



AI-Driven Analysis: A Case Study on Assessing Argumentation Proficiency and Skill Development Through Sequential Submissions

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ABSTRACT: This paper examines argumentation proficiency in essay writing, utilizing AI to investigate EFL students' development of argumentative skills across sequential submissions. Argumentation is crucial in academic writing, but assessing and grading it can be incredibly challenging due to its subjective nature. This study uses AI technology to evaluate students' argumentative essays in the College of Business and Science. AI-powered assessment is employed for two primary aims: assessing argumentation proficiency and identifying the progression of argumentative skills of the selected participants. Seventy-four students participated in the research through three assignments during the fall semester of 2024: an argumentative essay assignment, an argumentative essay test, and an argumentative-based research paper. An AI-based tool was used for argument analysis to provide detailed feedback across the selected argumentative submissions. The study results pointed out that the average grades at the end of the semester improved, and over half of the students improved their overall performance. Students' argumentative writing skills improved, as evidence indicates AI assessments enhance EFL outcomes and deepen understanding of students' potential. It also highlights how new learning technologies can foster critical thinking and communication skills. The study recommends developing advanced AI tools to analyze and monitor skill growth across submissions, providing precise feedback for improved writing.

Keywords: AI-driven Analysis, Argumentation Proficiency, Skill Development, Educational Assessment, Critical Thinking.

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1. Introduction

In light of the increasing competitiveness in higher education, students must cultivate critical analysis skills with business or scientific argumentation skills. These competencies empower students to articulate their reasoning and convey their ideas effectively. Argumentative contests serve as an effective means of assessing these skills, particularly with the increasing prominence of curriculum models that emphasize them. However, evaluating these essays often seems to rely more on personal opinion than objective standards, making it challenging to grasp the student's argument. The role of artificial intelligence in assessing educational processes is becoming increasingly important. Innovative AI models enable the re-evaluation of writing through advanced assessments of argumentative essays and trustworthy, AI-generated feedback. This progress allows teachers to redefine writing assessments and formulate

improved teaching practices. Additionally, AI feedback can be utilized in evaluations to address student weaknesses with targeted strategies. It supplies teachers with insights into the areas where students need improvement. Furthermore, AI assessment can help in large-scale essay assessments and enhance grading accuracy for a more significant number of students. This is especially beneficial for classes with large student bodies, as it reduces the challenges of providing feedback on numerous essays. AI can be used to assess argumentative essays, reducing the time and effort needed for grading and offering feedback while deepening students' understanding of their writing skills and integration of critical thinking, thereby enriching their learning experience.

The problem prompting this study is the need to effectively evaluate the argumentative skills of higher education students, as proficiency in these skills is crucial for academic success. However, the common practice of assessing these skills through extended essays is highly problematic. Teachers' evaluations and feedback are often subjective and biased, undermining validity and reliability. Even established rubrics fail to address this problem adequately. Therefore, from a different perspective, there is a significant need to identify reliable measures for assessing students' argumentative skills. This paper aims to meet this challenge by proposing and testing novel assessment methods that promise objectivity and reliability in evaluating argumentation skills.

This study uses AI technologies to improve assessing student argumentative essays in the General Education Department at MCBS. The purpose is to bolster the academic writing abilities, especially argumentation skills, of those students who will major in business and other science fields upon finishing their academic writing courses at GE. By recognizing patterns of strengths and weaknesses in their essays, the study seeks to enhance their overall writing skills, and based on this purpose, the following two objectives have been established:

1. Employ AI-based assessment to analyze in depth the argumentative essays submitted by the participants.
2. To assess the participants' competencies in argumentative writing and uncover their common strengths and deficiencies as well

This study is highly valuable due to AI assessments, which can enhance students' writing. Consequently, tailored teaching resources can be developed based on specific writing tools. Additionally, this research has the potential to advance educational technology by exploring the use of AI as an assessment method. Critical thinking and argumentation skills can be further improved through these curriculum adjustments. This technology addresses long-standing challenges in EFL teaching environments, particularly in utilizing AI for assessment, which can save considerable time. Furthermore, this AI-based assessment will help students to improve their argumentative skills.

2. Theoretical Overview of the Main Concepts

Integrating artificial intelligence (AI) in the learning process has expanded the possibilities of enhancing learning outcomes in developing argumentation skills and other relevant skills that can be beneficial for incorporating AI in an educational setting. This review aims to contextualize the analysis of argumentation skills using AI within the framework of previous research theory. Argumentation proficiency is a cognitive set of critical thinking, reasoning, and the ability to build and dismantle arguments. As Kuhn and Goh (2005) advocate, learners possessing advanced argumentation skills are expected to counter more, produce more alternatives, and think critically. This skill is essential in academics and professional life (Kuhn & Moore, 2015). Alawad and Ahmed (2024) add that effective academic writing involves an in-depth understanding of the topic, incorporating higher-order thinking. The fusion of technology and writing instruction has become a fascinating area of inquiry within educational research. The use of technology is enhanced when computers, mobile devices, and internet resources are part of everyday classroom activities (Chang et al., 2021). Ahmed et al. 2024 stress the use of new technologies by pointing out how these tools affect the students' writing performance and advocating using their applications to help students' writing skills development. According to Miller (2024), students should be given guidance on modifying how they construct and express a written argument. The AI Analyst Argument (YesChat, n.d.) and the Discourse Analyzer (n.d.) are **robust** AI-driven systems that thoroughly analyze arguments presented in any given discourse. Utilizing advanced Natural Language Processing techniques, these AI systems effectively break down, understand, and assess arguments and contextual strategies, allowing them to offer constructive

feedback to students. While teacher feedback is crucial for students' development of writing skills, there is ongoing debate among some learning technology researchers about how Artificial Intelligence (AI) systems might aid students in enhancing their writing abilities (Miller, 2024). Scaffolding that provides guidance has been suggested to help individuals formulate arguments and deepen their knowledge in a particular area when integrated into online instructional design (Noroozi et al., 2012; Scheuer et al., 2010). The AISS system, an AI-assisted growth model developed by Kim and colleagues (2024), is an online platform that supports students in enhancing their argument writing and information literacy skills. This additional support can significantly improve writing instruction and help cultivate the skills necessary for composing an argument. As presented in Toulmin's model, an argument is viewed as a statement supporting a claim, accompanied by data and a warrant that defines the claim's purpose (Wolfe, 2011). This model considers an argument as a claim that includes a specific protocol of warranting and data, facilitating the analysis of arguments critical for developing argument proficiency. Furthermore, Reed, Walton, and Macagno (2007) assert that schemes and diagrams are excellent tools for detecting and analyzing arguments. However, Schiappa (2002) has noted that no universally accepted numerical assessment can be applied to reversible everyday situations. Insufficient background knowledge and collaborative arguing skills may lead to dysfunction in communication and effective arguing, even when designing a complex problem-solving task (Beers et al., 2007). It is essential to help students acquire practices that involve constructing arguments, finding evidence, and developing counterarguments and rebuttals (Kuhn, 1991). Arguing is a crucial critical and higher-order thinking skill (Rapanta, Garcia-Mila & Gilabert, 2013). The results regarding argumentation skills advancement and ability development are promising when integrating AI-enabled tools in educational contexts. With these up-to-date tools and relevant theories, teachers can provide students with the support required for successful argumentative writing and critical thinking engagement. In any field, argumentative writing is the pillar of academic achievement and professional practice (Kuhn & Moore, 2015). Arguably, Lee (2017) defined argumentation as 'the practice of persuading others, through evidence, that one's position is correct in scenarios where two or more parties are disputing with one another' (p. 91). Furthermore, the legal, business, and political sectors, among others, can significantly benefit from argumentation (Fan & Chen, 2021). AI has been employed in this research to grade argumentative essays by pupils at the College of Business and Science. In contrast to standard testing, the technology was incredibly beneficial for assessing students' argumentation capabilities. In this regard, the study had twin goals: identifying the students' strengths and weaknesses in argumentative writing and understanding how the students used argumentative writing.

2.1. Previous Relevant Studies

The relevant existing literature generally focuses on the effective incorporation of artificial intelligence (AI) within foreign language lessons, which has proven successful in increasing students' motivation and developing writing skills. Tajik (2025) assessed the influence of AI-based dynamic writing aids to enhance EFL students' motivation and writing performance. The research proved that incorporating AI resulted in higher motivation, better coherence, vocabulary, grammar, and task completion than the control group, which had AI tools denied to them and had to stick to the conventional means. As for Al Fraidan (2024), the researcher explored the impact of AI tools on the writing performance of Saudi students learning English as a foreign language, focusing on efficacy motivation EM strategies for argumentative essays. It is noted that students with AI feedback produced written essays with better clarity, organization, and depth of content than the students without AI feedback. Finally, Abdul Rahman noted that to diversify the monotony, Abdul Rahman and his co-authors studied the effect of Automated Writing Evaluation (AWE) software on Malaysian undergraduates' motivation to write. The researchers found that including AWE in ESL writing classes would be helpful. On the other hand, Soriano and his team (4 years ago) found that AI tools improve the coherence and speed of writing and the frequency of errors of Filipino ESL writers. They also found that the results show that the dynamic feedback given by the AI tools is helpful in the writing process. However, Alkamel and Alwagieh (2024) found that ChatGPT improved the fluency, accuracy, and overall writing performance of Arabic EFL students, but they also discussed the issues of academic integrity and plagiarism. The same year, Biju and his colleagues found enhancements in the Foreign Language Assessment and Language Anxiety subcategories. They suggested these to create positive classroom

environments and reduce students' stress. Ghorbandordinejad and Kenshinbay (2024) emphasized the importance of feedback, immediacy, and personalization for the effective use of AI-based adaptive writing technologies by L2 students.

2.2. Research Gap

The gaps identified in the reviewed studies stem from a common problem: evaluating AI applications for developing and assessing argumentative writing. Some studies have dealt with AI integration in teaching and learning and, in particular, EFL motivation and writing (Tajik, 2025; Al Fraidan, 2024; Abdul Rahman et al., 2023), but there seems to be a dearth of specific literature on AI tools for argumentation evaluation. Most existing literature focuses on improving writing skills but does not address the specific evaluation and tools for argumentative writing. Some studies focus on specific writing tasks for specific time frames or use a period for external marking (for example, Soriano, 2024; Alkamel & Alwagieh, 2024). These studies are important in helping EFL teachers devise proper methodologies to train their students to use the language, especially when it comes to integrating AI. Monitoring AI impacts increases the importance of multi-trial assessment for skills in argumentation. Moreover, while Biju et al. (2024) and Ghorbandordinejad and Kenshinbay (2024) accept the benefits or at least some positive impacts of AI feedback, they do not explain how the feedback should be given along with other forms of teaching. Feedback from an AI combined with other forms of instruction is important because it makes it possible to target the provisions aimed at improving reasoning ability more precisely. In addition, this research is limited to certain sociographic characteristics of teachers and pupils, such as Tajik EFL learners from some particular areas. . . (Tajik, 2025; Al Fraidan, 2024; Alkamel & Alwagieh, 2024). Such limitation constrains our consideration of how students and learners from diverse cultures employ AI-powered tools. This further demonstrates the need for cross-cultural research that could reveal the efficiency of AI tools in different countries. One more serious consideration stems from the relationship between academic fraud and deception on plagiarism using AI-powered tools for writing essays. . . (Alkamel & Alwagieh, 2024). The erosion of academic ethics and providing education with proper supervision for these learners is still of hot and burning concern. Consequently, the literature suffers from a considerable lack regarding how to properly monitor and manage the development and application of AI technologies in education. To address these gaps, the following research questions are proposed:

1. How effectively can AI-driven tools analyze and track the development of argumentation proficiency in college students' essays through sequential submissions?
2. What are the strengths and weaknesses in argumentation skills identified by AI-driven tools over multiple submissions?

3. Methodology

3.1. Participants

The research involved 74 students from three sections of ENG102 enrolled at the Modern College of Business and Science, Department of General Education, during Fall 2024. These students submitted three pieces of argumentative writing: an argumentative essay, an argumentative test, and an argumentative-based research paper. The sampling method employed was convenience sampling, as the participants were students of the researcher, and their submissions were easily accessible for the study.

3.2. Tools and Approach

The primary instrument used in this research was the AI Argument Analyst, commonly known as DebateMaster, which can thoroughly evaluate arguments found in debates, essays, discussions, and other formats. All analyzed essays were initially submitted to Turnitin to verify the originality of the participants' work. This research employed descriptive, analytical, and quantitative measures to assess the participants' performance using average scores, the standard deviation, progress percentage, and Effect Size (Cohen's d).

3.3. Research Procedure

The participants were chosen from three ENG102 course sections that the researcher taught. These essays acted as continuous assessments in which students submitted three argumentative submissions throughout the semester. Initially, the essays were submitted to Turnitin for originality, integrity, and authenticity. Following this, the essays were analyzed using the AI Argument Analyst, which provided

detailed feedback highlighting the quality of arguments, strengths, and areas for improvement. The data obtained from the assessment was statistically analyzed across average scores, standard deviation, progress percentages, and Effect Size measured through Cohen's d. Finally, the analysis results were interpreted to evaluate the impact of the AI-based assessment on the students' argumentative writing skills. The findings were documented, emphasizing the influence of AI-based assessments on EFL pedagogy outcomes and providing insights into the learners' potential.

3.4. Data Collection

The process of gathering data consisted of three steps requiring students to write argumentative essays on specific topics. Then, all submissions were run through Turnitin to check for plagiarism and AI-generated content, and any flagged essays were discarded. The rest of the submissions were then scored using the AI Argumentative tool on the strength of the thesis, evidence provided by the student, counterarguments, and overall structure. The collected data included the number of participants, mean scores, score distribution, and other relevant metrics, providing a comprehensive view of student performance. This method helps analyze student understanding and knowledge gaps, offering ongoing support for revisions and skill improvement.

4. Findings and Discussion

The statistics shown in Table 1 and Table 2 offer comprehensive answers to the research questions raised. Table 1 provides a detailed analysis of argumentation proficiency across different assignments, while Table 2 highlights the improvement in argumentation skills among students over multiple submissions. These statistics will help address the effectiveness of AI-driven tools in analyzing and tracking the development of argumentation proficiency and identify common strengths and weaknesses in students' argumentation skills.

Table 1: AI-Driven Analysis of Argumentation Proficiency Across Assignments

Assignment Type	Number of Students	Average Score	Standard Deviation	Common Strengths Identified by AI	Common Weaknesses Identified by AI	Originality Check (Turnitin)
Argumentative Assignment 1	56	75	8.5	Clear thesis statements, logical structure	Lack of counterarguments, weak evidence	5 cases of AI content detected
Argumentative Test	70	78	7.9	Substantial evidence, well-organized arguments	Limited alternative perspectives, insufficient rebuttals	4 cases of AI content detected
Research Paper Argumentative Based	69	80	7.2	Effective use of counterarguments, critical thinking	Inconsistent reasoning, minor logical fallacies	5 cases of AI content detected

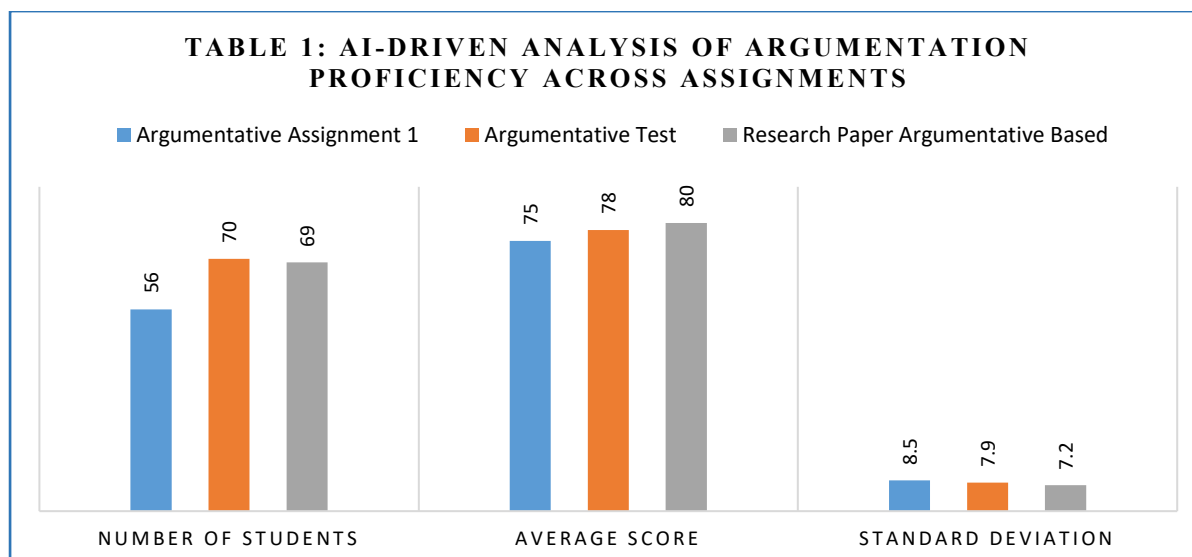


Figure 1: AI-Driven Analysis of Argumentation Proficiency Across Assignments

4.1 Findings Discussion

Regarding Table I and Figure 1, the analysis of arguments by the AI assessment tool offers valuable insights into student performance. Further, it demonstrates how useful AI has been in elucidating constructive feedback, reflecting AI tools' use in assigning assignments. Excluding five (5) AI-generated submissions, there were 56 valid submissions in Argumentative Assignment 1, out of which the mean average score was 75, with a standard deviation of 8.5. The tools possessed common weaknesses, such as a lack of counterargument and poor evidence, but they were found to share some strengths, such as a strong, clear thesis and a logically precise format. This preliminary assessment serves to underscore the students' capabilities and deficiencies. Excluding four (4) AI-generated submissions, there were 70 valid submissions for the Argumentative Test. The mean average score was 78, with a standard deviation of 7.9. Tools AI tools point out the strength provided in evidence and structure in argumentation, highlight the provision of rebuttals, and give alternative postures as weaknesses. This suggests that while the students' ability to employ evidence to support their arguments and structure improved, their ability to address opposing or counterarguments did not. As for the argumentative-based research paper, it had 69 legitimate submissions after subtracting AI-generated submissions by 5. The average grade was raised to 80, while the standard deviation recorded was 7.2. There was general feedback by AI tools, which pointed out the subjects' strengths, which included using counterarguments and critical thinking effectively; however, some weaknesses were pointed out, such as inconsistencies in their reasoning and minor logical fallacies. This implies that there was an improvement on the students' part in using critical thinking and arguments in their submissions, but some reasoning issues existed. Turnitin carried out an originality check, establishing that the assessment was based only on the students' work, preserving academic honesty. Detecting AI-generated materials in some instances demonstrates the necessity of such procedures in educational contexts. In short, these results indicate that AI tools improve students' argumentation skills and can provide thorough and practical advice.

Table 2: AI-Driven Improvement in Argumentation Proficiency Among Assignments

Assignment Type	Number of Students	Mean Improvement Score	Percentage of Students Showing Improvement	Effect Size (Cohen's d)
Argumentative Assignment 1	56	N/A	N/A	N/A
Argumentative Test	70	3	85%	0.37
Research Paper Argumentative Based	69	2	78%	0.26

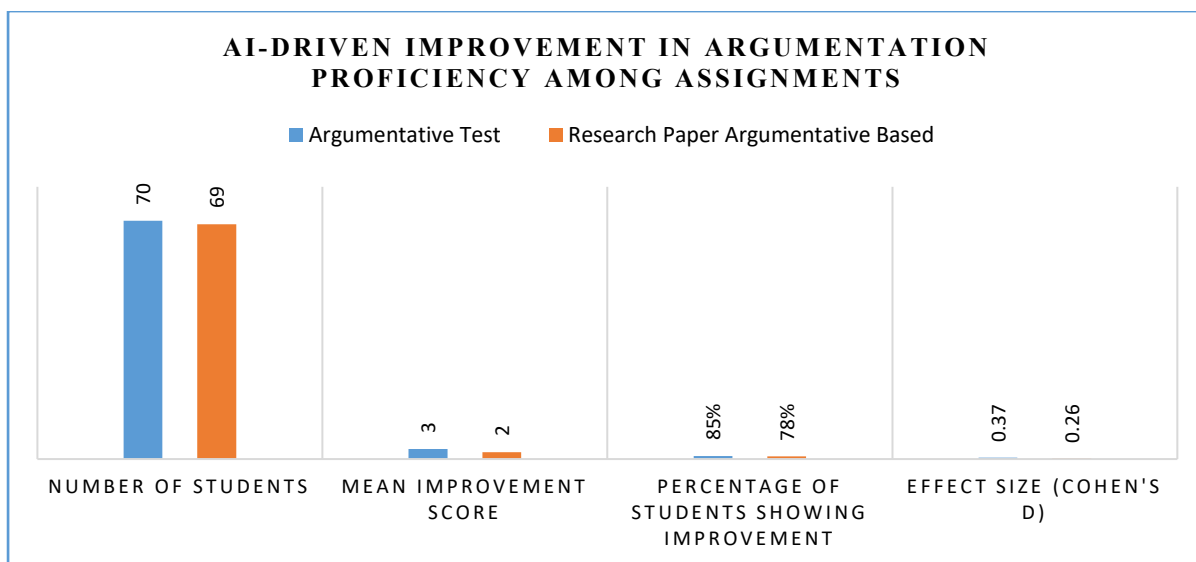


Figure 2: AI-Driven Improvement in Argumentation Proficiency Among Assignments

4.2 Findings Discussion

According to Table 2 and Figure 2, the statistical analysis has indicated that the argumentation capabilities of the assignments have improved. The transition from Argumentative Assignment 1 to the Argumentative Test had a mean improvement score of 3, and upward of 85% of the students showed improvement. The effect size (Cohen's d) was equal to 0.37, indicating a reliable score increase. This improvement corroborates the accuracy of AI feedback and students' revision processes, which assisted the students in improving their argumentation skills. Upon analyzing the context from the Argumentative Test to the Research Paper Argumentative Based, the average improvement score dropped drastically to 2, with 78% of the total students demonstrating improvement. The effect size (Cohen's d) equaled 0.26, indicating slight improvement. The improvement, though minimal compared to the change observed in the transition above, confirmed the continued influence of AI-based feedback on improving students' argumentation skills. Regarding the overall dynamics, it can be noted that the use of the AI Argument Analyst in argumentation assessment significantly impacted the participants' argumentative writing skills. This tool is powerful enough to provide detailed comments, enabling EFL students to self-correct and reorganize their areas of concern. This process stimulated improvement across all their completed works. Integrating self-comments and revisions with AI technology is an effective method for enhancing students' skills in argumentative writing. In summary, integrating AI tools in argumentation assessments enhances students' writing, planning, evaluation, and critical thinking abilities. Various findings show that different AI technologies can significantly boost student performance, leading to a more effective assessment of their competencies.

5. Synopsis of the Main Research Outcomes

The findings suggest that technology plays a key role in assessing students' argumentation skills. The AI Argument Analyst offered valuable insights into various aspects of argumentation, including claims, supporting evidence, and counterarguments. This feedback enabled students to recognize their weaknesses and consistently improve their performance on assigned tasks. As evidenced by the increased average scores, students' argumentation skills were significantly enhanced. While feedback and revision often pose challenges, in this instance, AI facilitated the development of students' argumentative writing abilities. Tools like Turnitin ensured originality and emphasized academic integrity within the EFL context, adding clarity to the analysis. These results align with Khjran's (2025) research, which highlighted that AI-powered essay writing applications offering real-time feedback contribute to enhancing students' writing skills and academic success. Moreover, Abdul Rahman et al. (2023) noted the positive effects of AWE software on the writing skills of Malaysian graduate students. Research by Soriano et al. (2024) explored how AI feedback tools impact student writing, revealing improvements in the writing speed and fluency of Filipino ESL learners, alongside reductions in spelling errors. Biju et al. (2024) argue that AI-assisted ATDD mode assessment can alleviate anxiety, foster a positive attitude, and boost motivation. Furthermore,

Ghorbandordinejad and Kenshinbay (2024) discussed how technology that adapts feedback, such as AI-driven writing prompts, addresses challenges second-language writers face, primarily due to its ability to provide immediate and personalized feedback.

6. Conclusions

This research demonstrates the usefulness of incorporating AI tools in assessing students' argumentative skills. The study found that AI methods, such as the AI Argument Analyst, can effectively provide feedback on key elements of an argument, including the claim, evidence presented, and counterarguments. With this feedback, students can identify weaknesses and enhance their arguments, leading to improved argumentative writing skills. Additionally, progress is evident in the students' advanced writing classes. Among those who scored highly, students excelled in argumentation. AI tools significantly benefit EFL learners by boosting their academic performance. Furthermore, AI tools in feedback and revision support earlier conclusions, as they enhance students' writing competency and are user-friendly. These findings align with other studies by Khjran (2025) and Abdul Rahman et al. (2023), highlighting the advantages of AI-powered applications in writing for students, particularly regarding enhanced academic performance. Tools for checking originality and plagiarism, such as Turnitin, assist EFL teachers in evaluating students' originality and emphasize the importance of academic achievement. This study strongly advocates for utilizing AI tools for educational purposes, especially in assessing and fostering the development of students' argumentative skills. With the help of technology, educators can provide unbiased, consistent, and personalized feedback. feedback, all of which contribute to improving students' writing and critical thinking skills.

7. Limitations, Implications, and Further Directions of Research

While the findings presented are promising, the study still has some shortcomings. First, the sample appears biased and self-selecting, which may limit its applicability to other student groups. Furthermore, the feedback and analysis provided by AI tools rely on technology that cannot replace human proficiency and judgment. Using tools like Turnitin to identify content as 'plagiarized' or even to assess the potential involvement of AI raises questions about what constitutes a justified measurement of punishment. AI detection systems must differentiate between work done by students and work generated by machines, as inaccuracies will lead to doubts about AI's capability to write essays. This lack of precision needs to be addressed by developing algorithms that align with existing technologies to support learning. To address the limitations associated with AI-based assessments, the following recommendations have been proposed to enhance their effectiveness:

1. Design and develop advanced AI programs to analyze all submitted documents and provide follow-up comments to improve students' writing skills.
2. Integrate comments with AI attestations to combine the advantages of both systems. Instructors should be equipped to understand and utilize AI tools while helping students enhance their reasoning abilities.
3. Regularly update AI detection systems to differentiate between genuine student work and AI-generated content, promoting trust and academic integrity in assessing argumentation skills.
4. Conduct a thorough analysis of how skills evolve through various submissions and environments. This will illustrate how technology can enhance skill acquisition and writing competencies.

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