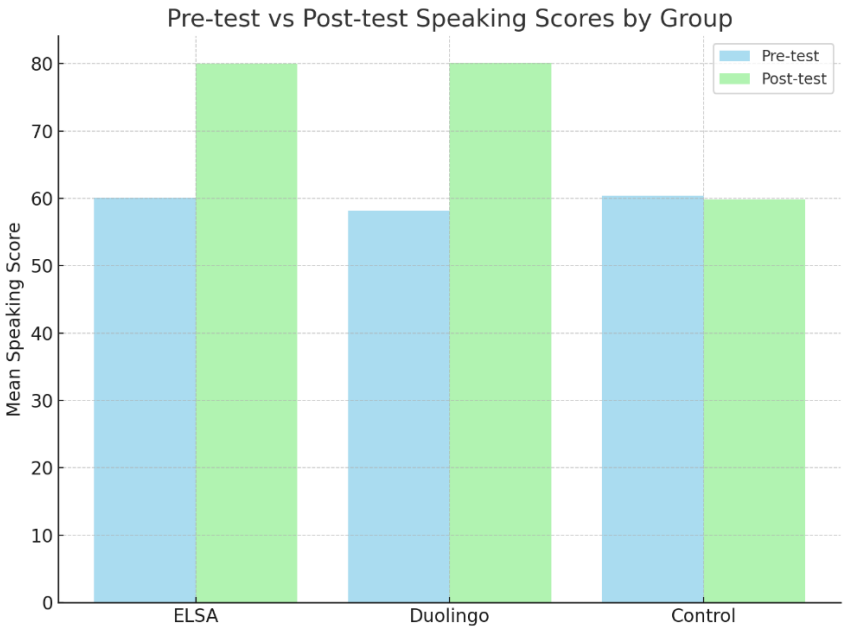


Figure 3 visually represents the differences in speaking performance across the three groups before and after the intervention. Both the ELSA and Duolingo groups show clear gains in post-test scores compared to pre-test scores, whereas the control group remains almost unchanged. These visual patterns reinforce the ANOVA and post hoc results presented in Table 3, which showed that students using NLP-based gamification applications significantly outperformed those following conventional learning methods.

DISCUSSION

This study examined the impact of NLP-based gamification applications on EFL students' speaking performance. Across all three research questions, the findings consistently showed that students using ELSA and Duolingo achieved significant gains in speaking skills, while the control group showed no meaningful improvement. Large effect sizes and significant ANOVA results confirmed that these applications not only improved speaking performance but did so to a substantially greater extent than conventional learning methods.

The findings align with previous research demonstrating the benefits of gamification and AI-powered tools in language learning (Safdar et al., 2025; Salmanova, 2025). By offering interactive tasks, immediate feedback, and game-like elements, NLP-based applications increase engagement and practice opportunities (Du, 2025; Purgina et al., 2020; Ramasamy et al., 2024; Zerkouk et al., 2025), which are critical factors for improving fluency, accuracy, and confidence. These results also support theoretical models such as the Technology Acceptance Model and Self-Determination Theory, suggesting that learners' perceived usefulness, autonomy, and motivation contribute to improved language outcomes (Chen & Zhao, 2022; Fathali & Okada, 2018; He & Li, 2023; Hsu, 2023; Rosli & Saleh, 2023). The results have important implications for language teaching and learning. Practically, they show that integrating NLP-based gamification applications can complement traditional instruction (Çopur Bilgi, 2025; Hsu, 2023; J. Liu, 2024; Rahmanipur Ali et al., 2025; Uppoor et al., 2022), giving students more autonomy and authentic practice opportunities. Theoretically, they demonstrate that combining NLP and gamification strengthens learner engagement and skill development (Kassenkhan et al., 2025; L. Liu, 2025; Marengo et al., 2025; Mohana et al., 2024; Pearlin & Gandhi, 2024; Torres Martín & Romano, 2025), supporting a shift toward more interactive and technology-rich pedagogies. However, this study is limited by its sample scope and lack of measurement of psychological factors such as motivation or anxiety, which may have influenced the outcomes.

Future research should examine the long-term effects of NLP-based gamification applications on speaking performance and explore which specific gamification elements such as points, badges, or leaderboards are most effective in enhancing language learning. Expanding the research to diverse contexts and measuring affective variables could further clarify how these tools work. Overall, the present study highlights the promise of AI-powered, gamified approaches to language learning and their potential to transform EFL instruction into a more engaging and effective experience.

CONCLUSION

This study demonstrates that NLP-based gamification applications significantly improve EFL students' speaking performance compared to conventional learning methods. Across all three research questions, both ELSA and Duolingo produced substantial and meaningful gains, supported by large effect sizes and significant ANOVA results, while the control group showed no improvement. These findings confirm the value of integrating AI-powered, gamified tools into language instruction to enhance engagement, autonomy, and skill development. Although limited by its scope and the absence of affective measures, this research provides strong evidence that NLP-based gamification can be a transformative approach to teaching and learning English speaking skills and sets the stage for future studies exploring its long-term and broader effects.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

AUTHOR (S) CONTRIBUTION

Shella Gherina Saptiany: Conceptualization (lead), methodology (lead), data analysis and interpretation (lead), writing – original draft (lead), review and editing (supporting), supervision (lead), correspondence. C. Susmono Widagdo: Conceptualization (supporting), methodology (supporting), data analysis and interpretation (supporting), writing – original draft (supporting), review (lead), editing (lead). Abel Julia Istifary: Data collection (lead), methodology (supporting), writing – original draft (supporting), review (supporting), editing (supporting). Aruf Mustofa: Data collection (supporting), methodology (supporting), writing – original draft (supporting), review (supporting), editing (supporting).

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