EJI (English Journal of Indragiri): Studies in Education, Literature, and Linguistics
Vol. 10. No. 2, July 2026
ISSN (Print). 2549-2144, ISSN (Online). 2589-5140
Homepage: https://ejournal-fkip.unisi.ac.id/index.php/eji/

Optimizing EFL Learners' Intonation for Speaking Fluency through AI-Powered Speech Recognition Tools

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Article History:
Received: 30/05/2026
Accepted: 13/06/2026
Published: 10/07/2026

Keywords*:*
Artificial Intelligence, Intonation Accuracy, Speaking Fluency

Abstract

Speaking competence remains a critical challenge for EFL learners, particularly in achieving accurate intonation and fluent speech due to limited speaking exposure, insufficient feedback, and conventional classroom practices that prioritize form over communication. Although recent studies have emphasized the potential of artificial intelligence (AI) in language learning, limited research has specifically examined the role of AI-powered speech recognition tools in improving suprasegmental features such as intonation within reflective classroom contexts. Therefore, this study aimed to identify to what extent the integration of AI-powered speech recognition tools optimize EFL learners' intonation accuracy, and to describe the integration of the tools influence learners to speak fluency. This study employed a Classroom Action Research (CAR) design using mix method data approach involving 20 undergraduate learners which selected by purposive sampling technique at a private university in Pekanbaru. The research was conducted in one cycle consisting of planning, action, observation, and reflection stages. The data were collected through intonation test and speaking fluency performance, observation checklists, reflective journals, and AI-generated performance reports, and analysed by using three data analysis theory. The findings revealed a noticable improvement in learners' speaking performance, with mean scores increasing from 60.25 in the pre-test to 80.75 in the post-test. In conclusion, the integration of AI-powered tools such as Stimuler can serve as effective complementary resources in speaking instruction, and it is recommended that educators integrate such technologies alongside communicative approaches while future research should explore long-term impacts and broader aspects of communicative competence.

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Kata Kunci:
Kecerdasan Buatan, Ketepatan Intonasi, Kelancaran Berbicasa

Abstrak

Kemampuan berbicara masih menjadi tantangan utama bagi pembelajar EFL, khususnya dalam mencapai intonasi yang akurat dan kefasihan berbicara akibat keterbatasan paparan berbicara, kurangnya umpan balik, serta praktik pembelajaran konvensional yang lebih menekankan pada bentuk daripada komunikasi. Meskipun studi terbaru telah menyoroti potensi kecerdasan buatan (AI) dalam pembelajaran bahasa, penelitian yang secara khusus mengkaji peran alat pengenalan ujaran berbasis AI dalam meningkatkan fitur suprasegmental seperti intonasi dalam konteks kelas reflektif masih terbatas. Oleh karena itu, penelitian ini bertujuan untuk mengidentifikasi sejauh mana penggunaan alat pengenalan ujaran berbasis AI dapat mengoptimalkan akurasi intonasi pembelajar EFL, serta mendeskripsikan bagaimana integrasi alat tersebut mempengaruhi kelancaran berbicara mereka. Penelitian ini menggunakan desain Penelitian Tindakan Kelas (PTK) yang melibatkan 20 mahasiswa sarjana yang dipilih melalui teknik purposive sampling di sebuah universitas swasta di Indonesia. Penelitian dilaksanakan dalam satu siklus yang terdiri dari tahap perencanaan, tindakan, observasi, dan refleksi. Data dikumpulkan melalui tes intonasi dalam konteks berbicara, lembar observasi, jurnal reflektif, serta laporan kinerja yang dihasilkan oleh AI, dan dianalisis menggunakan tiga pendekatan analisis data. Hasil penelitian menunjukkan adanya peningkatan signifikan dalam performa berbicara pembelajar, dengan rata-rata skor meningkat dari 60,25 pada pre-test menjadi 80,75 pada post-test. Penggunaan Stimuler secara efektif meningkatkan akurasi intonasi, penempatan tekanan, dan kefasihan, sekaligus meningkatkan partisipasi, kepercayaan diri, dan pembelajaran mandiri, serta mengurangi kecemasan berbicara. Sebagai kesimpulan, alat berbasis AI seperti Stimuler dapat berfungsi sebagai sumber pendukung yang efektif dalam pembelajaran berbicara, dan disarankan agar pendidik mengintegrasikan teknologi tersebut bersama pendekatan komunikatif, sementara penelitian selanjutnya perlu mengeksplorasi dampak jangka panjang serta aspek kompetensi komunikatif yang lebih luas.

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INTRODUCTION

Developing speaking competence remains a challenge for EFL learners, where instructional practices still prioritize receptive skills over productive communication. Empirical studies consistently reported that learners encountered serious difficulties in pronunciation, fluency, and confidence due to limited speaking exposure and insufficient oral practice (Arta, 2018). In addition, conventional classroom environments frequently restrict learners' opportunities to engage in authentic spoken interaction, resulting in fragmented speech production and monotonous intonation patterns. These limitations are further exacerbated by large class sizes and constrained instructional time, which prevent teachers from offering individualized feedback and continuous speaking monitoring (Ahyarudin & Jamilah, 2024; Pangestu & Suwartono, 2024). Consequently, many learners experience persistent speaking anxiety and low communicative competence, which negatively affect their academic performance and classroom participation (Ebadi et al., 2025). Therefore, addressing these systemic challenges is essential for improving the quality of EFL speaking instruction.

The urgency of enhancing EFL learners' speaking competence has become increasingly critical in the era of digital communication and global connectivity. Modern educational demands require learners to possess not only linguistic knowledge but also communicative fluency, confidence, and adaptability in diverse contexts (Fathi et al., 2024). However, traditional instructional approaches relying on teacher-centered explanations and mechanical drills have proven insufficient to foster meaningful speaking engagement (Arta, 2018; Fathi et al., 2024). Recent empirical evidence highlighted the potential of AI-based instructional tasks and digital platforms to improve speaking performance, reduce anxiety, and enhance learner motivation (Ahyarudin & Jamilah, 2024; Zhang et al., 2025). AI-mediated learning environments enable learners to practice pronunciation in speaking context independently beyond classroom constraints, thereby expanding exposure and interaction opportunities (Pangestu & Suwartono, 2024). Thus, integrating AI into r speaking instruction becomes an urgent pedagogical innovation to respond to evolving educational challenges.

Stimuler represents an emerging AI-powered speech recognition tool designed to facilitate interactive speaking practice through real-time feedback and automated evaluation. This application integrates advanced speech recognition algorithms capable of analyzing learners' pronunciation, rhythm, and intonation with considerable accuracy. Empirical findings demonstrated that AI-based applications such as Orai, Liulishuo, and ELSA Speak significantly enhance learners' pronunciation and speaking performance by providing immediate corrective feedback and personalized learning trajectories (Ali & Losi, 2025; Fathi et al., 2025; Rahayuningsih et al., 2025). Furthermore, AI-driven platforms foster learner autonomy, allowing students to monitor their progress independently while reducing speaking anxiety (Ebadi et al., 2025; Shafiee Rad, 2024). In the Indonesian context, Stimuler has shown promising potential in improving students' intonation and speaking engagement and classroom participation (Sari & Rahman, 2025). Consequently, employing Stimuler as a pedagogical intervention offers a strategic pathway to enhance intonation in speaking instruction through technology-supported learning.

Intonation for speaking fluency constitute core components of oral communication that significantly influence message clarity, listener comprehension, and communicative effectiveness. Proper intonation patterns enable speakers to convey pragmatic meaning, emotional nuance, and discourse coherence, while fluency reflects the continuity and natural flow of speech production (Qiao & Zhao, 2023) however, demonstrate monotonic intonation and hesitant speech due to insufficient exposure to authentic spoken English and limited practice opportunities (Maspufah and Zuriati, 2022). AI-powered pronunciation training systems have been shown to significantly improve learners' prosodic features and fluency through continuous feedback and iterative practice (Fu et al., 2021; Maspufah et al., 2024). Moreover, automatic speech evaluation programs enable learners to identify phonological errors and refine their oral production more effectively (Zou et al., 2023). Therefore, focusing instructional interventions on intonation and fluency development through AI technology is both pedagogically and linguistically justified.

Previous studies have demonstrated that AI-assisted language learning enhanced speaking performance, reduce speaking anxiety, and promote positive learner engagement (Fathi et al., 2025). However, most studies have examined speaking ability as a general construct, paying limited attention to specific aspects such as intonation accuracy and speaking fluency. Furthermore, existing research has predominantly employed experimental and survey-based designs (Ahyarudin & Jamilah, 2024; Zhang et al., 2025), providing limited insight into how AI-supported instruction can be continuously refined within authentic classroom contexts. Research on locally developed AI applications, such as Stimuler, also remains scarce in Indonesian EFL settings. Therefore, this study addresses these conceptual, methodological, and contextual gaps by investigating the use of AI-powered speech recognition tools to support learners' intonation accuracy and speaking fluency through a Classroom Action Research framework.

This study aims to identify to what extent the integration of AI-powered speech recognition tools optimize EFL learners' intonation accuracy, and to describe the integration of the tools influence learners to speak fluency through a Classroom Action Research (CAR) framework. Guided by the cyclical processes of planning, action, observation, and reflection (Kemmis & McTaggart, 1988), the study seeks to identify effective instructional practices for integrating AI-assisted pronunciation feedback into speaking activities and to continuously refine these practices based on classroom observations and learner responses. The findings are expected to provide practical insights into the implementation of AI-assisted pronunciation instruction in EFL classrooms and to offer evidence-based strategies for enhancing learners' prosodic competence and speaking performance. Furthermore, the study contributes to the growing body of literature on AI-assisted language learning by demonstrating how technology-enhanced feedback can be systematically integrated and refined through a Classroom Action Research approach. Ultimately, this research supports educators in developing more responsive, interactive, and effective speaking instruction practices.

The novelty of this research was in its integrative approach that combines AI-powered speech recognition technology with classroom action research methodology to enhance intonation for speaking fluency. Unlike previous studies which dominantly focused on experimental outcomes, this investigation emphasizes reflective instructional cycles responsive to learners' evolving needs. It uniquely positions Stimuler as a locally contextualized AI tool within Indonesian EFL pedagogy, thereby strengthening technological relevance and cultural alignment. Moreover, the study foregrounds intonation as a central analytical construct, which remains underexplored in existing AI-assisted speaking research. The classroom-based intervention model also enables sustainable pedagogical innovation rather than short-term instructional gains. Consequently, this research offers a distinctive and original contribution to contemporary EFL intonation for speaking pedagogy and AI-enhanced language learning.

METHOD

This study employed Classroom Action Research (CAR) using a mixed method data analysis approach as its primary research methodology to investigate AI-powered speech recognition tools in optimizing EFL learners' intonation accuracy for speaking fluency. CAR was selected because it emphasizes cyclical processes of planning, action, observation, and reflection, allowing systematic instructional improvement based on classroom evidence. This methodology is appropriate for addressing practical pedagogical problems and implementing real-time instructional interventions within authentic classroom contexts. Through iterative cycles, CAR enables teachers to refine teaching strategies and optimize learning outcomes continuously. Moreover, CAR provides empirical data that reflect actual learning processes, making it suitable for evaluating technology-enhanced instruction. Therefore, the use of CAR in this study was justified by its capacity to improve instructional practices while simultaneously generating rigorous empirical evidence.

The research subjects consisted of 20 undergraduate learners enrolled in a management class, comprising 14 female and 6 male, at a private university in

Pekanbaru during the 2025/2026 academic year. These participants were selected by using purposive sampling**,** based on preliminary diagnostic assessments indicating difficulties in pronunciation, intonation control, and speaking fluency. This sampling technique was considered appropriate because it enabled the researcher to target learners who most required instructional intervention. Furthermore, the class was selected due to its heterogeneity in speaking proficiency levels, which allowed comprehensive observation of learning improvement across diverse performance ranges. The relatively small class size facilitated intensive instructional treatment and close monitoring of learning progress. Consequently, this sample provided an optimal setting for implementing classroom action research aimed at enhancing speaking competence.

The data collected in this study consisted of both quantitative and qualitative data obtained from multiple sources to ensure methodological triangulation. Quantitative data were derived from pre-test and post-test speaking performance assessments, while qualitative data were collected through classroom observation sheets, students' reflective journals, and AI-generated performance analytics reports. Four research instruments were employed: a speaking fluency performance rubric adapted from Segalowitz (2010) and Skehan (2003), an observation checklist, a student reflection journal, and AI speech recognition assessment reports. To ensure content validity, the speaking performance rubric was reviewed by two experts in English language teaching and speaking assessment prior to implementation. The rubric assessed key speaking dimensions, including pronunciation, intonation, fluency, grammar, and comprehension. The speaking assessments were evaluated independently by two raters, consisting of the classroom teacher and an experienced EFL lecturer. Before scoring, both raters participated in a calibration session to establish a shared understanding of the scoring criteria and performance descriptors. To minimize subjectivity and enhance scoring reliability, inter-rater reliability was established by comparing the scores assigned by the two raters. Any substantial discrepancies were discussed until a consensus score was reached. In addition, AI-generated speech recognition reports were used as supplementary evidence to support the evaluation of learners'

pronunciation and intonation development. The speaking tests were administered at the beginning and end of each research cycle, while classroom observations and AI analytics were conducted continuously throughout the intervention. Students' reflective journals were collected after each treatment session to capture their learning experiences, perceptions, and challenges. This systematic data collection procedure ensured comprehensive documentation of both instructional processes and students' speaking development across the action research cycles.

Data analysis was conducted by using mixed-method analysis approaches, integrating quantitative and qualitative techniques to obtain comprehensive research findings. Quantitative data from speaking tests were analyzed using descriptive statistics, including mean scores, percentage improvement, and learning gain analysis, following the evaluation framework proposed by Cresswell (2014). Improvement in intonation accuracy and speaking fluency was examined by comparing learners' pre-test and post-test speaking performances across the action research cycles. Speaking fluency was operationalized based on the temporal fluency framework proposed by Segalowitz (2010) and (Skehan, 2003)Segalowitz (2010) and Skehan (2003), which emphasizes observable features of speech production. Specifically, fluency was assessed through four indicators: (1) speech rate, referring to the number of words produced per minute; (2) pause frequency, referring to the occurrence of silent pauses during speech; (3) hesitation markers, including fillers and self-repairs that interrupt speech flow; and (4) continuity of speech, referring to the ability to maintain smooth and connected utterances with minimal disruption. These indicators were evaluated using the speaking assessment rubric and supported by AI-generated speech analytics reports. Changes in learners' performance across these dimensions were used to determine the extent of improvement in speaking fluency throughout the intervention. Qualitative data from observation sheets and reflective journals were analyzed using the interactive model of Miles, Huberman, and Saldana (2014), which involves data reduction, data display, and conclusion drawing. This analytical approach enabled systematic interpretation of learners' behavioral changes, engagement levels, and learning

responses. Therefore, the integration of quantitative and qualitative analysis ensured methodological rigor and strengthened the validity of the research findings.

FINDINGS AND DISCUSSION

The findings of this study were described based on the research question; to what extent does the use of AI-powered speech recognition tools optimize EFL learners' intonation accuracy, and how does the integration of these tools influence EFL learners to speak fluency. The action research was carried out in one cycle through the stages of planning, action, observation, and reflection. It stopped as there was improvement in learners' achievement in one cycle. The cycle was designed in seven meetings consisting five meetings for treatment then two meetings for pre-test and post-test. In the first cycle, the pre-test was conducted on the learners' intonation with the mean score 58,95. From the pre-test, it was revealed that learners had difficulty in applying appropriate intonation and stress. Most learners used flat intonation and misplaced stress in multisyllabic words. None learners achieved the minimum mastery criterion (75). Learners received instruction by implementing AI-powered speech recognition tools to assist their learning. The followings were the description of every meeting in the research.

The planning stage was formulated based on the findings of the pre-test, which revealed that learners' speaking performance was unsatisfactory. The pre-test mean score was 60.25 and none of the learners achieved the minimum mastery criterion (75). The analysis indicated that students frequently produced flat intonation patterns, misapplied rising and falling tones, and misplaced word stress in multisyllabic words. These weaknesses resulted in reduced intelligibility and limited communicative effectiveness. In response to these findings, a structured instructional intervention was designed to address the identified problems systematically. The planning stage encompassed pedagogical preparation, material development, assessment design, and observation framework.

The acting stage was carried out over five treatment meetings following the pre-test. The instructional intervention integrated the use of the Stimuler application as a digital pronunciation and intonation support tool. The application functioned

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as a speaking stimulator by providing audio modelling, instant feedback, and repetition opportunities to enhance students' suprasegmental awareness. The implementation was structured progressively to facilitate systematic development of intonation and stress mastery.

The first meeting focused on raising learners' awareness of intonation patterns. The lecturer introduced rising and falling intonation conceptually and demonstrated examples using the Stimuler application. Learners listened to model utterances and observed pitch contour visualization provided by the application. Subsequently, learners practiced repeating short sentences by using Stimuler. The application provided immediate feedback on pitch variation, enabling students to notice discrepancies between their production and the model. This session emphasized perception and controlled production. The following graphs was the result of the first meeting.

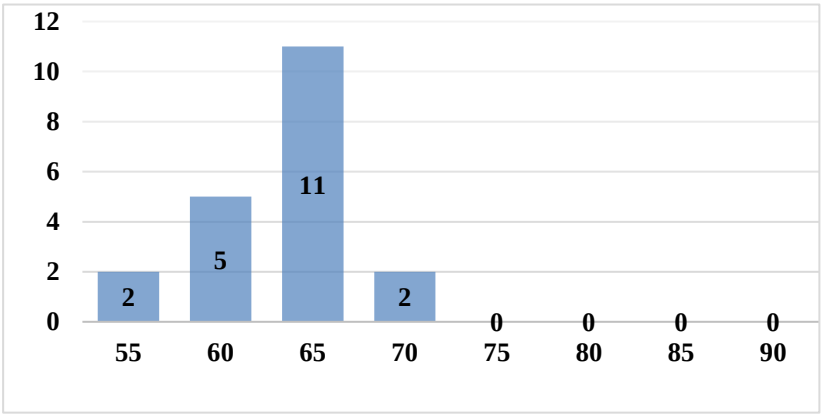

Figure 1. Learner's Score in the First Meeting

The figure was the result of first meeting test. From the graph, it figured out that two learners scored 55, five learners scored 60, eleven learners scored 65, and two learners scored 70. The average score was 63.25.

The second meeting emphasized functional application of rising intonation such as yes/no questions and falling intonation which includes statements and WH-questions. Learners engaged in structured dialogue practice supported by Stimuler application. Each pair practiced reading dialogues and recorded their performance using the application. Feedback from Stimuler application allowed learners to

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adjust their pitch movement. The teacher facilitated corrective feedback and highlighted communicative functions of each intonation type. Gradually, learners moved from repetition drills to semi-controlled role-play activities. The learners' score in second meeting was depicted in the following figure.

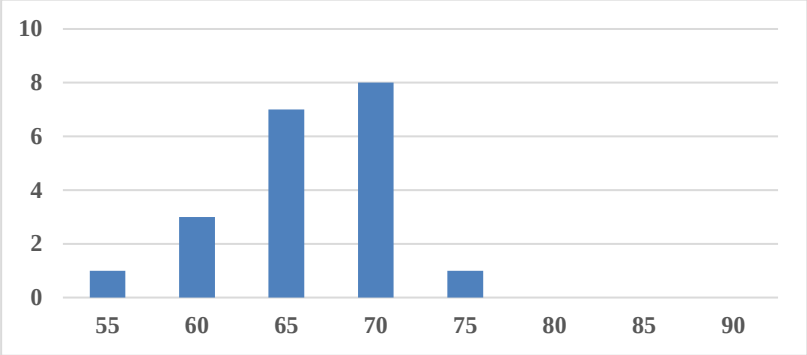

Figure 2. Learners' Score in the Second Meeting

The results of second meeting revealed encouraging progress in learners' pronunciation, particularly in the production of rising intonation. Learners became increasingly aware of intonation features through repeated practice and feedback activities. Although the improvement was modest, one learner achieved the minimum target score of 75, while the class average score increased from 63.25 to 66.25.

The third meeting focused on rising–falling intonation to express surprise, emphasis, and doubt. Learners explored emotional expression through contextual dialogues. Stimuler was used to compare neutral and expressive versions of the same utterance. Learners analysed differences in pitch movement and then practiced producing expressive intonation patterns. Group role-play tasks were implemented to encourage contextualized application. The integration of emotional meaning with pitch contour strengthened students' understanding of prosodic function beyond mechanical repetition.

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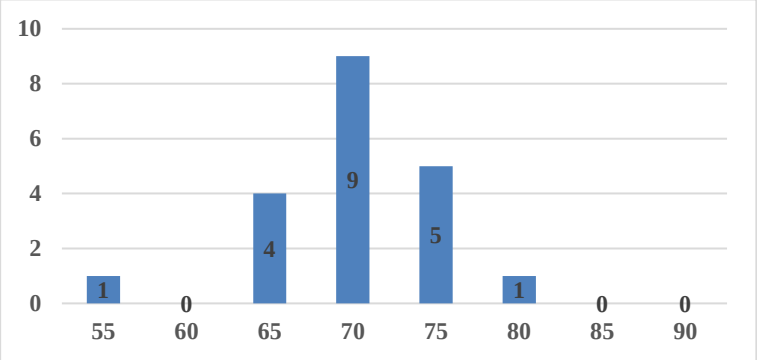

Figure 3. Learners' Score in the Third Meeting

The results of the third meeting indicated continued progress in learners' pronunciation, particularly in their production of falling-rising intonation patterns. Through the instructional activities and ongoing feedback provided during the cycle, students demonstrated greater awareness and more accurate use of this intonation feature. The assessment results showed that six learners successfully met the minimum achievement criterion. In addition, the class average score increased to 70, representing an improvement of 3.75 points compared to the previous meeting.

The fourth meeting concentrated on word stress. The learners learned rules of word stress in two and three syllable words, including verb, adjective, and sentence stress which dealing with content and function words. Learners practiced producing stress patterns and examined wave form emphasis displayed by implementing Stimuler application. Clapping rhythm exercises were combined with digital feedback to reinforce rhythmic awareness. Learners then performed short presentations in which sentence was emphasized to convey meaning clearly. The learners' score was displayed in the following graph:

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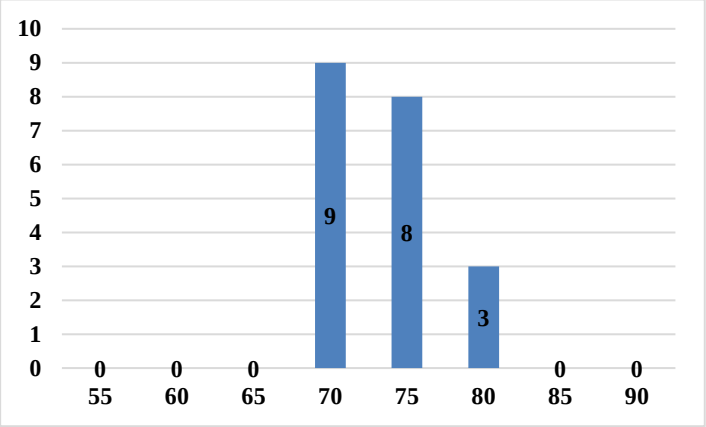

Figure 4. Learners' Score in the Fourth Meeting

The results indicated continued progress in learners' word stress pronunciation throughout the instructional process. Students demonstrated greater awareness of stress placement and showed increased accuracy in producing stressed syllables during speaking activities. By the end of the meeting, eleven learners had successfully achieved the minimum performance criterion. Furthermore, the class mean score reached 73.50, representing an increase of 3.50 points compared to the previous assessment

The fifth meeting integrated intonation and stress into communicative speaking tasks. Learners participated in storytelling and short discussions while using Stimuler to self-monitor pronunciation accuracy. The lecturer minimized direct correction and encouraged autonomous learning through repeated self-recording and self-evaluation. This stage emphasized fluency, naturalness, and confidence. Across the five meetings, the instructional strategy transitioned from explicit explanation and controlled drills to communicative and autonomous speaking performance supported by digital feedback. The learners' score displayed in the following graph:

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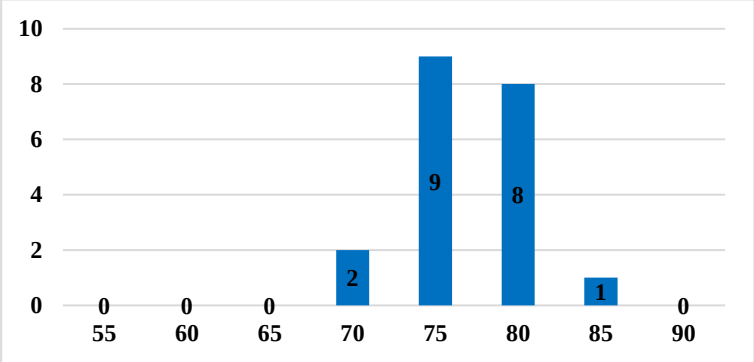

Figure 5. The Learners' Score in the Fifth Meeting

The fifth meeting demonstrated continued improvement in learners' communicative intonation. A total of eighteen learners met the minimum performance criterion, and the class mean score increased to 77.00. The results indicate that learners became more proficient in using appropriate intonation patterns during communicative speaking tasks.

The post-test was carried out in the sixth meeting. It was implemented after 5 meeting treatment. The test was conducted orally one by one. The test was 25 items of rising intonation, falling intonation, rising-falling intonation, word stress, and short speaking task. The test was conducted by applying Stimuler application. The learners' result was depicted in the following graph:

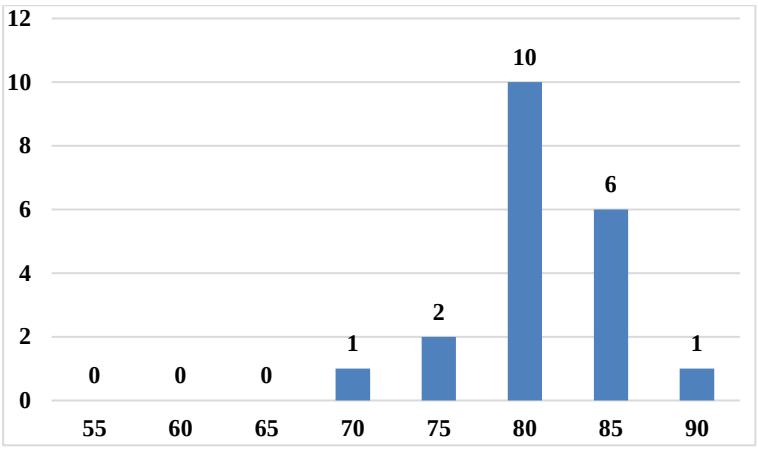

Figure 6 The Learners' Score in Post-test

The data were tabulated to determine learners' raw score after administering post-test. The average score was 80.75 and all of learners passed the minimum criteria.

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The learners' progress from the pre-test to post-test was significant. Their score increased from 60.25 to 80.75 or 20.50 points. Their progress can be seen in the following figure:

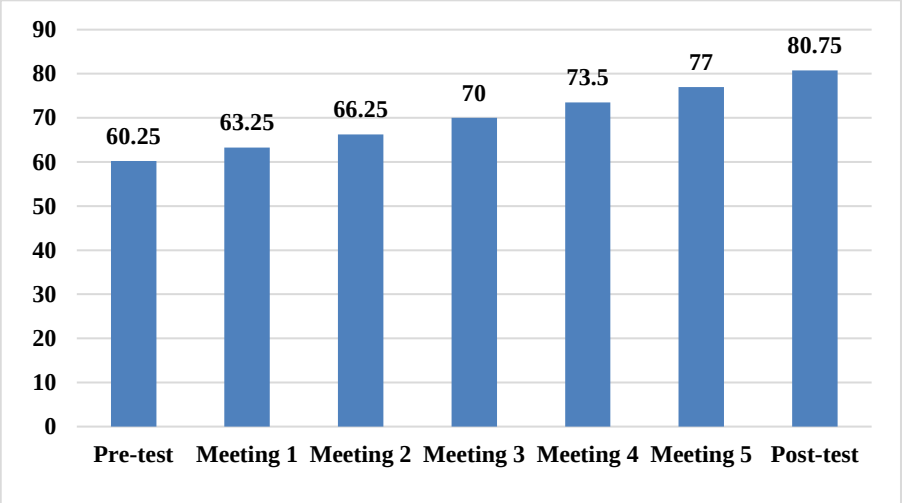

Figure 7. The Learners' Progress in Pronunciation for Speaking Fluency

Based on the graph, learners average score had been increased during the treatment. The learners' pre-test score was 60.25 and after the first treatment increased 3.00 points into 63.25. Then, in the second meeting the average score also increased 3.00 points into 66.25. Next, there was increased points about 3.75 to be 70 in the third meeting. And then, in the fourth meeting, the average score was also increased 3.50 points to be 73.50. Lastly, in the fifth meeting, learners' score was also increased another 3.50 points into 77.00 points. The post-test result showed that average score was 80.75 when it compared with the pre-test average score, 60.65, it had been increased 20.50 points. It can be inferred that stimuler application improved learners' intonation for speaking fluency.

To investigate the integration of the Stimuler application in influencing EFL learners' speaking fluency, the analysis focused on learners' speaking performance obtained from observation and reflection stages attributed to the repeated practice opportunities and immediate feedback provided by the AI-powered speech recognition tools, which enabled learners to monitor and refine their oral performance. This finding supports Segalowitz (2010) view that fluency

development is associated with increased automaticity in language processing, allowing learners to produce language more efficiently. It also aligns with Skehan (2003) argument that sustained speaking practice and feedback contribute to the enhancement of temporal fluency features such as speech rate, pause management, and speech continuity.

The reflection stage confirmed the effectiveness of the intervention, as evidenced by the increase in mean scores from 60.25 to 80.75 and the achievement of 90% mastery. This result met the success criteria in classroom action research, where improvement in both performance and behavior indicated successful intervention (Arikunto et al., 2014; Kemmis & McTaggart, 1988) Additionally, the findings are supported by Pratama & Hastuti (2025) who stated that AI integration significantly improves students' speaking outcomes. Overall, the action was considered successful within one cycle. The integration of Stimuler effectively improved students' intonation accuracy, word stress, fluency, and confidence. Therefore, a second cycle was deemed unnecessary.

CONCLUSION

This research was conducted to identify whether and to what extent does the use of AI-powered speech recognition tools optimize EFL learners' intonation accuracy, and how does the integration of these tools influence EFL learners to speak fluency. Based on the findings in the previous section, it can be concluded that the optimizing stimuler application contributed to the improvement of learners' speaking fluency. The integration of simuler application influenced EFL learners to speak fluently as it facilitates speaking practice and learners' engagement. .

Based on these findings, several recommendations are proposed. English language teachers as well as lecturers are encouraged to integrate AI-based applications such as Stimuler into their instructional practices to support the development of speaking skills in a more interactive and learner-centered manner. Learners should be motivated to utilize such applications independently to reinforce their speaking practice beyond the classroom. Educational institutions are advised to provide adequate technological infrastructure to facilitate the effective

implementation of AI-assisted learning. Finally, future research is recommended to examine the long-term effects of AI-based speaking instruction and to explore its impact on other dimensions of language proficiency, including listening skills, interactional competence, and pragmatic use of language

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