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From Feedback to Feedforward: AI-Enhanced Formative Assessment for Self-Evaluation in EFL Non-English Majors' Listening–Speaking Development

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Abstract

Research on formative assessment in English as a Foreign Language (EFL) contexts has emphasized its potential to enhance learner autonomy, reflection, and sustained improvement; however, limited research has explored how Artificial Intelligence (AI) can transform formative feedback into feedforward practices that strengthen learners' self-evaluation and skill development, particularly in listening and speaking. This study examined the effects of AI-enhanced formative assessment on learners' self-evaluation and their listening–speaking performance. Adopting a mixed-methods quasi-experimental design, the study involved 72 non-English majors enrolled in an "English for Communication" course at a private university in West Java, Indonesia. Participants were assigned to an experimental group *(n = 36)*, which received AI-supported formative feedback, and a control group *(n = 36)*, which received

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conventional feedback, over an eight-week intervention. Quantitative data were collected through pre- and post-tests of listening and speaking, while qualitative data were obtained from a closed-ended questionnaire incorporating AI feedback log items and semi-structured interviews with six selected participants. The results indicated that the AI-supported group achieved significantly greater gains in listening comprehension, pronunciation accuracy, fluency, and discourse organization than the control group. Qualitative findings further revealed enhanced self-monitoring, reflective awareness, and feedforward-oriented learning behaviors among learners using AI feedback. However, some participants reported challenges in interpreting nuanced AI-generated comments and translating them into actionable improvement strategies. Overall, the findings demonstrate that AI-enhanced formative assessment can effectively support self-evaluation and listening–speaking development, provided that pedagogical guidance is integrated to facilitate meaningful use of automated feedback.

***Keywords*:** artificial intelligence, EFL assessment, feedforward, listening–speaking development, self-evaluation

1. Introduction

Formative assessment has widely been acknowledged as an essential approach for fostering active learning and self-regulated development. However, in many English as a Foreign Language (EFL) classrooms, its practice tends to rely heavily on teacher judgment rather than engaging learners in reflective participation and autonomous evaluation (Dmitrenko et al., 2021; Stanja et al., 2023). Bennett (2011) and Black and Wiliam's (2009) definition of formative assessment involves a continuous cycle in which information about learners' performance is collected, interpreted, and applied to guide instruction and enhance subsequent learning outcomes. In EFL education, it has been associated with improved language proficiency, learner autonomy, and metacognitive growth (Granberg et al., 2021; Slamet & Mukminatien, 2024; Yang et al., 2022). Despite its pedagogical importance, existing studies have shown that formative assessment practices in EFL classrooms tend to emphasize corrective feedback over developmental guidance, focusing more on what students did wrong rather than on how they might improve (Zhang & Crawford, 2024). This narrow view of feedback often reduces learners' capacity for self-evaluation and restricts their ability to engage in self-regulated learning processes (Cochran et al., 2022; Yildirim-Erbasli & Bulut, 2023). Consequently, there is a growing call to shift from feedback as a retrospective activity toward feedforward as a prospective, dialogic, and developmental process that empowers learners to act on feedback and plan for future learning (Huang et al., 2024; Shin et al., 2022).

The emergence of Artificial Intelligence (AI) in language education presents new opportunities to address these limitations by offering scalable, individualized, and timely formative assessment. AI-driven tools can generate adaptive feedback, analyze learner performance patterns, and provide ongoing support that complements teacher mediation (Bo et al., 2026; Gardner et al., 2021; Li & Kesen Mutlu, 2025; Slamet, 2024; Slamet & Basthomi, 2025; Villarino, 2025; Yolum & Atay, 2026). Studies have also demonstrated that AI-enhanced feedback can improve accuracy, fluency, and learner engagement in EFL tasks (Alruwaili et al., 2026; Fathi & Rahimi, 2024; Li et al., 2025; Qiao & Zhao, 2023). However, the majority of this research remains concentrated on outcome-based improvements

rather than on learners' internal processes of self-evaluation and metacognitive awareness (Cooper, 2023; Owan et al., 2023; Tang & Cooper, 2025). Moreover, the extent to which AI feedback can be effectively transformed into feedforward learning actions is still underexplored, as most tools emphasize automated scoring or linguistic accuracy over reflective and strategic learning development (An et al., 2023; Derakhshan et al., 2026; Fathi et al., 2025). The literature therefore points to a critical need to examine not merely the performance gains resulting from AI use but also how AI-mediated formative assessment fosters learners' ability to monitor, interpret, and act upon feedback independently.

Listening–speaking development remains one of the most complex and under-assessed areas in EFL learning, as it involves real-time comprehension, cognitive processing, and interactive communication (Harris, 2025; Tran et al., 2024). Traditional assessment approaches, which often prioritize pronunciation or grammatical precision, fail to capture the multidimensional nature of spoken communication and learners' ability to co-construct meaning (Yu et al., 2021). Furthermore, formative assessment in listening and speaking has received far less empirical attention than in reading and writing (Abdolrezapour & Ghanbari, 2021; Cai et al., 2022; Chen et al., 2021). Studies have shown that EFL learners often struggle with self-evaluating their oral performance, largely due to limited awareness of pragmatic, discourse, and strategic elements (Alazemi, 2024; Köroğlu, 2021). AI tools with formative capabilities, such as speech recognition and automated feedback systems, offer potential to bridge this gap by providing immediate diagnostic input on aspects like fluency, coherence, and pronunciation (Du, 2024; Serván, 2023). Yet, despite this technological potential, existing evidence suggests that learners may either rely excessively on automated feedback or find it challenging to interpret algorithmic comments meaningfully (Rodríguez et al., 2022; Su & Huang, 2025). This highlights an emerging pedagogical dilemma: while AI feedback enhances accessibility and precision, it may inadvertently diminish learners' agency and reflective engagement if not pedagogically scaffolded.

To the best of our knowledge, despite growing interest in formative assessment and AI integration in EFL contexts, several critical gaps remain. First, existing

research has rarely examined how formative feedback is transformed into feedforward processes that actively support learners' self-evaluation. Second, studies on AI-assisted formative assessment have predominantly emphasized performance outcomes, with limited attention to metacognitive regulation and reflective engagement. Third, empirical evidence on the role of AI-generated feedback in listening–speaking development remains scarce, particularly regarding how learners interpret and operationalize such feedback for subsequent improvement. Finally, the interplay between automated feedback and pedagogical mediation has received insufficient scholarly attention, leaving unclear how human guidance shapes meaningful learner engagement with AI feedback. In response, this study conceptualizes AI-enhanced formative assessment as the integration of AI-generated feedback to support ongoing reflection and performance monitoring; feedforward as learners' capacity to translate feedback into future-oriented learning actions; and self-evaluation as learners' regulation of learning strategies based on reflective appraisal. By addressing these constructs, the study seeks to advance understanding of how AI-mediated formative assessment can foster self-regulated listening–speaking development in EFL contexts. This study is guided by the two research questions (RQs):

1. How does AI-enhanced formative assessment influence EFL learners' self-evaluation in listening–speaking development?

2. What challenges do learners experience in interpreting and applying AI-mediated feedforward feedback for their listening–speaking improvement?

2. Literature Review

This literature review synthesizes theoretical and empirical studies relevant to the present research by examining four interconnected strands. It first outlines the role of formative assessment in fostering learner self-evaluation in EFL contexts, followed by a discussion of the shift from feedback to feedforward in assessment for learning. It then reviews recent developments in AI-enhanced formative assessment in language learning and concludes by addressing key issues in listening–speaking development and assessment.

2.1. Formative Assessment and Learner Self-Evaluation in EFL Learning

Formative assessment has evolved from being merely an instructional technique to a cornerstone of effective pedagogy that drives learning through feedback, reflection, and adjustment (Bennett, 2011; Cochran et al., 2022). Within EFL learning, it fosters learners' awareness of their linguistic strengths and weaknesses while cultivating autonomy and self-regulated learning (Dmitrenko et al., 2021; Liao et al., 2024). Formative assessment emphasizes feedback that informs learners about the *process* of learning rather than merely the *product*, thereby allowing them to plan subsequent learning actions (Estaji & Eslami, 2022; Stanja et al., 2023). Despite these pedagogical benefits, its implementation in EFL classrooms often remains teacher-centered, focusing on correction and grading instead of guiding learners to become evaluators of their own progress (Cai et al., 2022; Slamet & Mukminatien, 2024). This limited interpretation of formative assessment prevents learners from engaging in self-monitoring or developing metacognitive skills necessary for independent learning. Research indicates that while many educators value formative assessment, they often lack the frameworks and tools to translate it into structured learner self-evaluation practices (Antonova & Tyrkheeva, 2021; Granberg et al., 2021; Liao et al., 2024). Consequently, the link between formative assessment and learner autonomy remains underdeveloped, suggesting the need for new assessment designs that explicitly promote self-evaluative processes through continuous and interactive feedback cycles. Overall, while formative assessment is widely recognized for its potential to promote learner autonomy and self-regulation in EFL contexts, its impact on learner self-evaluation remains limited by teacher-centered practices, highlighting the need for assessment designs that explicitly support continuous, learner-driven evaluative processes.

2.2. From Feedback to Feedforward: Rethinking Assessment for Learning

Recent shifts in assessment theory have reoriented attention from feedback, which focuses on information about past performance, to feedforward, which emphasizes actionable guidance for future learning (Müftüoğlu et al., 2024; Su & Huang, 2025). The feedforward perspective encourages learners to translate evaluative input into

purposeful learning strategies that foster deeper comprehension and sustained development rather than short-term correction (Hill & West, 2020; Tan & Chen, 2022; Zheng et al., 2024). Nevertheless, research in EFL contexts indicates that assessment practices continue to emphasize linguistic accuracy and surface-level error correction at the expense of learner engagement and strategy formation (Milovanovic et al., 2025). Such practices tend to confine students to mechanical revisions, preventing them from developing metacognitive awareness or critical reflection on their learning processes (Sadler et al., 2023; Wolstencroft & de Main, 2021). Scholars have therefore argued for a dialogic model of feedback in which learners actively interpret, question, and internalize evaluative input as part of a collaborative learning process (Latifi et al., 2021; Zarrinabadi & Rezazadeh, 2023). Despite this conceptual progress, the implementation of feedforward principles remains inconsistent in classroom practice, especially in listening and speaking assessment where performance is transient, multifaceted, and difficult to capture. Consequently, there is a growing need for innovative, technology-supported assessment frameworks that systematically integrate feedforward processes and empower learners to become autonomous, reflective agents in their own language development. In sum, although feedforward-oriented assessment offers a theoretically robust framework for promoting reflective and strategic learning, its limited and inconsistent application in EFL listening–speaking contexts underscores the need for innovative, technology-supported approaches that operationalize feedforward principles in practice.

2.3. AI-Enhanced Formative Assessment in Language Learning

AI-enhanced formative assessment has increasingly reshaped language learning by enabling more responsive, individualized, and continuous evaluation processes. Drawing on technologies such as speech recognition and natural language processing, AI systems provide timely feedback on learners' performance and extend assessment opportunities beyond conventional classroom constraints (Owoseni et al., 2024; Zhai & Nehm, 2023; Zheng et al., 2024). Studies have demonstrated that AI-assisted feedback can improve pronunciation, fluency, and

vocabulary acquisition (Biju et al., 2024; Vittorini et al., 2021). Research further indicates that AI applications can enhance learners' academic engagement and emotional experiences in EFL contexts (Guo & Wang, 2025; Zhu et al., 2026), while learners' beliefs about AI-mediated informal digital learning highlight both perceived autonomy gains and concerns regarding guidance and reliability (Wang et al., 2025). Despite these advances, much of the existing literature prioritizes performance outcomes and technological efficiency, offering limited insight into how learners interpret, internalize, and act upon AI-generated feedback to support self-evaluation and feedforward processes Erdiana et al., 2025; (Park & Derakhshan, 2026). Moreover, learners' overreliance on automated feedback has been noted as a concern, as it may weaken critical reflection and reduce teacher–student interaction (Huang et al., 2024). This duality presents a central tension in AI-enhanced assessment: while automation increases accessibility and immediacy, it must coexist with pedagogical scaffolding to maintain meaningful human mediation. Addressing this intersection requires an integrated approach where AI serves not as a replacement for human judgment but as a facilitator of formative dialogue that cultivates self-evaluative competence. Overall, the literature suggests that while AI-enhanced formative assessment offers substantial potential to enrich feedback practices and learner engagement, its effectiveness depends on pedagogically mediated use that supports learners' interpretation, reflection, and feedforward-oriented self-evaluation rather than reliance on automation alone.

2.4. Listening–Speaking Development and Assessment in EFL

Listening and speaking are interactive and cognitively demanding skills that require simultaneous attention to linguistic form, discourse coherence, and pragmatic appropriateness (Harris, 2025; Tran et al., 2024). However, these skills are notoriously difficult to assess formatively, as their dynamic and context-dependent nature challenges traditional testing frameworks (Abdolrezapour & Ghanbari, 2021; Yu et al., 2021). Research on oral assessment has typically centered on pronunciation accuracy and grammatical control, overlooking the communicative and strategic dimensions that underpin successful spoken interaction (Gkomptzia,

2024). Learners often struggle to evaluate their listening and speaking performances due to limited metacognitive awareness and insufficient feedback opportunities (Tran et al., 2024). AI-assisted assessment tools, such as automated speech evaluators and listening analysis systems, have shown promise in bridging these gaps by providing real-time, analytic feedback on fluency, coherence, and prosody (Su & Huang, 2025; Zheng et al., 2024). Yet, these systems still face limitations in capturing pragmatic and discourse-level nuances, underscoring the need for blended assessment approaches that combine AI precision with pedagogical intentionality. The literature therefore calls for further exploration of how AI-enhanced formative assessment can be strategically used to support learners' self-evaluation and feedforward processes in listening-speaking development. In summary, the complexity of listening–speaking assessment in EFL highlights the need for blended formative approaches in which AI-enhanced feedback is pedagogically guided to support learners' self-evaluation and feedforward-oriented development beyond surface-level performance measures.

3. Methodology

3.1. Research Design and the Participants

This study employed a quasi-experimental design within a mixed-methods framework to explore the role of AI-enhanced formative assessment in developing self-evaluation and learning improvement in EFL learners' listening–speaking performance. The mixed-methods design was chosen to provide both empirical evidence of learning outcomes and rich qualitative insights into learners' perceptions, aligning with the research aims of examining both the influence and challenges associated with AI-mediated formative feedback. The quasi-experimental design involved pre- and post-tests to measure changes in learners' performance quantitatively, while semi-structured interviews complemented the results by illuminating the underlying learner experiences and reflective processes. This design was appropriate given the educational setting's constraints, where intact classes could not be randomly assigned, yet sufficient control and comparison could still be maintained to ensure internal validity.

A total of 72 undergraduate students participated in the study. They were purposively selected from two intact classes enrolled in an "English for Communication" course at a private university in West Java. The purposive sampling ensured that participants shared similar instructional backgrounds, learning materials, and language proficiency levels, thereby minimizing extraneous variables. The inclusion criteria required students to (1) be non-English majors enrolled in the second or third semester, (2) have completed at least one previous general English course, and (3) demonstrate intermediate proficiency as verified by institutional placement tests. This selection was crucial to ensure that participants had sufficient foundational skills to engage meaningfully with both listening and speaking activities as well as AI feedback systems. The sample size *(n = 72)* was considered adequate for a quasi-experimental design, as it meets commonly accepted thresholds for detecting medium effect sizes with sufficient statistical power in educational intervention studies, particularly when groups are balanced *(n = 36 per group)*.To mitigate selection bias (Bouncken et al., 2025), the two classes were randomly assigned as experimental and comparison groups after eligibility was confirmed. Both groups received the same instructional content, learning objectives, and total exposure time. The key distinction was that the experimental group received AI-enhanced formative feedback integrated within their speaking and listening tasks, whereas the comparison group relied solely on conventional teacher feedback.

Table 1
Participants' Demographic Information by Group *(n = 72)*

Demographic Variable	Category	Experimental Group *(n = 36)*	Control Group *(n = 36)*	Total *(n = 72)*	Percentage *(%)*
Gender	Male	14	14	28	38.89
	Female	22	22	44	61.11
Age Range	18–19 years	12	13	25	34.72
	20–24 years	16	17	33	45.83
	25+	8	6	14	19.45
Major	Management	10	9	19	26.39
	Accounting	8	9	17	23.61
	Informatics	9	7	16	22.22
	Early Childhood	9	11	20	27.78

Demographic Variable	Category	Experimental Group *(n = 36)*	Control Group *(n = 36)*	Total *(n = 72)*	Percentage *(%)*
Prior English Exposure	Education				
	< 2 years	7	8	15	20.83
	2–4 years	15	16	31	43.06
	> 4 years	14	12	26	36.11
AI Literacy Level *(Self-Reported)*	Low	10	11	21	29.17
	Moderate	19	19	38	52.78
	High	7	6	13	18.05

3.2. Theoretical Framework and the Study Context

The present study draws upon formative assessment theory (Bennett, 2011; Black & Wiliam, 2009), self-regulated learning theory (Zimmerman, 2002), and dialogic feedback models (Hill & West, 2020) to conceptualize how AI-mediated feedback can foster learners' capacity for self-evaluation and feedforward-oriented learning. Within this framework, formative assessment is understood as a continuous learning cycle integrating AI feedback, reflection, and strategic planning. Self-regulated learning provides the psychological basis for understanding how learners internalize AI-generated insights to monitor and adjust performance, while dialogic feedback theory emphasizes feedback as a co-constructed process involving interaction between human and digital agents. The study was conducted at a private university in West Java, Indonesia, selected for its growing emphasis on digital integration and EFL innovation. This institution represents a broader trend in Indonesian higher education toward incorporating technology in language learning, thus providing a suitable context for examining AI-mediated formative assessment. Its student population, comprising diverse non-English majors, reflects the wider demographic of EFL learners in Southeast Asian tertiary settings, enabling the findings to offer transferable implications for similar contexts where AI integration in language assessment remains emergent but increasingly essential.

3.3. Instruments

To ensure methodological rigor and depth, multiple instruments were employed to capture both quantitative and qualitative dimensions of AI-enhanced formative assessment.

1. *Listening and Speaking Performance Tests:* Pre- and post-tests were designed to measure participants' progress in listening comprehension and speaking fluency. The listening test consisted of 20 comprehension items based on authentic materials adapted from English communication contexts, while the speaking test required students to engage in two short dialogues and one monologue task evaluated using a validated rubric adapted from the Common European Framework of Reference (CEFR) B1–B2 descriptors. The rubric assessed fluency, accuracy, coherence, vocabulary range, and pronunciation. Inter-rater reliability procedures were applied to both the listening and speaking tests, with two EFL experts independently scoring participants' performances. The analysis yielded a Cohen's kappa coefficient of 0.89, indicating strong agreement across both assessment components.

2. *Closed-Ended Questionnaire:* The questionnaire, adapted from Abdolrezapour and Ghanbari (2021) and Harris (2025), consisted of a 20 five-point Likert scale items distributed across four constructs: (a) learners' engagement with AI feedback, (b) self-evaluation and reflection, (c) perception of feedforward guidance, and (d) challenges in interpreting AI-mediated comments. Embedded within this instrument were items derived from AI-generated formative feedback logs, which captured learners' interactions with the system (e.g., number of feedback requests, types of revisions, and response times). The instrument underwent expert validation by three specialists in applied linguistics and educational technology to ensure construct validity and relevance. A pilot test with 15 students from a comparable cohort resulted in a Cronbach's alpha of 0.91, demonstrating high internal consistency.

3. *Semi-Structured Interviews:* To complement the quantitative findings, semi-structured interviews were conducted with 6 purposively selected participants representing varying proficiency levels and degrees of AI engagement. The interview protocol explored learners' perceptions, difficulties, and adaptive

strategies when interpreting and applying AI feedback. To mitigate bias, interview questions were peer-reviewed by two experienced qualitative researchers to ensure neutrality and clarity (Braun & Clarke, 2025). Based on the experts' feedback, several questions were refined in terms of wording, sequencing, and prompts to enhance comprehensibility and encourage more reflective responses, while the core focus of the protocol was retained. All interviews were conducted in a supportive and non-evaluative manner, audio-recorded with participants' informed consent, and transcribed verbatim for analysis. The transcribed data were coded inductively to identify recurring patterns and themes across participants' responses. To strengthen interpretive validity, methodological triangulation was employed by systematically comparing interview findings with data from the questionnaire and listening–speaking performance tests, thereby ensuring consistency and depth in the qualitative interpretation.

3.4. Data Collection Procedures

Data collection was conducted over a six-week instructional cycle, integrating AI-enhanced formative assessment into regular classroom activities. The procedures followed a systematic sequence designed to capture the influence of AI-mediated feedback on learners' self-evaluation and learning improvement in listening–speaking development. The intervention was implemented through the "English for Communication" course, emphasizing communicative competence and strategic language use. The AI platform selected for this study provided automated feedback on pronunciation, fluency, lexical range, and discourse coherence, while also recording learner interactions in a feedback log for later analysis.

Prior to the intervention, all participants completed a pre-test assessing their listening and speaking performance to establish baseline proficiency levels. The experimental group was introduced to the AI-enhanced formative assessment model, where they received orientation on how to access, interpret, and apply AI feedback in their practice tasks. The comparison group received conventional formative assessment, relying on teacher-led comments and peer feedback. Both groups were taught identical materials and topics, ensuring instructional

consistency and validity of comparison.

The implementation scenario of the AI-enhanced formative assessment was structured around six weekly modules, each focusing on a specific communicative objective aligned with the course syllabus. Each week combined input, practice, feedback, and reflection phases, supported by both teacher scaffolding and AI-generated feedback.

Table 2
Weekly Implementation of AI-Enhanced Formative Assessment

Week	Topic & Learning Objectives	Materials & Tasks	AI-Enhanced Formative Assessment Activities	Learner Reflection & Feedforward Actions
1	Introducing Yourself and Building Rapport – Develop basic self-introduction fluency and coherence.	Recorded dialogues, model introductions, listening excerpts of real interactions.	AI analyzed speech samples for pronunciation and fluency; learners received instant feedback on word stress and pacing.	Learners reviewed AI feedback logs, set weekly speaking goals, and shared reflections via journal entries.
2	Exchanging Personal Information and Asking Questions – Improve accuracy in forming and responding to questions.	Listening comprehension exercises; pair dialogues.	AI identified question formation errors and intonation patterns; learners practiced corrections using AI suggestions.	Learners evaluated changes between original and revised recordings using the feedback dashboard.
3	Describing Daily Routines – Enhance lexical variety and grammatical control.	Authentic monologues, interactive video tasks.	AI provided lexical frequency analysis and error tagging; learners adjusted word choice and sentence structure.	Students completed a mini self-assessment checklist comparing AI results with peer comments.
4	Expressing Opinions on Familiar Topics – Develop argumentation and discourse	Audio discussions, TED-Ed listening materials.	AI highlighted discourse markers, coherence, and hesitations; learners received segment-specific feedback.	Learners summarized AI feedback to plan improvements for the next speaking task.

Week	Topic & Learning Objectives	Materials & Tasks	AI-Enhanced Formative Assessment Activities	Learner Reflection & Feedforward Actions
	organization.			
5	Making Requests and Giving Suggestions – Strengthen pragmatic and politeness strategies.	Audio role-plays and situational dialogues.	AI analyzed modality and tone appropriateness; feedback focused on politeness formula and speech acts.	Learners reflected on pragmatic awareness and logged personal progress in the AI system.
6	Giving Short Presentations – Integrate all skills with improved confidence and delivery.	Presentation scripts, multimedia support.	AI generated comprehensive feedback on fluency, intonation, and lexical density; learners reviewed comparative analytics with previous weeks.	Final reflective essay and peer discussion on AI feedback usefulness and learning progress.

At the end of the sixth week, all participants completed post-tests to measure improvement in listening and speaking performance. The closed-ended questionnaire incorporating AI-generated feedback log items was then administered to both groups to collect data on learners' engagement with formative assessment, self-evaluation, and perceptions of feedback utility. Finally, semi-structured interviews were conducted with 6 representative participants to gain deeper insight into their interpretive processes, challenges, and adaptive strategies when using AI feedback. The interviews were conducted in a quiet environment, recorded for accuracy, and transcribed for thematic analysis.

3.5. Data Analysis

Data were examined using a convergent mixed-methods strategy to combine quantitative and qualitative insights. Pre- and post-test results were evaluated through both descriptive and inferential techniques, including calculation of mean scores and standard deviations to assess learners' listening and speaking performance. Paired-sample t-tests determined within-group changes, and independent-sample t-tests compared improvements across the experimental and

control groups. Questionnaire data were summarized descriptively, with factor analysis applied to confirm the validity of the underlying constructs, and correlation analyses explored the association between learners' interaction with AI feedback and their self-evaluation practices.

Qualitative data from the semi-structured interviews were analyzed thematically using Braun and Clarke (2006) six-step framework. First, the researchers familiarized themselves with the data by repeatedly reading the interview transcripts to gain an overall understanding of participants' responses. Second, initial codes were generated inductively by systematically identifying meaningful segments related to learners' interpretation of AI feedback, challenges in implementing feedforward strategies, and changes in metacognitive awareness. Third, the coded data were examined to search for potential themes by grouping conceptually related codes. Fourth, these preliminary themes were reviewed and refined by checking their coherence within and across transcripts. Fifth, the finalized themes were clearly defined and named to capture their core meanings and relationships. Finally, the themes were organized and synthesized to produce an analytic narrative that addressed the research objectives. Throughout the analysis, triangulation was achieved by cross-referencing qualitative themes with quantitative findings and AI feedback logs to enhance analytical credibility. To minimize researcher bias, two independent coders conducted the analysis, and any discrepancies were resolved through consensus discussions.

3.6. Ethical Considerations

This study adhered to ethical principles of respect, integrity, and confidentiality. Approval was granted by the Institutional Review Board of Sekolah Tinggi Agama Islam Putra Galuh Ciamis (IRB No. 5.6.7/STAI-PG.3/JS/2025). Participation was voluntary, with informed consent obtained after explaining the study's aims, procedures, and the right to withdraw without academic penalty. Personal data were anonymized and stored securely in password-protected folders accessible only to the research team. Feedback content was reviewed to avoid evaluative or emotionally charged language, and participants were reassured that interviews

would not affect course grades. Reflexivity protocols were maintained, documenting researchers' positionality and reflections to minimize bias. These measures ensured participant welfare, methodological transparency, and the credibility of findings in AI-enhanced formative assessment research.

4. Results

4.1. Effects of AI-Enhanced Formative Assessment on EFL Learners' Self-Evaluation in Listening–Speaking Development

To explore how AI-enhanced formative assessment influenced EFL learners' self-evaluation in listening–speaking development, pre- and post-test data were analyzed in depth for both listening comprehension and speaking fluency. The analysis aimed not only to identify overall performance gains but also to examine improvements across specific subskills, providing insight into which aspects of listening and speaking were most affected by the AI-mediated feedback.

Table 3

Pre- and Post-Test Scores for Listening Comprehension and Speaking Fluency (Experimental Group, n = 36)

Subskill	Pre-Test Mean *(SD)*	Post-Test Mean *(SD)*	Mean Difference	*t*-value	*p*-value	Cohen's *d*
Main Idea Identification	63.50 (8.12)	81.75 (6.38)	18.25	13.10	<0.001	2.28
Supporting Details Recognition	61.44 (7.95)	78.33 (6.49)	16.89	12.34	<0.001	2.11
Inference and Predictive Comprehension	62.47 (7.62)	76.69 (7.03)	14.22	10.47	<0.001	1.83
Listening for Discourse Cohesion	62.98 (7.41)	79.12 (6.17)	16.14	11.92	<0.001	2.09

The results indicate that AI-enhanced formative assessment substantially improved learners' listening comprehension across all subskills. Main idea identification showed the largest gain of 18.25 points with a very large effect size (Cohen's $d = 2.28$), suggesting that AI feedback on highlighting central concepts,

intonation cues, and repetition strategies effectively guided learners' focus. Supporting details recognition also improved significantly (16.89 points; Cohen's $d = 2.11$), reflecting the learners' enhanced ability to attend to specific information within longer audio texts. Inference and predictive comprehension increased by 14.22 points, indicating that learners were able to use AI prompts to anticipate content and make educated guesses, while listening for discourse cohesion improved by 16.14 points, demonstrating growth in understanding connected speech, discourse markers, and logical sequencing. The combination of immediate corrective feedback, highlighted examples, and targeted suggestions in the AI platform contributed to these gains.

Table 4

Pre- and Post-Test Scores for Speaking Fluency Subskills (Experimental Group, n = 36)

Subskill	Pre-Test Mean *(SD)*	Post-Test Mean *(SD)*	Mean Difference	*t*-value	*p*-value	Cohen's *d*
Pronunciation Accuracy	59.44 (8.21)	74.88 (7.12)	15.44	11.72	<0.001	1.95
Fluency and Pace	57.36 (7.88)	73.22 (6.95)	15.86	12.08	<0.001	2.01
Lexical and Grammatical Range	58.11 (8.05)	72.97 (7.18)	14.86	11.10	<0.001	1.87
Discourse Organization & Cohesion	56.89 (7.92)	73.14 (7.03)	16.25	12.36	<0.001	2.05

The speaking fluency analysis highlights notable improvements in multiple subskills following AI-mediated feedback. Pronunciation accuracy increased by 15.44 points with a large effect size (Cohen's $d = 1.95$), indicating that targeted AI feedback on stress, intonation, and segmental articulation significantly enhanced learners' phonological competence. Fluency and pace improved by 15.86 points (Cohen's $d = 2.01$), reflecting learners' ability to speak more smoothly, reduce hesitation, and regulate speech tempo after repeated AI-guided practice. Lexical and grammatical range grew by 14.86 points, demonstrating the effectiveness of AI suggestions in enriching vocabulary choice and syntactic variety. Finally, discourse organization and cohesion increased by 16.25 points (Cohen's $d = 2.05$), suggesting

that learners were able to integrate cohesive devices, logical sequencing, and clear thematic progression in their spoken responses.

Collectively, the findings indicate that AI-enhanced formative assessment significantly strengthens learners' listening and speaking subskills by providing real-time, personalized, and actionable feedback. This process fosters active self-monitoring, critical reflection, and effective feedforward application, leading to more consistent and meaningful self-evaluation. The integration of AI feedback logs with reflective activities enabled learners to track progress systematically and address weaknesses in specific subskills such as pronunciation, fluency, and comprehension. Continuous, subskill-focused guidance heightened learners' metacognitive awareness and strategic learning behaviors. The large effect sizes across all measured dimensions highlight the substantial pedagogical value of AI-mediated assessment in advancing EFL listening–speaking development.

4.2. EFL Learners' Challenges in Interpreting and Applying AI-Mediated Feedforward Feedback for Listening–Speaking Improvement

To address RQ2, the study examined learners' experiences and challenges in interpreting and applying AI-mediated feedforward feedback for their listening–speaking improvement by analyzing data from both the closed-ended questionnaire and semi-structured interviews. The questionnaire consisted of 20 items grouped into four constructs: (a) learners' engagement with AI feedback, (b) self-evaluation and reflection, (c) perception of feedforward guidance, and (d) challenges in interpreting AI-mediated comments, using a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). Complementing this quantitative data, interviews with 6 representative participants provided deeper insights into learners' perceptions, difficulties, and adaptive strategies when responding to AI-generated formative feedback.

Table 6

Questionnaire Results for Learners' Engagement with AI Feedback (n = 36)

No	Item	SD *n (%)*	D *n (%)*	N *n (%)*	A *n (%)*	SA *n (%)*	Mean	Std. Dev
1	I check AI feedback immediately after task completion	0 (0,00)	2 (5,56)	1 (2,78)	22 (61,11)	11 (30,56)	4,22	0,71
2	I read AI feedback thoroughly for every task	1 (2,78)	3 (8,33)	2 (5,56)	19 (52,78)	11 (30,56)	4,08	0,84
3	I follow AI suggestions during my revisions	0 (0,00)	2 (5,56)	3 (8,33)	21 (58,33)	10 (27,78)	4,03	0,74
4	I spend extra time understanding AI feedback	1 (2,78)	5 (13,89)	3 (8,33)	17 (47,22)	10 (27,78)	3,83	0,94
5	I frequently review AI feedback logs	0 (0,00)	4 (11,11)	2 (5,56)	18 (50,00)	12 (33,33)	4,06	0,83

The results reveal that learners demonstrated consistent engagement with AI-generated feedback, with mean scores ranging from 3.83 to 4.22. A substantial majority (91.67%) reported checking AI feedback promptly after completing tasks *(M = 4.22, SD = 0.71)*, and 83.34% indicated reading the feedback thoroughly *(M = 4.08, SD = 0.84)*. Similarly, most participants (86.11%) stated they applied AI suggestions during revisions *(M = 4.03, SD = 0.74)*, suggesting that AI feedback was perceived as actionable and relevant to improving performance. Meanwhile, the item on spending extra time to interpret feedback obtained the lowest mean *(M = 3.83, SD = 0.94)*, indicating that deeper cognitive engagement with complex or lengthy feedback required more effort. Reviewing feedback logs *(M = 4.06, SD = 0.83)* also showed strong engagement, although with moderate variability, implying differences in learners' persistence and feedback literacy when revisiting AI input for self-improvement.

Table 7

Questionnaire Results for Self-Evaluation and Reflection (n = 36)

No	Item	SD *n (%)*	D *n (%)*	N *n (%)*	A *n (%)*	SA *n (%)*	Mean	Std. Dev
6	I identify my mistakes using AI feedback	0 (0,00)	3 (8,33)	2 (5,56)	20 (55,56)	11 (30,56)	4,08	0,79
7	I compare AI feedback	1	2	4	18	11	4,00	0,87

No	Item	SD *n (%)*	D *n (%)*	N *n (%)*	A *n (%)*	SA *n (%)*	Mean	Std. Dev
	with my own evaluation	(2,78)	(5,56)	(11,11)	(50,00)	(30,56)		
8	I reflect on my progress after using AI feedback	0 (0,00)	3 (8,33)	3 (8,33)	19 (52,78)	11 (30,56)	4,03	0,81
9	I set learning goals based on AI feedback	0 (0,00)	4 (11,11)	2 (5,56)	20 (55,56)	10 (27,78)	4,00	0,80
10	I adjust my strategies according to AI feedback	0 (0,00)	5 (13,89)	3 (8,33)	18 (50,00)	10 (27,78)	3,94	0,87

The results indicate that learners demonstrated a generally strong capacity for self-evaluation and reflection when supported by AI feedback, with mean scores ranging from 3.94 to 4.08. Most participants (86.12%) reported identifying their mistakes effectively *(M = 4.08, SD = 0.79)*, and a similar proportion (83.34%) reflected on their progress after receiving AI input *(M = 4.03, SD = 0.81)*. Learners also compared AI evaluations with their own judgments *(M = 4.00, SD = 0.87)*, suggesting emerging self-monitoring awareness and critical reflection. However, slightly lower means for goal setting *(M = 4.00, SD = 0.80)* and strategy adjustment *(M = 3.94, SD = 0.87)* indicate that while learners could recognize performance gaps, transforming feedback into structured, long-term improvement plans remained challenging. Moderate variability across items reflects individual differences in reflective depth, with some students showing difficulty translating AI insights into concrete learning strategies or sustained self-regulatory actions.

Table 8

Questionnaire Results for Perception of Feedforward Guidance (n = 36)

No	Item	SD *n (%)*	D *n (%)*	N *n (%)*	A *n (%)*	SA *n (%)*	Mean	Std. Dev
11	I understand how AI feedback helps my next tasks	0 (0,00)	3 (8,33)	3 (8,33)	19 (52,78)	11 (30,56)	4,03	0,83
12	I use AI suggestions to improve future performance	0 (0,00)	2 (5,56)	4 (11,11)	20 (55,56)	10 (27,78)	4,03	0,79
13	I plan my practice tasks based on AI feedback	1 (2,78)	4 (11,11)	3 (8,33)	18 (50,00)	10 (27,78)	3,92	0,89
14	I monitor my improvements after	0 (0,00)	3 (8,33)	5 (13,89)	19 (52,78)	9 (25,00)	3,81	0,87

No	Item	SD *n (%)*	D *n (%)*	N *n (%)*	A *n (%)*	SA *n (%)*	Mean	Std. Dev
	implementing AI suggestions							
15	I feel AI feedback guides me to focus on key areas	0 (0,00)	4 (11,11)	2 (5,56)	20 (55,56)	10 (27,78)	4,00	0,82

The results indicate that learners perceived AI-mediated feedforward guidance as a constructive tool for directing their future learning efforts, with mean scores ranging from 3.81 to 4.03. Most participants (83.34%) acknowledged that AI feedback clarified how to improve subsequent tasks *(M = 4.03, SD = 0.83)* and supported their use of feedback to enhance later performance *(M = 4.03, SD = 0.79)*. Similarly, over three-quarters of learners (77.78%) reported that AI input helped them focus on key areas requiring improvement *(M = 4.00, SD = 0.82)*. However, slightly lower scores were observed for planning practice tasks *(M = 3.92, SD = 0.89)* and monitoring progress after applying AI suggestions *(M = 3.81, SD = 0.87)*, suggesting that sustained, autonomous application of feedforward strategies remained inconsistent. Moderate variability across responses implies differing levels of learner readiness and self-regulatory capacity in translating AI feedback into ongoing, strategic learning behaviors.

Table 9

Questionnaire Results for Challenges in Interpreting AI-Mediated Comments (n = 36)

No	Item	SD *n (%)*	D *n (%)*	N *n (%)*	A *n (%)*	SA *n (%)*	Mean	Std. Dev
16	I find AI terminology difficult to understand	3 (8,33)	6 (16,67)	7 (19,44)	12 (33,33)	8 (22,22)	3,61	1,11
17	I sometimes misinterpret AI suggestions	2 (5,56)	5 (13,89)	6 (16,67)	15 (41,67)	8 (22,22)	3,72	1,01
18	I feel uncertain applying AI recommendations	1 (2,78)	7 (19,44)	5 (13,89)	14 (38,89)	9 (25,00)	3,72	1,02
19	I need additional teacher guidance to understand AI feedback	0 (0,00)	5 (13,89)	4 (11,11)	16 (44,44)	11 (30,56)	4,03	0,90
20	I find some AI comments unclear or vague	2 (5,56)	6 (16,67)	5 (13,89)	15 (41,67)	8 (22,22)	3,67	0,97

The results demonstrate that while learners generally benefited from AI-mediated comments, they also encountered notable interpretive challenges, with mean scores ranging from 3.61 to 4.03. A considerable proportion (55.55%) reported difficulty understanding AI terminology *(M = 3.61, SD = 1.11)*, and 63.89% admitted to occasionally misinterpreting AI suggestions *(M = 3.72, SD = 1.01)*. Similarly, 63.89% indicated uncertainty when applying AI recommendations *(M = 3.72, SD = 1.02)*, reflecting limited confidence in independently transferring automated insights into actionable strategies. The highest agreement (74.99%) was recorded for the need for additional teacher guidance *(M = 4.03, SD = 0.90)*, underscoring that AI feedback alone was insufficient for deep comprehension. Furthermore, 63.89% perceived some AI comments as vague *(M = 3.67, SD = 0.97)*. The relatively high standard deviations across items suggest that learners' interpretive competence varied considerably, influenced by differences in digital familiarity, linguistic proficiency, and reflective ability in managing AI-driven input.

Overall, the questionnaire results reveal that learners interacted actively with AI feedback, showing increased awareness of how automated input could support ongoing self-evaluation and feedforward-oriented learning. They demonstrated consistent engagement and reflection across listening–speaking tasks, yet many experienced uncertainty in interpreting technical terms and applying AI suggestions independently. The frequent call for teacher guidance highlights that while AI can promote reflective autonomy, its pedagogical effectiveness depends on human mediation to contextualize feedback and clarify meaning. These findings suggest that meaningful integration of AI-enhanced formative assessment requires a structured feedback literacy framework that bridges algorithmic precision with learners' cognitive and metacognitive development.

4.2.1. Interview results

To complement the questionnaire data and provide a deeper understanding of learners' experiences, semi-structured interviews were conducted with six representative participants (P1–P6). The interviews aimed to explore learners' perceptions of AI-mediated feedback, the challenges they faced in applying feedforward suggestions, and the shifts in their metacognitive awareness during

listening and speaking tasks. The data were analyzed thematically, focusing on recurring patterns that revealed both facilitators and obstacles in learners' engagement with AI feedback. Each theme includes illustrative quotes to provide nuanced insight into learners' experiences and reflective processes.

a. Theme 1: Interpretation of AI Feedback

This theme addresses how learners understood and processed AI-generated comments for their listening and speaking tasks. The guiding question was: *How do you interpret the AI feedback provided for your listening and speaking tasks?*

Table 10

Interview Results on Interpretation of AI Feedback

Code	Description	Participant Quotes
Clarity and Specificity	Feedback that clearly highlighted errors and suggested improvements	**P1:** *"I can tell which words I said wrong and fix them immediately."* **P4:** *"Some comments directly point out stress and intonation mistakes, which helps me a lot."*
Ambiguity and Confusion	Feedback that was difficult to understand due to technical terms or vague explanations	**P3:** *"I get confused when the AI says 'your discourse cohesion needs work'."* **P6:** *"Sometimes I do not know what the AI means by certain comments, so I ignore them."*
Prompting Self-Reflection	Feedback encouraging learners to think critically about their own performance	**P2:** *"The AI makes me notice patterns in my mistakes I didn't see before."* **P5:** *"I try to reflect why I hesitated in some parts after reading the feedback."*

The interview results on the "Interpretation of AI Feedback" dimension reveal that learners' understanding and utilization of AI feedback were strongly influenced by the degree of clarity and linguistic accessibility of the comments. Participants such as P1 and P4 emphasized that explicit feedback on pronunciation errors, stress, and intonation allowed them to make immediate corrections and build greater awareness of their spoken accuracy. In contrast, participants like P3 and P6 indicated that vague or technical phrases such as "discourse cohesion" generated confusion, leading to disengagement or selective attention to more comprehensible feedback. Learners like P2 and P5 highlighted that reflective prompts within the AI system encouraged them to analyze recurring patterns and explore underlying causes of hesitation or mispronunciation. However, when feedback lacked concrete

examples or contextual explanation, self-evaluation became fragmented. These insights underscore that effective AI-mediated assessment relies on transparent language, contextualized guidance, and ongoing teacher facilitation to sustain interpretive depth and metacognitive engagement.

b. Theme 2: Challenges in Feedforward Implementation

This theme explored learners' experiences in applying AI feedback to subsequent tasks. The guiding question was: *What difficulties do you experience when applying AI feedback to improve your next listening or speaking task?*

Table 11
Interview Results on Challenges in Feedforward Implementation

Code	Description	Participant Quotes
Difficulty Prioritizing Feedback	Learners struggled to decide which feedback to address first	**P1:** *"The AI highlights so many errors that I don't know where to start."* **P5:** *"I try to remember everything, but some mistakes slip through when I speak."*
Cognitive Load	Applying multiple feedback points simultaneously was overwhelming	**P3:** *"I feel stressed when the AI shows corrections in pronunciation and vocabulary at the same time."* **P6:** *"Sometimes I freeze because I try to apply all suggestions in one go."*
Adaptive Strategies	Learners developed methods to manage feedback effectively	**P2:** *"I focus on one type of error per practice session."* **P4:** *"I record myself again to see if I improved based on the AI feedback from the last session."*

The interview results on "Challenges in Feedforward Implementation" demonstrate that while learners acknowledged the usefulness of AI-generated guidance, they experienced considerable difficulty in determining how to apply it effectively during subsequent tasks. Participants such as P1 and P5 noted being overwhelmed by the quantity of feedback provided, describing uncertainty about which aspects to prioritize, especially when multiple linguistic elements required simultaneous attention. P3 and P6 reported mental fatigue and hesitation when attempting to integrate several feedback points at once, illustrating how cognitive overload can hinder fluency and spontaneous speech production. Nonetheless, some participants, including P2 and P4, displayed proactive approaches by narrowing their focus to one error type or using self-recordings to monitor incremental improvement. These responses indicate that while AI feedforward fosters

awareness of performance gaps, learners' ability to transform suggestions into practice depends on their strategic regulation and the presence of structured support to manage feedback complexity effectively.

c. Theme 3: Shifts in Metacognitive Awareness

This theme investigated how using AI feedback influenced learners' awareness of their own learning processes. The guiding question was: *How does using AI feedback affect your ability to reflect on your learning and plan improvements?*

Table 12
Interview Results on Shifts in Metacognitive Awareness

Code	Description	Participant Quotes
Enhanced Error Awareness	Learners recognized recurring mistakes and patterns	**P2:** *"I now notice my hesitation patterns before I even start speaking."* **P3:** *"I can identify which types of words I usually mispronounce."*
Strategic Planning	Learners applied feedback to plan targeted improvements	**P1:** *"I make a small list of words and sentences to practice each day based on AI comments."* **P6:** *"I decide which aspects of fluency to focus on for each task."*
Reflective Monitoring	Learners tracked progress and adjusted strategies	**P4:** *"I compare my recordings to see if I really improved."* **P5:** *"I think about why I make certain errors and test different ways to correct them."*

The interview findings on "Shifts in Metacognitive Awareness" reveal that learners increasingly engaged in conscious monitoring and regulation of their listening–speaking development as a result of AI feedback integration. Participants such as P2 and P3 reported heightened awareness of recurring pronunciation and hesitation patterns, indicating that AI prompts enabled them to detect linguistic weaknesses with greater precision. P1 and P6 demonstrated deliberate planning behaviors, including the creation of individualized practice lists and prioritization of fluency goals for each session, reflecting a shift toward structured self-regulation. Similarly, P4 and P5 emphasized reflective monitoring, comparing their recordings across sessions and experimenting with corrective strategies to ensure tangible progress. Despite these gains, some learners initially depended heavily on AI cues

before developing autonomous reflective habits. Overall, the results suggest that AI-enhanced assessment not only guided learners toward recognizing their linguistic limitations but also nurtured more strategic, intentional, and self-regulated learning behaviors over time.

Overall, the interview findings offer an in-depth understanding of how learners engage with AI-mediated formative assessment in developing listening–speaking proficiency. Learners benefited from enhanced error recognition, reflective monitoring, and strategic planning, indicating the potential of AI feedback to cultivate deeper self-regulation. However, difficulties in interpreting complex feedback, managing simultaneous correction demands, and determining priorities revealed the cognitive demands of autonomous application. These experiences underscore the need for pedagogical scaffolding that complements AI feedback, enabling learners to transform automated input into meaningful, context-sensitive learning actions. Integrating teacher mediation with AI tools emerges as essential for sustaining reflective and independent learning growth.

To confirm, the findings from RQ1 and RQ2 demonstrate that AI-enhanced formative assessment substantially supported learners' self-evaluation and listening–speaking development while highlighting areas needing additional guidance. Interaction with AI feedback encouraged systematic error monitoring, targeted practice, and reflection, resulting in improvements in listening comprehension subskills and speaking fluency, including pronunciation, lexical range, and discourse cohesion. At the same time, learners faced difficulties interpreting ambiguous comments, prioritizing multiple feedback points, and managing cognitive load, which sometimes limited immediate application. These results indicate that AI feedback effectively fosters self-regulated learning, particularly when combined with instructional scaffolding and structured feedforward strategies. Future research should investigate adaptive feedback interfaces, incremental scaffolding methods, and longitudinal impacts on metacognitive and autonomous learning in diverse EFL settings.

5. Discussion

This study demonstrates that AI-enhanced formative assessment substantially supports EFL learners' self-evaluation and listening–speaking skills by providing immediate, structured, and actionable feedback aligned with self-regulated learning and feedforward principles. Learners used AI feedback to identify errors in pronunciation, vocabulary, fluency, and discourse organization while reflecting on their learning strategies. These findings align with previous research highlighting the importance of formative feedback in fostering learners' monitoring and reflective practices (Chen et al., 2021; Serván, 2023), yet the present study extends these insights by demonstrating how AI-mediated feedback can operationalize these processes systematically across multiple subskills in listening and speaking. Unlike traditional feedback mechanisms that are often delayed or generic, AI feedback in this study provided personalized guidance in real time, facilitating learners' immediate application of corrective strategies and fostering a more proactive stance toward skill improvement, which aligns with claims regarding the potential of intelligent tutoring systems to promote adaptive learning behaviors (Gardner et al., 2021; Villarino, 2025; Zheng et al., 2024).

The study further illustrates that AI-enhanced formative assessment contributes to heightened metacognitive awareness by supporting learners across multiple stages of metacognitive monitoring. At the initial monitoring stage, AI-generated feedback enabled learners to systematically identify recurring errors in pronunciation, fluency, and comprehension, thereby increasing their awareness of performance discrepancies in real time. During the evaluative stage, learners used analytic indicators and explanatory prompts to compare their current performance against task expectations, which helped them prioritize specific learning goals rather than attending to feedback in a fragmented manner. At the regulatory stage, the iterative and immediate nature of AI-mediated feedback encouraged learners to plan and implement targeted strategies, such as adjusting speech rate, refining lexical choices, or revisiting listening segments for focused practice. These process-oriented functions align with theoretical perspectives that conceptualize formative feedback as a mechanism for activating higher-order cognitive processes essential for self-regulated learning, including monitoring, evaluation, and strategic control

(Owoseni et al., 2024; Zhai & Nehm, 2023). Importantly, the AI-mediated feedback in this study extended beyond corrective information by offering reflective prompts that explicitly invited learners to anticipate potential challenges and adapt subsequent learning actions, thereby operationalizing a feedforward orientation. This structured integration of AI-supported metacognitive scaffolding addresses a critical gap in prior research, which has largely emphasized teacher- or peer-provided feedback without systematically examining how AI tools can mediate self-regulatory processes within EFL listening–speaking development (Abdolrezapour & Ghanbari, 2021; Tran et al., 2024).

Despite the overall effectiveness of AI-mediated formative assessment, the findings also reveal nuanced challenges that learners encountered when interpreting and applying feedback. Ambiguity in AI comments, cognitive overload, and difficulties prioritizing multiple corrective suggestions indicate that learners' self-evaluation processes are influenced not only by the presence of feedback but also by their ability to decode, internalize, and operationalize it effectively. These challenges align with earlier concerns in feedback research regarding the limitations of automated systems when learners lack sufficient scaffolding or prior experience with technology-mediated assessment (Hill & West, 2020; Latifi et al., 2021). By documenting the specific obstacles learners face in feedforward implementation, the study provides a more nuanced understanding of how AI feedback interacts with learners' cognitive and metacognitive capacities. This insight extends the discourse on formative assessment by highlighting the necessity of adaptive interfaces, clear explanatory frameworks, and instructional scaffolding to enhance the interpretability and usability of AI-generated guidance, which remains underexplored in prior EFL research (Milovanovic et al., 2025; Rodríguez et al., 2022).

The integration of AI feedback with structured reflection and task planning underscores the complementary role of technology and human agency in learning. While AI provides consistent, immediate, and individualized guidance, learners' strategic engagement, goal-setting, and iterative application of feedback are crucial to realizing its full potential. This synthesis resonates with studies that advocate for a balanced interplay between automated feedback and pedagogical support to optimize learning outcomes (Cooper, 2023; Tang & Cooper, 2025; Zheng et al.,

2024). By operationalizing self-evaluation through AI-enhanced tasks, this study contributes to expanding the conceptualization of formative assessment beyond assessment-for-learning to assessment-as-learning, wherein learners actively interpret, internalize, and act upon feedback to improve performance (Fathi & Rahimi, 2024; Owan et al., 2023). Additionally, the study emphasizes the multidimensionality of listening and speaking development, suggesting that targeted AI feedback can simultaneously address pronunciation, fluency, lexical range, and discourse cohesion, thereby supporting holistic skill enhancement in ways that traditional approaches often fail to achieve.

The findings also illuminate pathways for future research and practical applications. Enhancing the clarity of AI feedback, designing scaffolded interfaces, and integrating progressive difficulty levels in tasks could further mitigate learners' cognitive load and improve feedforward application. Longitudinal studies investigating the sustained impact of AI-mediated formative assessment on metacognitive skill development, autonomous learning behaviors, and transferability across contexts could deepen the understanding of how technology can support lifelong learning competencies in EFL settings. Furthermore, exploring learners' individual differences in digital literacy, self-regulation, and prior language proficiency may provide insights into optimizing AI feedback to meet diverse learner needs. Overall, this study demonstrates that AI-enhanced formative assessment represents a promising avenue for fostering self-evaluation, metacognitive growth, and effective listening–speaking development, while simultaneously identifying critical considerations for its pedagogical implementation and further scholarly inquiry.

6. Conclusion

The present study demonstrates that AI-enhanced formative assessment plays a pivotal role in fostering EFL learners' self-evaluation and listening–speaking development by providing immediate, actionable, and individualized feedback that supports reflection, error identification, and strategic planning. Learners actively engaged with AI feedback to monitor performance, prioritize learning goals, and

adjust strategies, which facilitated measurable improvements in pronunciation, fluency, lexical range, and discourse cohesion. At the same time, challenges emerged related to interpreting ambiguous comments, managing cognitive load, and applying multiple feedback points simultaneously, highlighting the need for scaffolded guidance and structured support to optimize the feedforward potential of AI-mediated feedback. These findings carry important pedagogical and theoretical implications. Pedagogically, they underscore the value of integrating AI-enhanced formative assessment as a complement to teacher facilitation, particularly through the design of transparent and interpretable feedback interfaces and the systematic incorporation of reflective activities that foster metacognitive awareness and self-regulated learning. Theoretically, the study extends formative assessment theory by demonstrating how feedback can be operationalized as feedforward through AI-mediated scaffolding that activates core SRL processes, including self-monitoring, self-evaluation, and strategic regulation. By situating AI feedback within an SRL framework, the findings provide empirical support for conceptualizing formative assessment as an iterative, learner-driven process rather than a unidirectional transmission of corrective information. Nonetheless, the study is limited by its relatively small sample size, the short intervention period, and its focus on a single institutional context, which may constrain the generalizability of the results. Future research should therefore examine longitudinal and cross-contextual implementations, investigate adaptive and explainable AI feedback designs, and include more diverse learner populations to further clarify the role of AI-enhanced formative assessment in supporting sustained listening–speaking development, learner autonomy, and strategic engagement across varied EFL settings.

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Declaration of Interest Statement

The authors declare no competing financial or personal interests related to this study.

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