

AI-Driven Tools in Providing Feedback on Students' Writing

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ABSTRACT

Artificial Intelligence (AI) has seen substantial progress in recent years, establishing itself as a crucial element in diverse sectors, particularly education. Providing feedback is one of the key areas where AI has made a notable impact, and it is essential for fostering students' learning, particularly in developing writing skills. Feedback in writing represents a critical component of effective teaching practices, and AI introduces innovative approaches to enhance its delivery and impact. This systematic review rigorously examines the existing body of literature on the use of AI in educational feedback systems. By synthesizing findings from scholarly research, the review explores the effectiveness, challenges, and prospects of AI-driven feedback mechanisms. The studies illustrate the potential of AI to deliver personalized, timely, and constructive feedback while also addressing challenges such as integrating AI tools into diverse pedagogical contexts and their applicability across various educational levels. Furthermore, the review identifies significant gaps in the current literature and suggests directions for future research to optimize AI-powered feedback for improving students' writing abilities. This study aims to serve as a valuable resource for educators, researchers, and policymakers striving to harness the potential of AI in enhancing feedback practices.

Keywords: Artificial Intelligence, Automated Feedback, Writing Skill, Systematic Review, Feedback

INTRODUCTION

Feedback is a fundamental aspect of effective teaching and is particularly crucial for developing writing skills [1]. Nevertheless, delivering meaningful feedback on writing can be a labor-intensive process for educators, often resulting in delays in evaluations. Conventional feedback methods, which depend entirely on human instructors, frequently fail to offer the timely and personalized feedback needed to enhance students' writing abilities [2]. This limitation has sparked interest in exploring innovative solutions that can alleviate the burden on educators while improving the quality of feedback.

The advent of Artificial Intelligence (AI)-based feedback systems, particularly those utilizing Natural Language Processing (NLP) and Machine Learning (ML), presents a transformative approach by automating feedback processes and delivering real-time assessments. AI tools, such as ChatGPT, have shown the capability to approximate human feedback in both content and style, demonstrating their effectiveness in supporting formative assessment [3]. Nevertheless, challenges persist, especially in generating nuanced and contextually relevant feedback, emphasizing the need to integrate AI-driven feedback with human input [1], [4]. While AI has been widely applied across various domains, its potential to enhance feedback for improving students' writing skills remains relatively underexplored.

This study represents a novel contribution by systematically reviewing the existing literature to evaluate the impact of AI in providing feedback for teaching writing. Through an analysis of the educational context, the various types of AI-driven feedback, and the identification of gaps in current practices, this research provides valuable insights that deepen the understanding of AI's role in enhancing writing instruction. Additionally, it paves the way for future innovations in this area.

The study is structured around the following research questions:

- i. What are the emerging trends in AI-driven feedback research?
- ii. What is the distribution of research on AI-driven feedback tools across educational levels?
- iii. What AI-driven feedback tools have been used in previous studies?

LITERATURE REVIEW

Feedback in writing

Effective feedback requires delivering detailed, actionable, and timely insights to students, helping them to refine their writing processes and outputs. Research reveals that meaningful feedback can considerably boost learners' cognitive engagement and promote more excellent knowledge of writing [5]. However, traditional feedback methods have been critiqued for being time-consuming and inconsistent. Educators often face challenges in providing high-quality feedback due to large class sizes, frequently resulting in delayed responses [6].

AI-driven feedback tools in providing feedback

Integrating AI into feedback mechanisms has introduced innovative solutions to overcome the challenges in education, particularly by transforming the feedback process. Advances in Natural Language Processing (NLP) and Machine Learning (ML) have opened new possibilities for automating feedback in writing instruction [6], [7]. Early AI-based writing tools, such as Grammarly and Criterion, primarily provided surface-level feedback, focusing on syntax, punctuation, and sentence structure. These tools significantly reduced instructors' workload, enhancing the efficiency of the feedback process. However, they demonstrated limitations in addressing more complex aspects of writing, such as coherence, reasoning, and creativity [8], [9].

Recent advancements in Natural Language Processing (NLP) and Machine Learning (ML) have significantly expanded the capabilities of AI-driven feedback mechanisms, allowing for more detailed and nuanced evaluations. Tools like ChatGPT, Chatbots, and Automated Grading Systems have proven effective in assessing content and writing style while providing recommendations for improvements in organization and reasoning [7]. These AI systems now offer feedback that closely mirrors human evaluations regarding content depth and stylistic nuance, making them increasingly valuable for formative assessment in writing [3].

As AI-driven feedback systems evolve, their application spans various educational contexts, from K-12 classrooms to higher education and professional development programs. AI technologies have demonstrated considerable potential in scaffolding learners through automated corrections and suggestions tailored to their skill levels [10]. A significant use of AI in writing instruction is in formative evaluation, where real-time feedback enables students to refine their work continuously [5]. AI tools, such as Automated Writing Evaluation systems, facilitate self-directed learning by providing prompt, actionable feedback, offering benefits in asynchronous learning environments.

Challenges in utilizing AI-driven feedback tools

Despite the promising potential of AI-driven feedback methods, several significant challenges remain. A primary concern is the inherent bias within AI systems, which can result in inconsistent or culturally inappropriate responses [10]. AI tools like Grammarly are effective at detecting surface-level issues such as grammar and punctuation but often fail to address cultural nuances or thematic depth in writing, which are critical for diverse educational contexts [9]. Language models trained predominantly on Western-centric data may marginalize non-Western perspectives or misinterpret non-standard English varieties, as evidenced in studies examining their application in EFL (English as a Foreign Language) contexts [11]. This can result in feedback that is inconsistent or culturally inappropriate.

Additionally, AI-driven tools struggle to accurately assess the nuances of creative writing or advanced

academic texts [8], [9], where subjective judgment and contextual understanding are crucial. LLMs like ChatGPT excel at providing immediate, criteria-based feedback but often lack the formative, qualitative depth necessary for advanced learning [9].

To address these limitations, the researchers advocated the integration of both AI and human input [12], [13], [14], combining the strengths of both approaches for more effective feedback. Combining the efficiency of AI with the contextual understanding of human feedback provides a more holistic and equitable feedback mechanism across educational settings [14].

Integration with Traditional Feedback

Integrating AI-driven feedback tools with traditional feedback offers a hybrid approach that leverages the strengths of both feedback systems. AI tools are adept at providing immediate, consistent, and surface-level feedback on aspects such as grammar and syntax. In contrast, traditional feedback methods address higher-order aspects like coherence, creativity, and argumentation. Studies demonstrate the efficacy of hybrid feedback models, where AI systems handle technical corrections, allowing educators to focus on content-driven feedback [4]. Tools like ChatGPT improve student engagement and revision quality when paired with instructor evaluations during the drafting processes [5]. Meanwhile, instructors can concentrate on complex issues, such as logical organization and idea development, thereby enhancing the overall learning process [15].

Furthermore, scaffolded feedback approaches further illustrate how AI and traditional methods can complement each other. AI systems like Pigai provide students with immediate, actionable feedback on mechanical aspects of their writing, enabling them to make self-directed improvements before receiving teacher input. Additionally, collaborative frameworks integrate AI feedback with peer and teacher evaluations, ensuring students engage deeply with revisions and benefit from diverse perspectives [1]. By leveraging both approaches, educators can optimize writing instruction, but further research is needed to refine these hybrid models and address their limitations.

Research gap

Although tremendous work was made in building AI-driven systems for writing feedback, some gaps remain in the literature. Most studies have concentrated on higher education, with limited exploration of AI-driven feedback applications in primary and secondary education settings. Additionally, research remains scarce on how AI systems address higher-order writing issues such as coherence, creativity, and the effective communication of ideas. Another notable gap is the lack of investigation into how AI-driven feedback can be integrated with traditional teaching methods to create a more comprehensive approach to writing instruction. This analysis highlights the need for further research into designing and implementing AI feedback systems that are adaptable to diverse writing contexts and purposes.

METHODOLOGY

The systematic review employed a rigorous and structured approach to identify, evaluate, and synthesize relevant research on AI-based feedback in writing. A comprehensive search was conducted across prominent academic databases, including Scopus and Web of Science, focusing on publications from 2018 to 2024. Initially, 298 studies were identified, and through predefined inclusion and exclusion criteria—focusing specifically on studies that addressed AI-driven feedback mechanisms in educational settings, particularly concerning writing skills—75 articles were selected for detailed analysis. The selected studies employed a variety of methodological approaches, including experimental designs, case studies, and qualitative research. The findings from these studies were synthesized to identify common themes, with particular emphasis placed on the publication trends and the educational context of AI-driven feedback and the types of AI-driven tools used in the studies.

Data sources

Data for this study was collected from two reputable and frequently cited academic databases, which are

Scopus and Web of Science (WOS), which are regarded as reliable sources for evaluating research impact [16]. The selection of articles was based on advanced search techniques, utilizing specific search terms such as "AI feedback in writing," "AI-generated feedback," "automated feedback," and "automated writing assessment." To ensure the inclusion of recent research in the field, the search was limited to publications published between 2018 and 2024, capturing the latest developments and breakthroughs in AI applications within the education sector.

Process flow

To illustrate the process of identifying, screening, qualifying, and selecting articles for inclusion, a PRISMA flowchart (Figure 1) was created. During the identification phase, 298 articles were retrieved from both Scopus and WOS databases. Following the application of inclusion and exclusion criteria application during the full-text review, 75 articles were ultimately selected for inclusion in the systematic review. Articles were excluded based on several factors, including non-English language, lack of empirical study, and irrelevance to the study's focus.

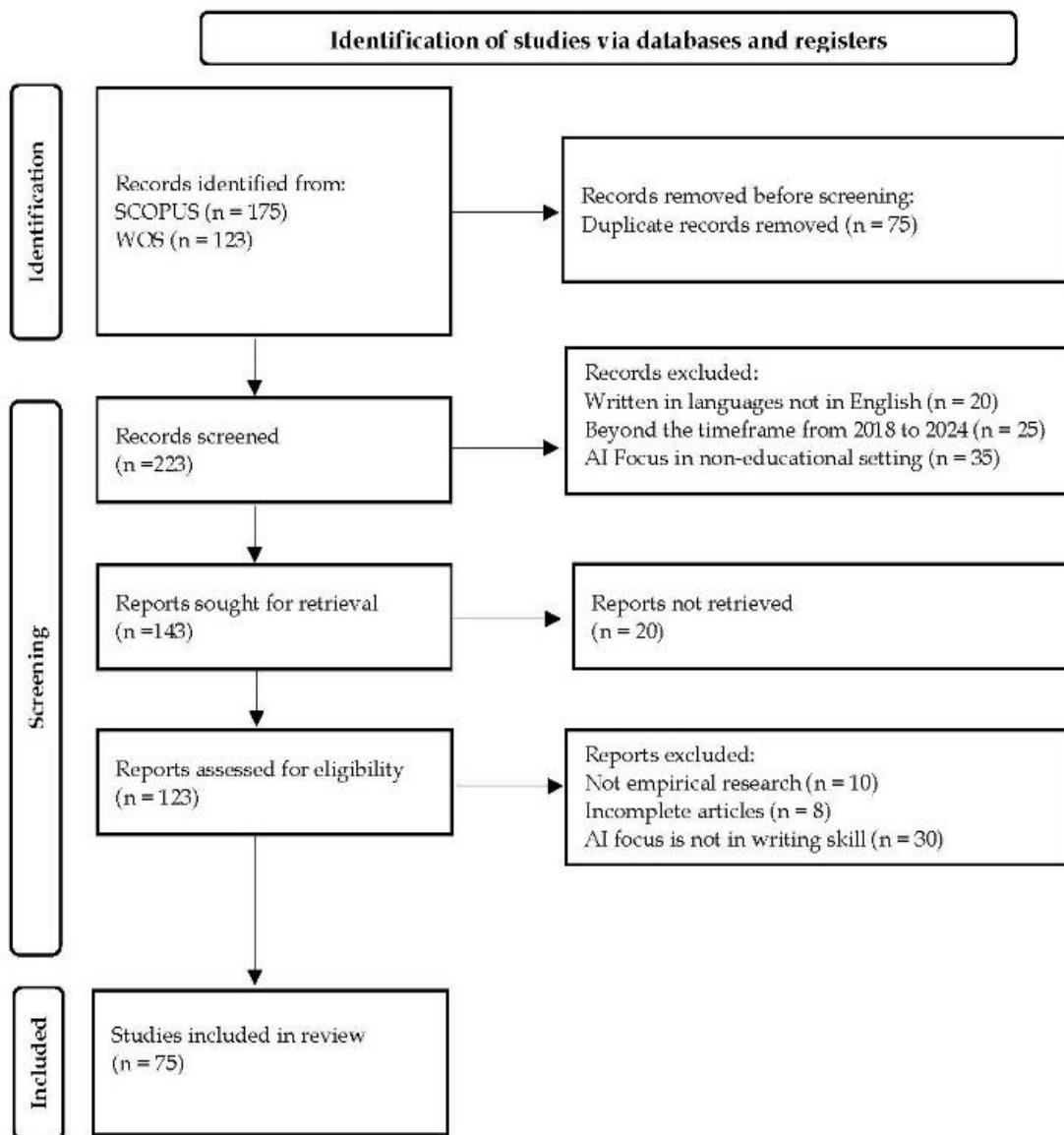


Fig. 1 Process flow using PRISMA

Research procedures

All 75 articles were downloaded and examined to identify the inclusion eligibility in the final review. The process adhered to the inclusion and exclusion criteria specified in Table 1.

Table. 1 Inclusion and exclusion criteria for article selection

No.	Criterion	Inclusion Criteria	Exclusion Criteria
1.	Language	English must be the primary language used in the article.	Articles that were written in languages other than English.
2.	Research Setting	The focus is on AI-driven or automated feedback in education, particularly in writing.	AI focused on non-educational settings or language skills other than writing.
3.	Research Method	Empirical primary research articles employ qualitative, quantitative, or mixed methods.	Theoretical or conceptual articles are excluded.
4.	Publication Date	Articles that were published from 2018 to 2024.	Publications from other years are excluded.
5.	Publication Source	Only peer- reviewed journal articles from the Web of Science or Scopus were indexed.	Master’s and PhD thesis, book chapters, biographical items, and review articles are excluded.
6.	Content	AI-driven or automated feedback is the primary focus in teaching and learning.	AI feedback in language learning is not the prior focus, so the AI-driven mechanisms should not be mentioned.

Six criteria were used to determine the inclusion and exclusion criteria. This method is used to identify the most significant articles. A total of 298 papers were initially retrieved. However, 40 papers were selected for inclusion in this systematic review after applying the inclusion and exclusion criteria,

FINDINGS AND DISCUSSION

The systematic review elucidates three pivotal findings regarding the usage of AI-driven feedback systems in the context of teaching writing. The results and discussion for this study are presented according to the research questions.

Research Question 1: What are the emerging trends in AI-driven feedback research?

When reviewing the years of publication in this review (Figure 2), the emerging publication trends depicted in the graph highlight the increasing prominence of AI-driven tools in providing feedback over the years. The data also indicates a significant increase in academic interest in this topic, reflecting its increasing relevance and impact in research and practice.

From 2018 to 2024 In 2018, only one study was recorded, marking the field’s early adoption and initial exploration of the field. A steady growth is observed from 2018 to 2021, with the number of studies rising incrementally to 4 by 2021. This period reflects the foundational stage of the research domain. However, the growth becomes more pronounced from 2022 onward, with a steep rise in publications, reaching 9 studies by 2023. By 2024, the number of studies reached 13, indicating a substantial acceleration in research. This trend suggests that the field has matured and gained widespread recognition over the years, driven by advancements in AI technologies. It also shows a growing acknowledgment of its effectiveness in enhancing feedback mechanisms across various domains.

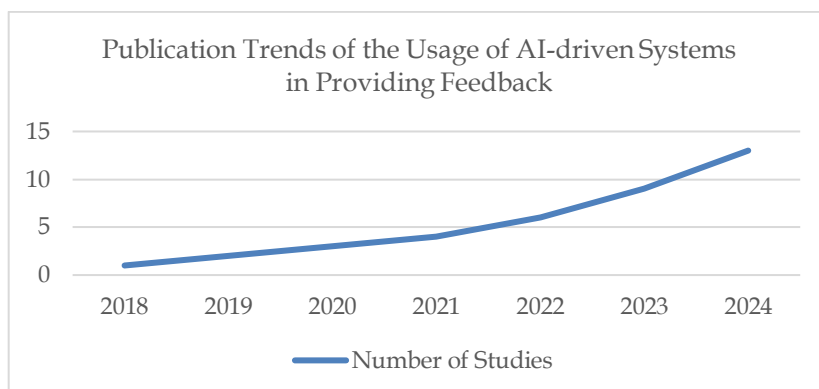


Fig. 2 Publication trends in years

The rapid growth in publications, particularly from 2022 to 2024, can be attributed to advancements in AI technologies. Innovations in machine learning, natural language processing, and generative AI have made AI-driven feedback tools more robust and accessible, especially their effectiveness in improving feedback timeliness and personalisation [17], [18]. These technological breakthroughs likely enabled researchers to explore diverse applications and evaluate the effectiveness of AI in various contexts.

Furthermore, the surge in research after 2020 could also be linked to the COVID-19 pandemic, which necessitated the adoption of digital tools in education and workplaces. AI-driven feedback tools became essential in remote learning and virtual environments, where immediate, personalized feedback was critical for maintaining productivity and engagement [19]. This societal shift likely spurred academic interest and led to an increase in studies.

Research Question 2: What is the distribution of research on AI-driven feedback tools across educational levels?

Most of the published studies were in tertiary schools (n=24), reflecting a strong interest in leveraging these tools for advanced academic writing and research. It is then followed by teachers' institutions (n=6), secondary schools (n=5) and lastly primary schools' context (n=2). This indicated that AI-driven feedback mechanisms have been intensively used in tertiary schools' context.

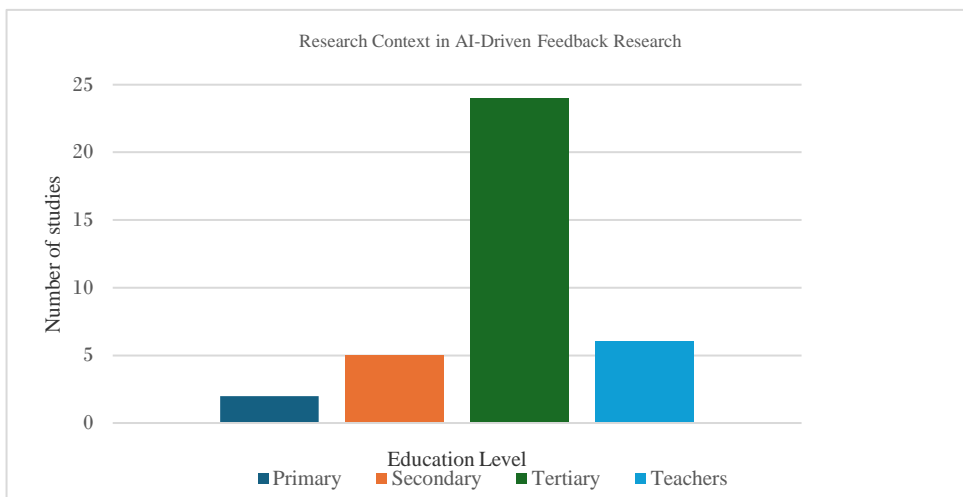


Fig. 3 Educational levels of the students in AI-driven feedback research

Research on AI-driven feedback predominantly focuses on tertiary education, highlighting the sector's critical demand for efficient feedback mechanisms to support the development of advanced writing skills among a diverse student population. This emphasis aligns with recent studies indicating that higher education institutions increasingly adopt AI technologies due to their ability to provide detailed, systematic, and prompt feedback. Such tools have been shown to streamline the revision process and improve students' writing proficiency [3], [5].

The limited exploration of AI-driven feedback in primary and secondary education reveals a significant gap in understanding its role in early-stage writing development. With only two studies addressing this educational context, further investigation is essential to examine how AI tools can effectively support young learners during their formative years. Preliminary evidence suggests that automated feedback systems, such as Pigai, hold promise for foundational writing instruction but require additional teacher intervention to yield comprehensive outcomes [19]. Given that primary education lays the groundwork for lifelong learning [19], it is critical to assess how AI-driven feedback can meet the unique needs of this age group, enhance their foundational writing skills, and integrate seamlessly with traditional teaching methods.

Moreover, the existing research on teacher development through AI-driven feedback highlights a significant gap that warrants further exploration. Teachers are pivotal in applying and interpreting AI-generated feedback,

as they provide the human judgment necessary to address complex writing elements, such as coherence and organisation, which AI systems struggle to handle effectively [21]. Despite this, studies are scarce exploring how these technologies can foster teachers' professional development or enhance their feedback practices. This gap underscores the need for hybrid feedback models that combine AI's efficiency with educators' contextual awareness. Such an approach not only improves the quality of feedback provided to students. It also offers teachers professional growth opportunities by alleviating their workload and allowing them to focus on higher-order instructional tasks [11] [21].

Future research should prioritize examining how AI-driven technologies can be tailored to meet primary and secondary learners' unique needs while ensuring their effective integration into classroom practices. While AI-driven feedback systems have demonstrated significant advantages in higher education, expanding the scope of research to encompass primary and secondary education, along with teacher development, is crucial. Such efforts would contribute to creating an inclusive framework that supports diverse learning needs across educational levels, leveraging the complementary strengths of AI and human evaluators to optimize the feedback process.

Research Question 3: What AI-driven feedback tools have been used in previous studies?

Table 1 summarizes the types of AI-driven feedback systems identified in previous studies. ChatGPT emerged as the most frequently studied system, accounting for 34% of the studies. Grammarly followed, being featured in 17.6% of the research. Other tools, such as Pigai (8.8%) and various systems including, Aim Writing, MY Access!, WhiteSmoke, and several others, were each examined in 2.9% of the studies. Additionally, 14.7% of the studies utilized unspecified AI-driven feedback tools, highlighting the use of generic or unreported systems in some research.

Table. 2 AI-driven feedback systems

Number	AI-driven feedback systems	Number of studies	Percentage (%)
1	ChatGPT	12	32.43
2	Grammarly	5	13.51
3	Pigai	3	8.11
4	Aim Writing	2	5.41
5	MY Access!	1	2.70
6	WhiteSmoke	1	2.70
7	InfinigoChatIC	1	2.70
8	Textopia	1	2.70
9	MI Write	1	2.70
10	ProofWriter	1	2.70
11	Packback	1	2.70
12	QuillBot	1	2.70
13	SafeAssign	1	2.70
14	Unspecified Tool	6	16.22

The data indicate that ChatGPT and Grammarly are the leading AI-driven feedback systems in the research landscape. ChatGPT's prominence can be attributed to its advanced natural language processing capabilities and broad accessibility, positioning it as a versatile tool across various educational contexts [2], [5], [7].

On the other hand, Grammarly is notably recognized for its focus on grammar and style improvement, significantly reducing the time educators invest in error correction. This makes it an invaluable tool for enhancing writing quality. Research indicates that Grammarly excels in providing surface-level corrections and stylistic suggestions, proving an effective aid in writing development [22].

However, human feedback maximizes its utility when used [12], [19]. Despite their effectiveness in addressing lower-order concerns, both tools face limitations when it comes to higher-order aspects of writing, such as content coherence and organization. While emerging systems like ChatGPT show promise in addressing these

higher-order issues, their ability to offer meaningful, contextually relevant suggestions for complex writing is still in development.

The relatively limited attention given to tools such as Pigai, Aim Writing, and MY Access! suggest that these systems are either less widely adopted or applied in more specialized educational contexts. For example, Aim Writing has demonstrated low generalizability, with participants indicating a preference for hybrid feedback models that integrate automated systems with teacher feedback to address the diverse needs of learners [4]. This finding implies that while AI-driven systems can be effective, their full potential in writing instruction may be realized when complemented by human expertise. Consequently, further research is warranted to explore these less-studied tools and assess their unique contributions to writing development.

In addition, 14.7% of studies that report undefined tools highlight potential challenges in standardizing research methodologies and reporting practices within the field. The absence of clear tool identification complicates cross-study comparisons and hampers the reproducibility of findings. Future research should provide more precise methodological definitions to enhance consistency and improve the comparability of studies.

Overall, the findings underscore the dominance of a few prominent AI tools in feedback research while emphasizing the need to expand the focus to include lesser-studied systems for a more comprehensive understanding of their role in writing instruction. This aligns with calls for hybrid feedback models that combine the efficiency of AI with the nuanced insights provided by human evaluators [5], [12]. Broader research into these underexplored AI tools and their specific contributions to writing instruction is essential for developing a more thorough knowledge of how these systems can be optimally implemented across diverse educational contexts.

CONCLUSION AND RECOMMENDATION

The review emphasizes the progression of feedback practices over the seven years from 2018 to 2024, shifting from traditional instructor-led methods to AI-driven automated systems. Although current research highlights the efficiency of AI in delivering systematic, timely, and consistent feedback, its use in primary education remains largely unexplored. Bridging this gap is essential to fostering early writing development among younger learners.

Previous studies have shown that AI systems can provide timely, structured feedback that improves student performance [1], [3]. These findings suggest that AI-generated feedback mirrors human evaluations in aspects such as content, grammar, and syntax while offering consistent guidance that helps students enhance their writing skills.

The integration of AI in writing instruction should be regarded as a complement to, rather than a substitute for, traditional feedback methods. Combining AI-driven tools with conventional approaches has the potential to address diverse learning requirements and improve the overall quality of writing instruction [14], [19]. To ensure successful integration, educators should establish clear goals for using AI tools in their classrooms, whether the focus is on improving grammatical accuracy or supporting self-directed revisions. Defining the specific objectives will help educators to select the most appropriate AI tools and tailor their usage to student needs. By aligning tool selection with instructional priorities, educators can ensure that AI enhances, rather than overshadows, traditional feedback methods.

Moreover, embedding AI into collaborative learning activities can significantly enrich the feedback process. For instance, AI-generated feedback can serve as a foundation for collaborative revision activities, allowing students to refine their drafts based on AI suggestions before seeking input from the teachers [4]. This integration not only improves the quality of revisions but also fosters active engagement with feedback, encouraging students to reflect critically on their work rather than passively accepting corrections [3], [22]. By engaging with AI feedback, students can address surface-level issues effectively while building the confidence and motivation needed to tackle more complex writing tasks [9]. This process further deepens their understanding of writing principles and builds their ability to independently identify and address areas for

improvement in their work [9].

Future research should prioritize the development of hybrid feedback systems that capitalize on the strengths of both AI and human input. Additionally, it is essential to address ethical considerations and tailor these tools to accommodate the varied needs of learners. By refining AI systems and examining their long-term effects, significant advancements can be achieved in promoting equitable and effective writing instruction across diverse learner populations.

In conclusion, the current scope of research and the highlighted gaps lay a solid foundation for developing a comprehensive journal paper. By building on existing findings and tackling the identified challenges, this study has the potential to significantly advance both theoretical understanding and practical applications in writing instruction.

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