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# Evaluating the Efficacy of Explainable Artificial Intelligence Frameworks in Supporting ESL Learners within Tertiary Education

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***Abstract:*** This research assesses how XAI supports ESL learners at the tertiary education level. With the growing use of AI in language learning, many systems are "black boxes" and provide little transparency in the feedback generated. This opacity limits learners' understanding, trust, and effective use of feedback, especially in academic situations for which ESL learners need more support. This research explores XAI's role in improving comprehension, engagement, and autonomy in AI-enhanced environments. A mixed-methods approach was taken with ESL students at a higher education institution. Data was collected from language performance tasks, structured questionnaires and semi-structured interviews to capture as much of the quantitative and qualitative data as possible. The XAI framework in the research provided interpretable feedback which provided learners with a clearer understanding of the rationale of the corrections and suggestions. Learners using XAI systems achieved better language performance, feedback interpretation and engagement than learners using conventional AI systems. Increased trust and confidence in the learning process were reported by participants. This emphasizes, in educational technology, the value of Explainable AI. This research illustrates the importance of incorporating explainability into AI language learning systems, and adds to the emerging research in the AI and ESL education space. It advocates for the use of explainable AI in higher education as a means to promote more effective learner-centric approaches.

***Key Words:*** explainable artificial intelligence (xai), english as a second language (esl), tertiary education, artificial intelligence in education (aied), language learning, technologies, learner autonomy, educational technology

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## Introduction

In recent years, as part of a wider global trend, different industries have started experimenting with Artificial Intelligence (AI) and its capabilities, particularly in relation to how education is structured and how different processes of teaching and learning are carried out. AI is now being integrated into different facets of language teaching, including as a tool for language assessment, for providing feedback, and for the development of individualized learning pathways. Current research has identified the positive impacts of AI in relation to the assessment of English as a second language (ESL) and language teaching in a scalable manner, particularly in higher education contexts where there is a large degree of learner heterogeneity (Abedi et al., 2025). Moreover, the use of chatbots and automated assessment systems has

shown positive outcomes in relation to learner achievement and the promotion of autonomous learning in English language learners (Du, 2025; Zou et al., 2025).

In higher education, achievement in English is critical as students must engage with different types of texts, including analytical and argumentative essays, and have to articulate themselves in a language-specific manner. All of these tasks are highly demanding, even for native speakers. Language professionals have a particularly demanding role as they are responsible for assessing, providing feedback, and mentoring learners. ESL learners face significant challenges in academic writing, understanding, and responding to feedback, and in obtaining individualized, tailored consultancy and support. Although AI-based systems have been developed to address some of these problems, many AI systems tend to use non-transparent processes to generate outputs, which can result in a lack of trust in the feedback and a lack of trust in AI systems in general (Jiang & Zhang, 2025).

To alleviate some of the concerns, the need for transparency and interpretability in algorithmic decision-making has launched a new approach called Explainable Artificial Intelligence (XAI). Explainable Artificial Intelligence Systems (XAIs) assist users in forming a feedback loop, in which they critically evaluate feedback, thus forming a positive feedback loop and modifying the learning approach. XAI has shown promise in the field of education in teaching grammar, automated feedback, and adaptive tutoring systems (Habib, 2023; Villegas-Ch et al., 2025). The research also stresses the need for the Explainable Artificial Intelligence (XAI) approach in pedagogy, which will help foster ethically accountable and learner-centric, AI in education (Meylani, 2025).

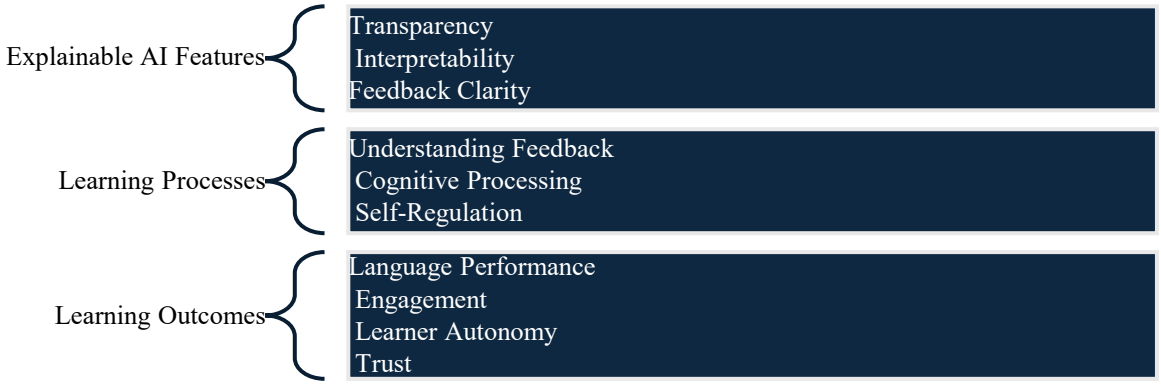


Figure 1: Conceptual Framework of Explainable Artificial Intelligence in ESL Learning

This figure 1 shows the study's conceptual framework and how key aspects of Explainable Artificial Intelligence (XAI), such as transparency, interpretability, and clarity of feedback, impact processes in ESL learning. These XAI features aid learners in comprehending feedback and help cognitive processing and self-regulation. These processes improve learning and lead to enhanced language skills, greater engagement, increased learner autonomy, and trust in AI-supported learning environments.

The research of the use of XAI in tertiary education ESL pedagogy is virtually nonexistent. Most research in this area has been general, and has been focused on one of the applied AI subdomains, rather than focusing on the language learning process where explainability is a virtue, and student engagement. Some research has been focused on explainable models as a means of increasing transparency in assessments, and predicting student performance. However, nothing has been concentrated on the teaching/learning models of the XAI systems, which justify the use of the ESL learning paradigm (Guo, 2025; Mastour et al., 2025; Singh et al., 2024).

The increasing implementation of Artificial Intelligence in higher education has illustrated the need for systems that are not only efficient, but also transparent and pedagogically useful. For ESL students, the lack of interpretability in AI systems is a challenge and makes developing and sustaining proficiency in the language of instruction more difficult. The challenge is to create a learning environment in universities that can be equitable, effective, and more importantly transparent learning.

The research investigates the efficacy of Explainable Artificial Intelligence frameworks for ESL learners, thereby contributing to the growing field of AI and Language Education. It provides empirical data on the effects of explainability and lack of explainability in relation to learners' comprehension of feedback, level of interaction, and degree of language growth. It also suggests how transparent AI can be employed in practice in ESL teaching at the tertiary level.

From this perspective, the current research aims to examine the influence of XAI frameworks on ESL education in tertiary level. More specifically, how explainable systems affect learners' comprehension of feedback, involvement in learning activities, and academic achievement.

The research is based on three main questions that focus on the explains the role Explainable Artificial Intelligence (XAI) in ESL teaching and learning contexts. It aims to find out the role of XAI frameworks in fostering ESL learners' understanding of AI feedback in terms of clarity, interpretability, and usability. Furthermore, the study investigates how explainable AI systems impact learner engagement and autonomy, and whether increased transparency leads to greater engagement and more self-directed learning. Lastly, the study aims at assessing the influence of XAI tools on ESL learners' language proficiency at the tertiary level, especially in the area of academic language.

The remainder of this paper is organized as follows. Section II presents a review of the relevant literature, focusing on ESL learners in tertiary education, the role of Artificial Intelligence in language learning, and the emerging significance of Explainable Artificial Intelligence. Section III outlines the research methodology, including the design, participants, data collection procedures, and analysis techniques. Section IV reports the results of the study, presenting the key findings in relation to language performance, feedback understanding, and learner engagement. Section V discusses these findings in light of theoretical perspectives and existing knowledge. Finally, Section VI concludes the paper by summarizing the main contributions, outlining practical implications, and suggesting directions for future research.

## Literature Review

One issue with ESL learners in post-secondary education is reliance on English skills in almost every aspect of their education. Communicating in English on the required levels of the post-secondary education system requires proficiency in critical reading, academic writing, and the specific discipline's communication style. A lot of learners, however, have difficulties with advanced text interpretation, argumentation, and grammatical accuracy. Complex challenges often arise from the proximity of learners to a feedback system. Many studies agree that without the means to internalize the feedback, and develop skills through the support of targeted scaffolding, learners usually remain in stagnation (Kot & Nykyporets, 2024). Lacking mechanisms to feedback, ESL learners often cannot see development in constructive criticism, and in turn, cannot self-motivate to improve their skills for a long-term development.

The integration of Artificial Intelligence in post-secondary education lays the foundation for the development of big ideas to meet the ongoing demands of the modern education system. AI writing

assistants have proved to be instrumental in the education of graduate writers through advanced and immediate feedback (Nazari et al., 2021). The same applies to the contributing learners to acclaimed participation in blended classrooms (Zhou et al., 2025). With the added, skill-related features, AI aims to develop individualized and self-motivated learners through the allocation of specific feedback on content (Zhao, 2025). Unquestionably, research indicates that AI systems can stimulate interest in their studies and assist students psychologically, which is a fundamental component of sustained interest (Li & Lin, 2025). AI systems, furthermore, have shown to enhance reading comprehension and foster self-regulated learning by prompting students to consider how they plan and adjust their learning (Shafiee Rad, 2025). Even with these benefits, a major challenge exists. Many AI systems still function without providing transparent pathways to their outputs. Such opacity can create confusion, decrease trust, and limit the remedial learning opportunities, particularly for English as a Second Language (ESL) students, who depend on feedback to learn a new language.

As a result of the lack of transparency in traditional AI systems, Explainable Artificial Intelligence (XAI), aims to bring transparency and interpretability to AI systems. In education, XAI is helping students to learn by providing a rationale for the feedback, predictions, and recommendations for students. This is aiding students to learn more deeply. For instance, XAI technologies have been used to predict students who are likely to fail a course and to recommend remediation. This shows a successful balance of interpretability and prediction (Albreiki et al., 2022). Likewise, other studies have noted an increase in the use of new AI technologies, including deep learning and reinforcement learning, to improve students' academic outcomes, and have stressed the need for explainability to ensure their responsible use (Stasolla et al., 2025). The ongoing incorporation of technology in English language teaching has also acknowledged AI's benefits in teaching and learning English (Loor et al., 2024). However, other reviews of technology in TESOL align technology with teaching to know how and when students interact with AI and what kind of interaction is valuable when students receive feedback from AI (Ali et al., 2025). These reviews note the promise of XAI, but its use is almost nonexistent and unproven for tertiary ESL students.

The literature concerning technological advancements and language learning has identified positive trends in language learning due to the personalization of learning, active participation, and improvement in learning outcomes. However, this is not the case for ESL students who lack cohesive and comprehensible feedback. XAI has the potential to address these concerns, but its use in ESL teaching within higher education is limited. Thus, there is a need to implement XAI in higher education for ESL students to develop their language skills. Thus, this study intends to address this gap.

## Methodology

### Research Design

It utilize a mixed-methods research design for this specific study to assess how effective XAI frameworks are for assisting ESL learners within tertiary education. Using both quantitative and qualitative methods allows a two-pronged assessment of both learner outcomes and learner experiences with explainable systems.

### Participants

Participants are tertiary institution undergraduate ESL students. Using purposive sampling, 60 students underwent selection, with sample members matched for equal English proficiency and digital

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learning tool exposure. Sample members were split into 2 subgroups one experimental group that interacted with an XAI system, and one control group that interacted with a non-explainable AI tool.

**XAI Framework Description**

The XAI framework used for this study is a correction tool with post-activity feedback that is designed to communicate with learners concisely and clearly. Unlike most AI, this tool provides both visual and textual feedback alongside one rationale for each correction and each component of a learner's grammatical, lexical, and structural errors.

**Data Collection Methods**

It uses a combination of quantitative and qualitative methods to assess study outcomes. To assess language performance, it use both a pre- and post-test, while learners' perceptions of feedback clarity, level of engagement, and trust in the system are assessed through Likert/scaled questionnaires. Select participants from the experimental group were recruited for semi-structured interviews, to aid qualitative data. Out of the data collection methods, written and reading comprehension homework were included as well.

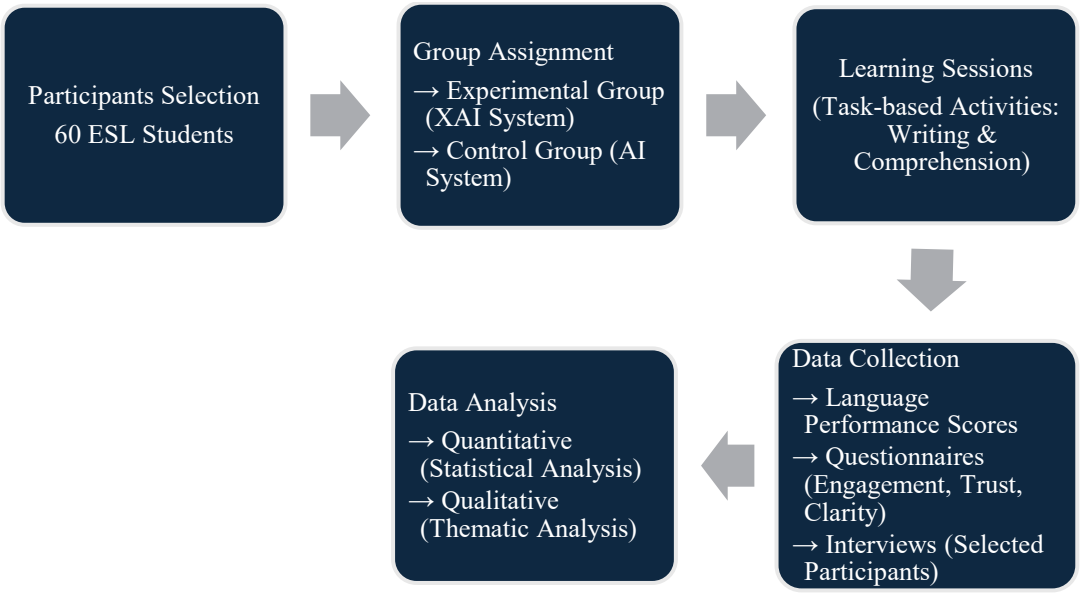


Figure 2: Research Design and Methodological Procedure

Figure 2 shows this study's general research approach and steps, starting with choosing ESL participants and assigning them to the experimental and control groups. The figure describes the order of learning sessions with task-based activities, then explains the data collection, which involves language performance scores, questionnaires, and interviews. Finally, the figure describes the data analysis step and points out the quantitative and qualitative methods to assess how the XAI-based system affected ESL learners.

**Procedure**

The study spanned across 6 weeks. Both groups carried out learning sessions consistently; the experimental group got explainable feedback, whereas the control group was given standard AI feedback. To ensure uniformity across the study, all participants executed identical tasks under similar conditions.

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### Data Analysis Techniques

Descriptive and inferential statistics were used to break down the quantitative data from tests and questionnaires. These were targeted towards the performance gap between the groups. Engagement, understanding, and the explainable feedback perception patterns from the interviews were analyzed qualitatively through thematic coding.

## Results

### Language Performance Outcomes

The experimental group (XAI-based system) performed better than the control group (conventional AI system). Language assessment scores proved this. The experimental group achieved a mean score of 74.6 compared to 66.2 mean score of the control group. Also, students in the experimental group were more concentrated in the upper performance range than in the control group.

Table 1: Overall Language Performance Scores

| Group | Mean Score | Standard Deviation | Highest Score | Lowest Score |
|---|---|---|---|---|
| Experimental (XAI) | 74.6 | 6.8 | 88 | 62 |
| Control (AI) | 66.2 | 7.5 | 81 | 54 |

Table 1 shows an overview of both groups' language performance scores. The experimental group achieved a higher mean score coupled with a standard deviation that was smaller than that of the control group. This denotes that the learners using the XAI-based system had a more consistent performance.

### Distribution of Performance Levels

Table 2: Distribution of Performance Levels

| Performance Level | Score Range | Experimental (%) | Control (%) |
|---|---|---|---|
| High | 75–90 | 58% | 32% |
| Medium | 60–74 | 34% | 46% |
| Low | Below 60 | 8% | 22% |

Table 2 demonstrates the distribution of learners by their performance levels. More students belonging to the experimental group can be classified as high performers. On the other hand, the control group has comparatively more learners in the medium and low performance ranges.

### Understanding of AI-Generated Feedback

Survey outcomes have demonstrated a difference in grade levels, the experimental group indicating greater than the control group. Feedback for experimental group was, in fact, more understandable. Feedback was also perceived to be more transparent in reasoning for corrections.

Table 3: Learners' Understanding of AI-Generated Feedback

| Feedback Perception | Experimental (%) | Control (%) |
|---|---|---|
| Very Clear | 48% | 21% |
| Clear | 34% | 25% |
| Moderately Clear | 12% | 30% |
| Unclear | 6% | 24% |

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This table 3 summarizes learners' perceptions of feedback clarity. The experimental group reported higher levels of clarity, with most participants indicating that the feedback was either clear or very clear, whereas a larger proportion of the control group found the feedback moderately clear or unclear.

**Learner Engagement and Autonomy**

Engagement of the learners was measured in terms of participation, task engagement, and autonomous revision. The experimental group demonstrated greater engagement and self-directed learning.

Table 4: Learner Engagement and Autonomy

| Engagement Indicators | Experimental (%) | Control (%) |
|---|---|---|
| High Engagement | 52% | 29% |
| Moderate Engagement | 24% | 23% |
| Low Engagement | 24% | 48% |
| Independent Revision Practice | 71% | 44% |

Table 4 provides information centred around learner engagement and autonomy. The experimental group demonstrated more active engagement and a stronger inclination to revise independently, whereas the control group shows a larger share of low engagement responses.

**Trust in AI Systems**

Table 5: Trust in AI Systems

| Trust Level | Experimental (%) | Control (%) |
|---|---|---|
| High Trust | 80% | 55% |
| Moderate Trust | 14% | 27% |
| Low Trust | 6% | 18% |

In Table 5, the level of trust that learners have in the AI systems is shown. Larger proportions of those in the experimental group showed high trust. In contrast, the control group has more participants who reported moderate or low trust.

**Task-Based Performance Patterns**

There is a distinction in task-based activities between the two groups. The experimental group performed better than the control group. In terms of frequency, the control group exhibited a greater number of grammatical and structural errors than did the experimental group.

Table 6: Task-Based Error Frequency

| Error Type | Experimental (Avg. Frequency) | Control (Avg. Frequency) |
|---|---|---|
| Grammar Errors | 3.2 | 5.8 |
| Sentence Structure | 2.7 | 4.9 |
| Vocabulary Misuse | 2.1 | 3.6 |

Table 6 offers information regarding the average frequency of errors present in task-based activities. All error types are observed to be fewer in the experimental group. In contrast, the control group has a comparatively higher frequency in errors relating to grammar, structure, and vocabulary.

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## Discussion

### Interpretation of Findings

The data from the study illustrates the positive effects of the integration of explainability in AI systems and the potential improvement in the learning outcomes of ESL learners in higher education. Feedback that were accompanied by explanations also resulted in learning experience of the learners in an appreciable manner. The learners were able to systematically analyze their mistakes and correct them. This illustrated the active role of the learners in verifying the feedback.

### Role of XAI in ESL Learning

The role of Explainable Artificial Intelligence in language learning is to enhance clarity, control, and improvement in the learning skills. Understanding the logic behind the corrections motivates learners to internalize the language. The transparency of the AI systems also encourages learners to take more ownership over their learning and decreases their dependence on others to revise and improve their work. This is to say that XAI contributes to task performance and language learning.

### Theoretical Implications

The findings may be examined from the perspective of constructivist learning theory. The theory provides explanation on the learning process, where XAI systems apply the direct instructions in feedback and enable learners to self-correct. In addition, from the perspective of Cognitive Load Theory, explainable systems reduce the cognitive load. This allows learners to focus more on their linguistic problems.

### Study Outcomes

This study largely coincides with existing literature asserting that AI-based implementations within education improve engagement and learning outcomes. This study adds to the literature by showing that the addition of explainability features improves learning engagement and outcomes. It appears that the feedback from AI tools, even though it is likely considered helpful by the developers, is of limited usefulness to the learners if they cannot see the reasoning behind the feedback. Explainable systems, on the other hand, have the potential to create a learning experience that is more engaging and meaningful.

### New Insights

The experimental group demonstrated a higher engagement and trust, but it was interesting to see that even some learners from the control group reported a moderate level of engagement with the AI system. Apart from this, the control group reported less clarity, which shows the disadvantages of non-transparent systems. All in all, these learners explain that while the addition of explainable systems is likely to produce more consistency to the outcomes, the explainable system's features alone do not solely determine effectiveness.

## Conclusion

The purpose of this study was to find out how effective the Explainable Artificial Intelligence (XAI) frameworks are in helping ESL learners in tertiary education in terms of learners' comprehension of feedback, learner engagement, and language performance. The study found that the explainable design features in the AI systems helped learners to understand feedback better, which helped learners to improve their language proficiency, and reduce the number of persistent language mistakes learners made.

Furthermore, learners using XAI systems displayed greater engagement, autonomy, and trust. This finding shows that explainability is a key design feature in XAI systems that supports and fosters better and more meaningful learning experiences in the language learning process. The study makes a contribution to ESL pedagogy in the language teaching profession in that it shows the role and importance of explainability in helping learners make language progress, and as a broader message, the study shows that AI educational technology needs to be more transparent. The study also shows that teachers can use explainable systems that improve their feedback mechanisms, and educational institutions can use the study's findings to improve their digital learning environments, and system developers can use the findings to improve the explainability and language-interface features of the systems. The study is however limited in that it has a small sample size, was conducted in a short time frame and in a specific context, and this limits the ability to generalize the findings. Therefore, future studies should be carried out using more diverse samples and larger study populations and longer study durations to determine how different design features of XAI systems impact language learning.

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