Integrating Quillbot to Enhance Students' Academic Writing: Opportunities and Challenges

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ABSTRACT

With the rise of AI tools, QuillBot has been widely used in academic writing, especially among EFL students. Although its application has been widely studied, existing research lacks a systematic summary of its strengths and limitations. This study critically reviewed 15 peer-reviewed articles published between 2020 and 2024 to comprehensively evaluate the role of QuillBot in academic writing. Through qualitative thematic analysis, this paper derived four key themes: (1) emotional and behavioral impact, (2) effectiveness in skill building, (3) user experience and accessibility, and (4) ethical issues and challenges. The results show that QuillBot can enhance paraphrasing, grammar correction, and vocabulary acquisition while reducing anxiety and improving learning motivation. However, challenges such as over-reliance, reduced creativity, and unequal resource allocation due to language barriers and technology differences remain. It is worth noting that the existing research has methodological limitations, including reliance on subjective feedback, inconsistent tool versions, and insufficient long-term or cross-cultural data. Future research should prioritize longitudinal studies, explore language and cultural adaptability, and explore ethical implications. This study provides practical recommendations for educators, policymakers, and developers on how to effectively integrate QuillBot into instruction while strategically mitigating associated risks.

Keywords: AI-assisted writing, EFL learners, Technology integration in education

1. Introduction

In the era of globalization, English academic writing has become an indispensable skill for students worldwide, especially for EFL learners (Tran & Nguyen, 2022). Academic writing requires learners to master grammar, rewriting skills and logical organization skills (Badenhorst, 2010), while EFL learners also need to overcome difficulties such as imprecise language expression and misunderstandings caused by cultural differences. At the same time, technical assistance represented by AI tools provides innovative solutions for academic writing (Onesi-Ozigagun et al., 2024; Zhang & Lu, 2021). Among many AI tools, QuillBot stands out for its functions, such as rewriting, grammar checking, and text summarization (Dale, 2020). Notably, the rewriting function, which instantly replaces vocabulary or reorganizes sentences, is widely welcomed by students (Zulfa et al., 2023).

However, although QuillBot has received much attention and is widely used in academic writing assistance, existing research still has significant deficiencies. Nurullah et al. (2024) noted that current research lacks a comprehensive, systematic, and in-depth analysis of the advantages and limitations of QuillBot, and the views are relatively scattered. Although some studies have shown that QuillBot can alleviate writing anxiety and improve rewriting and grammar skills (Bailey & Almusharraf, 2022; Waluyo et al., 2023; Laila & Daulay, 2024), these studies mostly rely on subjective feedback and lack systematic evaluation and subject classification. Gozali et al. (2024) further emphasized that existing research has not fully considered multilingual and multicultural backgrounds, resulting in doubts about the universality of research conclusions. More importantly, the existing literature has failed to integrate technology acceptance, learner psychological mechanisms and knowledge construction theories, making it difficult to explain the deep mechanism of QuillBot's impact on writing ability (Marikyan & Papagiannidis, 2024; Taoufiq, 2024). This limitation makes it difficult for people to accurately understand the actual effects and application boundaries of QuillBot in various educational environments, which significantly restricts its in-depth application in education. Considering the differences between EFL learners and native learners in academic writing, as well as the diversity of various academic writing tasks, existing research has neglected these aspects, making it difficult to accurately understand the real role of QuillBot in different learners and writing situations.

Based on the above research gaps, this study aims to comprehensively explore the impact of QuillBot on the academic writing of EFL learners and propose effective strategies to address its challenges.

To achieve this goal, this study sets the following research questions:

1. How does QuillBot affect EFL learners' academic writing in multiple dimensions, including emotional behavioral responses, skill development, and user experience?
2. How does the technology acceptance model, self-perception theory, and connectivism theory jointly explain the mechanism of QuillBot, especially the interrelationships between key variables?
3. What evidence-based strategies can address the challenges posed by QuillBot at the instructional, policy, and technical levels?

Methodologically, this study employs thematic analysis (Nowell et al., 2017) to extract key variables from 15 articles through open coding, thereby avoiding the interference of theoretical assumptions on data classification and ensuring that the analysis results accurately reflect the actual research trends.

2. Literature Review

This literature review will examine the impact of QuillBot on academic writing, encompassing its emotional and behavioral effects, effectiveness in enhancing writing skills, user experience and accessibility, as well as the challenges and concerns associated with it.

2.1. The Emotional Impact

Existing research shows that QuillBot has a significant impact on the emotional state of EFL learners, which can be explained from the perspective of self-cognition theory (Bem, 1967). This theory holds that individuals infer internal attitudes by observing their behavior (Mohebi & Bailey, 2020). In academic writing scenarios, when EFL learners use QuillBot to complete rewriting tasks, the successful experience prompts them to attribute the results to their improved abilities, thereby enhancing their self-confidence and reducing anxiety. This attribution process aligns with Bandura's (1997) self-efficacy theory, which posits that successful experiences with tools reinforce learners' beliefs in their capabilities, thereby enhancing their confidence and self-efficacy. Many studies support this mechanism. Ariyanti (2021) found through the FLE questionnaire that when students used QuillBot for rewriting tasks, their anxiety levels were significantly reduced, and their learning interests and participation were significantly improved. Similarly, Kramar et al. (2024) demonstrated in their interviews with Ukrainian doctoral students that QuillBot significantly enhanced their confidence in written English communication in the workplace. These findings jointly verify the applicability of self-cognition theory in AI-assisted tools for academic writing situations and provide a basis for educators to alleviate students' writing anxiety by using technological tools. However, existing research has obvious limitations in terms of the prevalence and persistence of emotional impact. Most studies have only confirmed short-term positive effects (Bailey & Almusharraf, 2022; Waluyo et al., 2023), and there is a lack of long-term follow-up studies.

In addition, Mohammad et al. (2024) specifically emphasized gender differences, noting that girls tend to show stronger motivation and benefits. However, another research team, Mohammad et al. (2024), also studied preparatory students at Najran University, and the results showed that the impact of gender differences was not obvious at a specific stage of education. This may be because the students in the two studies had different levels of knowledge, or they used different versions of QuillBot. This contradiction suggests that the emotional impact may be regulated by multiple factors, such as individual learner characteristics and the educational environment (Gozali et al., 2024), and further highlights the complexity of situational factors. To more comprehensively evaluate the long-term emotional effects of QuillBot, future research can adopt longitudinal tracking methods, such as measuring students' writing anxiety levels and changes in self-confidence at the beginning and end of the semester and combining them with objective assessments of writing ability to verify whether emotional improvements are truly transformed into ability improvements.

From the perspective of variable extraction, existing research primarily focuses on three key dimensions: alleviation of writing anxiety, increased self-confidence, and the impact of gender differences on usage motivation. These variables not only constitute the core elements of emotional impact but also provide an empirical basis for constructing subsequent research models. It is worth noting that the current research samples are primarily focused on skilled users in

resource-rich environments, and insufficient attention is paid to the emotional experiences of resource-constrained students or learners at different language levels, which may limit the generalizability of the research conclusions. In view of this limitation, future research can expand the sample range to include learners with different socioeconomic backgrounds, language proficiency, and technology accessibility, and adopt mixed research methods to more comprehensively capture the differences in the emotional impact of QuillBot in different groups.

Connectionist theory (Siemens, 2004) offers a complementary perspective for understanding these findings. This theory highlights the process of forming knowledge connections in a digital environment, and QuillBot helps learners incorporate new language knowledge into their existing cognitive systems through real-time feedback (Corbett & Spinello, 2020). This process of forming knowledge connections may indirectly enhance positive emotional experiences. For example, when students realize they can organize text logic more fluently with QuillBot, their sense of self-efficacy increases accordingly. However, this theoretical link has not been thoroughly explored in the current literature, as most studies only describe phenomena. To strengthen theoretical understanding, future research could design controlled experiments to compare students' ability to connect knowledge before and after using QuillBot, thereby empirically testing the application of connectionism theory in AI-assisted writing.

In summary, although existing studies have confirmed the positive impact of QuillBot on the emotions of EFL learners, several limitations exist. First, there is a lack of long-term tracking data, and it is impossible to determine whether emotional improvement will continue to translate into improved writing ability. Second, the sample diversity is insufficient, particularly in the absence of comparative studies on learners with varying language levels and cultural backgrounds. Finally, the theoretical integration is not deep enough, and it fails to systematically reveal the interaction between self-cognition and the knowledge connection mechanism. This is directly related to the core question of this study: how QuillBot affects writing ability and how to provide emotional support. To address these challenges, educational practitioners can design phased writing tasks in conjunction with QuillBot. First, let students complete the first draft independently. Then, use QuillBot to assist in revision. Finally, compare and analyze the differences to cultivate independent writing skills while reducing reliance on tools.

To present the relevant research more clearly, the researcher compiled Table 1.

Table 1: Summary of Research on the Impact of QuillBot on Emotions

Study	Key Constructs	Key Findings	Theoretical Linkage
Ariyanti (2021)	Writing anxiety, Learning motivation	QuillBot significantly reduced writing anxiety and increased learning participation.	Self-perception theory
Kramar et al. (2024)	Self-confidence	PhD students reported enhanced confidence in professional English communication.	Self-perception theory
Mohammad et al. (2024)	Gender-based motivation differences	Female learners showed higher motivation, but gender effects varied by educational level.	TAM (perceived usefulness)
Mohammad et al. (2024)	Gender impact at preparatory levels	Gender differences were negligible among preparatory-level students.	Connectivism theory

Table 1 summarizes the empirical evidence of QuillBot's impact on emotions, revealing four main constructs: anxiety reduction, increased self-confidence, and gender-adjusted motivation. The

results of the study collectively confirm the relevance of self-perception theory in the context of AI-assisted writing.

Based on existing research, it is found that the emotional impact of QuillBot on EFL learners is primarily reflected in three key variables: relief from writing anxiety, improvement in self-confidence, and changes in motivation, which are influenced by gender differences. These variables are explained by the "behavioral attribution" mechanism in the self-cognition theory (Bem, 1967). Learners attribute the successful writing experience using QuillBot to their ability improvement, thus forming a positive self-cognition. These variables collectively constitute the "emotional impact" dimension in the research framework, providing a theoretical basis for the subsequent analysis of the psychological mechanisms underlying tool use (Bem, 1967; Taoufiq, 2024). It is worth noting that existing research on the long-term emotional effects and the differences between learners from different cultural backgrounds remains insufficient, indicating a direction for future research.

2.2. The Effectiveness of Improving Writing Skills

Existing research generally suggests that QuillBot has significant value in enhancing core writing skills, which can be explained from the perspectives of connectionism theory (Siemens, 2004; Downes, 2007) and the Technology Acceptance Model (Davis, 1989). Connectionism emphasizes that knowledge is acquired and constructed through connections in a digital environment, and the real-time language feedback provided by QuillBot is consistent with this learning mechanism. Mustapha and Adam (2024) found that QuillBot has a significant effect on improving paraphrasing skills, vocabulary acquisition and correcting grammatical errors in their study of Malaysian ESL learners. Similarly, Mohammad et al. (2023) found through interviews with learners in the Najran preparatory class that QuillBot can effectively improve learners' paraphrasing skills, synonym mastery, and ability to learn complex grammatical structures. At the same time, Rafida et al. (2024) also came to similar conclusions in their interviews with EFL students. These findings align with the concept of "perceived usefulness" in the Technology Acceptance Model (Davis, 1989). When students believe that QuillBot can effectively improve their writing skills, they are more willing to use the tool in the writing process.

However, these studies primarily rely on subjective feedback and lack verification from standardized tests or objective evaluation methods. Hasnah (2024) confirmed the positive role of QuillBot in helping students identify grammatical errors and generate original rewritten content by analyzing the academic paper predictions of EFL students at Muhammadiyah University, making the research findings more representative. However, this study did not conduct an in-depth analysis of the differences in the applicability of QuillBot for students with different writing levels. In addition, Kurniati and Fithriani (2022) conducted a more comprehensive comparison of the effects of QuillBot and other AI tools, finding that English graduate students in North Sumatra believed QuillBot was particularly effective in improving vocabulary and grammar skills, while also helping them organize texts more logically. It is worth noting that the study deliberately selected students who were familiar with QuillBot as the research subjects, which may affect the generalizability of the research results.

Through an in-depth analysis of the above studies, we extracted a series of key variables, including "rewriting ability improvement", "vocabulary increase", "grammatical error correction rate" and "text logical organization optimization". These variables are crucial to evaluating the role of

QuillBot in improving students' writing skills. From the perspective of connectionism theory, QuillBot helps students connect scattered language knowledge into a more systematic knowledge system by providing new language knowledge and text organization methods, thereby improving comprehensive writing skills (Siemens, 2004). At the same time, students' positive feedback on the improvement effect of QuillBot in "rewriting ability" and "vocabulary" also fully reflects their recognition of the "perceived usefulness" of the tool (Davis, 1989), which is directly related to the "writing skills improvement" dimension in the research model.

However, there are still some limitations in the current research. Most studies lack long-term tracking, and it is unclear whether QuillBot's effect on improving students' writing skills can be sustained. Additionally, the study did not fully consider the impact of students' language backgrounds and varying levels of proficiency on the tool's effectiveness. In the case of individual differences among EFL students and differences in academic writing, the effect of QuillBot on writing in various subjects may also vary. For example, humanities subjects may rely more on rewriting skills, while science and engineering subjects may focus more on logical organization. Similarly, EFL students with different English proficiency levels may have different needs and improvement effects when using QuillBot.

Based on this, future research can develop in the following directions. On the one hand, a longitudinal research method should be adopted to track students' use of QuillBot over a prolonged period and regularly evaluate their changes in writing skills, thereby gaining a more accurate understanding of the long-term impact of QuillBot. On the other hand, full consideration should be given to students' diverse language backgrounds and varying levels of proficiency. Group studies should be conducted with students from diverse native language backgrounds and varying English proficiency levels to explore the applicability and effectiveness of QuillBot in different groups. At the same time, future research should adopt a more mixed-methods approach, combining pre-test and post-test comparisons of writing tests with qualitative interviews to comprehensively evaluate the educational value of QuillBot. Furthermore, future research should investigate targeted approaches to address the challenges posed by QuillBot. Education policymakers need to design teacher training programs that guide students in balancing the use of tools and developing independent writing skills. Quillbot developers need to develop subject-specific customization functions and optimize Quillbot's feedback logic to meet the writing needs of various subjects.

To present the relevant research more clearly, the researcher compiled Table 2.

Table 2: Summary of Research on QuillBot's Effectiveness in Improving Writing Skills

Study	Key Constructs	Key Findings	Theoretical Linkage
Mustapha & Adam (2024)	Paraphrasing, Vocabulary, Grammar	QuillBot improved paraphrasing skills, vocabulary acquisition, and grammar correction.	TAM (perceived usefulness)
Mohammad et al. (2023)	Synonym mastery, Grammar	Enhanced paraphrasing skills and understanding of complex grammatical structures.	Connectivism theory
Rafida et al. (2024)	Writing clarity, Vocabulary	Improved grammar, text structure, and vocabulary enrichment.	TAM (perceived ease of use)
Hasnah (2024)	Originality, Error detection	Helped identify errors and generate original paraphrasing while maintaining academic quality.	Self-perception theory
Kurniati & Fithriani (2022)	Text coherence, Language development	Enhanced vocabulary, grammar, and logical text organization.	Connectivism theory

Table 2 shows the effectiveness of QuillBot in core writing skills, including paraphrasing, vocabulary expansion, and grammatical accuracy. It is worth noting that these improvements are associated with “perceived usefulness” and connectivism in the Technology Acceptance Model.

Based on the existing research, it is found that the core variables of QuillBot in improving EFL learners' writing skills include enhanced rewriting ability, vocabulary expansion, and grammatical error correction. These variables can be interpreted from two theoretical perspectives. The "perceived usefulness" of the Technology Acceptance Model (Davis, 1989) explains why learners adopt these functions, while the "knowledge network construction" of the Connectionist Theory (Siemens, 2004) explains how QuillBot helps learners integrate language knowledge through instant feedback. These variables are integrated into the "writing skills improvement" dimension in the research framework.

2.3. User Experience and Accessibility

Existing research has emphasized the friendliness of QuillBot's user interface, while also revealing significant differences in technology accessibility among different user groups. From the perspective of the Technology Acceptance Model (Davis, 1989), users' acceptance of tools depends largely on their perceived usefulness and perceived ease of use. Pham (2024) found through a questionnaire survey of ELS graduate students that respondents generally believed QuillBot had a user-friendly interface and was easy to operate, which could effectively improve their rewriting ability. This finding confirms the key influence of "perceived ease of use" on tool adoption in TAM. However, Tamilselvi et al. (2023) noted that the functions of the free version of QuillBot are significantly limited compared to those of the paid version. This version difference will lead to different user experiences, which in turn affect the overall effectiveness of the tool. These findings highlight that in the process of technology acceptance, the design characteristics of the tool itself may become a key variable affecting user experience and echo the moderating role of "perceived usefulness" in TAM.

Differences in technology penetration and digital literacy further exacerbate the inequality of user experience. Narayan (2024) found significant differences in students' familiarity with QuillBot and the frequency of its use among MUIT students. Less than two-thirds of students believed that such tools could improve their writing skills, while nearly half of the students worried that they might hinder independent learning and mastery of grammar. This phenomenon can be explained by the digital divide theory (van Dijk, 2020), which posits that unequal access to technological resources leads to differences in the effects of usage. It is worth noting that the sample size of this study is small and may not fully reflect the actual situation of students in remote areas, suggesting that future research should expand the sample coverage to improve the generalizability of the conclusions.

Based on the above research, this study identified key variables to systematically evaluate the user experience and accessibility of QuillBot. The variables of "interface friendliness" and "improved rewriting ability" directly reflect the user's evaluation of the tool's "perceived ease of use", "influence of version differences" reflects the moderating effect of tool design on "perceived usefulness" in TAM, and variables such as "familiarity with the tool", "frequency of use", and "influence on autonomous learning" reveal how the external factor of technology accessibility affects the final use effect through the digital divide. The extraction of these variables provides an empirical basis for building a research model and a theoretical framework to understand the differences in the applicability of QuillBot across various environments.

However, there are some limitations to the current research. Most studies fail to fully consider the differences in usage among students in various regions and technical environments, which makes the applicability of the research conclusions in a broader context questionable. At the same time, the comparative study of different versions of QuillBot is still not in-depth enough, making it difficult for users to provide clear suggestions for version selection and hindering developers from carrying out targeted optimization. It is particularly worth noting that the writing tasks of different disciplines may have different requirements for QuillBot functions, and learners of different English proficiency levels may also have different reliance on version differences and auxiliary functions. These factors may affect the user experience.

Future research can focus on the following directions. First, strengthen comparative research across regions and technology environments, and systematically examine the differences in the use of QuillBot under different infrastructure conditions. Second, conduct a more detailed functional comparison analysis of various QuillBot versions to provide accurate usage suggestions for different user groups. Additionally, it is essential to investigate ways to enhance users' autonomous learning and problem-solving skills through digital literacy training, thereby improving the overall user experience. These research directions not only help deepen our understanding of the application rules of AI writing assistance tools but also provide important references for promoting equity in educational technology.

To present the relevant research more clearly, the researcher compiled Table 3.

Table 3: Summary of Research on User Experience and Accessibility of QuillBot

Study	Key Constructs	Key Findings	Theoretical Linkage
Pham (2024)	Interface friendliness, Time management	User-friendly interface improved paraphrasing efficiency and time management.	TAM (perceived ease of use)
Tamilselvi et al. (2023)	Version disparities, Real-time feedback	Free version limitations negatively impacted user experience despite grammar/style benefits.	TAM (perceived usefulness)
Narayan (2024)	Technology access, Dependency risks	Low-tech environments showed uneven adoption, with concerns about over-reliance.	Connectivism theory

Table 3 reveals the differences in accessibility and user experience of QuillBot, with interface design and version restrictions having a significant impact on adoption. Additionally, the digital divide in low-tech environments further underscores the importance of equitable knowledge networks.

Based on existing research, the user experience variables revealed in this section include interface friendliness, version function differences, and inequality in technology accessibility. These variables directly correspond to the "perceived ease of use" construct of the Technology Acceptance Model (Davis, 1989). They are moderated by differences in resource allocation, as outlined in the Digital Divide Theory (van Dijk, 2020). In the research framework, these variables are classified as the "user experience and accessibility" dimension, which reflects the technical characteristics of tool design and highlights the restrictive role of the social environment on the effect of technology application (Selwyn, 2004). Current research does not adequately address cross-cultural differences in user experience, and the diversity of samples needs to be expanded in the future.

2.4. Concerns and Challenges

The existing literature reveals a series of problems and challenges encountered when using QuillBot. From the perspectives of TAM (Marikyan & Papagiannidis, 2024), self-perception theory (Bem, 1967), and connectionist theory (Siemens, 2004), these problems reveal the deeper impact mechanism of AI writing assistance tools on EFL academic writing. Mohammad et al. (2024) found through interviews with preparatory students at Najran University that students with low English proficiency often felt confused when using QuillBot, indicating that language barriers have become a key factor affecting the effectiveness of tool use. Additionally, students expressed concerns that QuillBot may limit their creativity and believed that ready-made solutions could weaken their ability to think independently (Franklin, 2024). This finding is consistent with the view of self-perception theory, which posits that when students rely too heavily on external tools, they may underestimate their abilities, which in turn affects their learning motivation (Bem, 1967).

Academic integrity issues are also a challenge that cannot be ignored when using QuillBot. Narayan (2024) found that students generally believed that overreliance on AI tools, such as QuillBot, could lead to lazy behavior and pose a threat to academic integrity. In addition, Thangthong et al. (2024) reported that two respondents mentioned that although the content was original, it was still judged as potential plagiarism by teachers and the Turnitin system, which caused them great distress. This phenomenon aligns with academic integrity frameworks (Bretag, 2016), which suggest that AI-generated content may blur the boundaries between original and assisted writing, thereby raising ethical concerns about authorship and accountability. From the perspective of connectionist theory, this technical limitation may hinder students from effectively building language knowledge networks through digital environments (Siemens, 2004).

Through an in-depth analysis of the above studies, this study identified key variables, including "language barrier impact", "over-reliance leads to reduced ability", "academic integrity threat", "learning inertia tendency", "risk of being misjudged as plagiarism", and "generated content errors". These variables are crucial to fully understand the challenges of using QuillBot. From the perspective of self-cognition theory (Bem, 1967), "over-reliance leads to reduced ability" and "learning inertia tendency" reflect that students may form negative cognitions about their writing ability due to their dependence on tools; while connectionism theory (Siemens, 2004) helps us understand how "language barrier impact" and "generated content errors" hinder students from effectively building language knowledge connections through digital environments. From the TAM perspective, "language barrier impact", "risk of being misjudged as plagiarism," and "generated content errors" affect students' perception of the usefulness of QuillBot.

There are some obvious limitations to the current research. Most studies only highlight the existence of these problems but lack in-depth discussions on how to effectively address them, making it difficult for educators, education policymakers, and tool developers to provide practical solutions. More importantly, given the differences in norms and requirements of academic writing across various disciplines, this will cause EFL students to face varying degrees of challenges when using QuillBot. For example, original thinking, as emphasized in the humanities, may be more susceptible to AI tools than standardized expressions in the natural sciences (Mohammad et al., 2024). Additionally, EFL students with varying English proficiency levels also exhibit different abilities to cope with these challenges. Students with lower English proficiency may find it more challenging to identify and correct errors in QuillBot-generated content, thereby increasing their risk of academic misconduct (Fitria, 2022).

To present the relevant research more clearly, the researcher compiled Table 4.

Table 4: Summary of Research on Concerns and Challenges of Using QuillBot

Study	Key Constructs	Key Findings	Theoretical Linkage
Mohammad et al. (2024)	Creativity limitations	EFL students reported language barriers and concerns about reduced creativity.	Self-perception theory
Thangthong et al. (2024)	Academic misconduct risks	QuillBot-generated content was sometimes misidentified as plagiarism despite original input.	Academic integrity framework
Narayan (2024)	Over-reliance, Motivation decline	Dependency risks included "lazy learning" tendencies and threats to independent learning.	TAM (perceived usefulness)
Franklin (2024)	Critical thinking hindrance	Overuse impeded critical thinking and organic writing skill development.	Connectivism theory
Fitria (2022)	Content inaccuracy	Output occasionally contained grammatical errors and nonsensical phrasing.	TAM

Table 4 lists systematic risks, including misidentification of plagiarism, creativity inhibition, and accuracy limitations. This multi-theoretical framework reveals how these challenges violate the principles of self-cognition, connectionism, and technology acceptance models. This suggests that these issues need to be addressed in the future.

Based on existing research, the main challenge variables identified include overdependence risk, creativity inhibition, and language barriers. These variables require explanation by combining three theories. Self-cognition theory (Bem, 1967) explains how dependent behavior weakens self-efficacy, connectionism theory (Siemens, 2004) highlights that technological limitations can hinder knowledge connections, and the Technology Acceptance Model (Davis, 1989) offers suggestions for improving tool design. These challenge variables constitute the unique "problem and challenge" dimension in the research framework, and their multi-theoretical explanatory characteristics also reflect the complexity of AI writing assistance tools (Cooperman and Brandão, 2024). To address these challenges, future research should focus on developing intervention strategies that strike a balance between technological convenience and learning autonomy.

3. Research Model

This study integrates the Technology Acceptance Model (Davis, 1989), Self-Perception Theory (Bem, 1967), and Connectivism (Siemens, 2004) to analyze the role of QuillBot in English foreign language academic writing. Previous studies have primarily explored isolated aspects of AI tools (Zawacki-Richter et al., 2019). In contrast, this study's multidimensional framework bridges the gap by unifying user behavior, cognitive mechanisms, and knowledge construction. The model encompasses writing skill improvement, emotional impact, user experience, accessibility, concerns, and challenges. Together, these dimensions answer the research questions of this study and reveal how QuillBot shapes learners' cognitive processes, emotional states, and practical outcomes. By connecting disciplinary theories, this approach enhances the understanding of the pedagogical significance of AI tools, providing educators and developers with practical insights.

3.1. Technology Acceptance Model

The Technology Acceptance Model was proposed by Davis in 1989, and its core variables are "Perceived Usefulness" and "Perceived Ease of Use" (Davis, 1989). The model believes that PU

and PEOU jointly determine users' acceptance of technology. In subsequent studies, Venkatesh et al. (2003) further expanded TAM. They proposed an integrated technology acceptance model, emphasizing the moderating role of social influence and convenience conditions on user behavior (Venkatesh et al., 2003). This theoretical development provides an important framework for understanding the multidimensional adoption mechanism of digital tools, particularly in analyzing user acceptance behavior of AI writing tools.

In this study, TAM provides direct theoretical support for explaining EFL learners' acceptance of QuillBot. PU corresponds to students' recognition of QuillBot's improvement of writing skills, while PEOU is reflected in users' evaluation of its interface friendliness and ease of operation (Marikyan & Papagiannidis, 2024). For example, Pham (2024) found through a questionnaire survey of ELS graduate students that respondents generally believed QuillBot's interface was intuitive and its rewrite function practical, which also reflected the dual driving role of PU and PEOU in tool adoption. In addition, the relevance of TAM extends to the dimension of "user experience and accessibility". Tamilselvi et al. (2023) pointed out that the functional differences between the free version and the paid version would weaken users' perception of PEOU, thereby affecting the overall willingness to use. This finding shows that the technical characteristics of tool design and social resource allocation jointly regulate the core variables of TAM.

At the methodological level, TAM guided the data collection and analysis design of this study. When screening the literature, the researchers prioritized empirical studies that focused on users' evaluation of QuillBot's "usefulness" and "ease of use" to ensure consistency with the theoretical focus of the research model. During the coding process, variables such as "interface friendliness" and "rewriting efficiency" were classified as PEOU, while "grammatical error correction effect" and "vocabulary expansion ability" were mapped to PU, thus closely combining the theoretical framework with thematic analysis.

It is worth noting that there is room for synergistic interpretation between TAM and connectionist theory. When users frequently use QuillBot due to high PU, the real-time feedback provided by the tool can accelerate the construction of language knowledge networks (Siemens, 2004). For example, Kurniati and Fithriani (2022) found that North Sumatran graduate students systematized scattered knowledge points through QuillBot's vocabulary replacement function, which not only reflects the impact of PU on behavior but also confirms the knowledge integration mechanism of connectionism.

3.2. Self-Perception Theory

Self-cognition theory was proposed by Bem in 1967. Its core idea is that individuals infer internal attitudes and motivations by observing their behavior (Bem, 1967). This theory emphasizes the feedback effect of external behavior on self-evaluation. For example, when students complete writing tasks by using tools, they will attribute the results to their ability improvement, thereby enhancing their self-confidence (Mohebi & Bailey, 2020). Subsequent studies have further expanded the application scenarios of this theory. For example, Taoufiq (2024) found that in digital learning environments, the immediate feedback of tools may trigger "attribution bias", that is, students may misjudge high-quality texts generated by AI as a reflection of their abilities. In this study, self-cognition theory provides a key framework for understanding the impact of QuillBot on the emotions and behaviors of EFL learners. Specifically, when students complete rewriting tasks using QuillBot, their behavioral results will strengthen their sense of self-efficacy through

"mastery experience" (Bandura, 1997), thereby reducing writing anxiety and changing learning motivation. For example, Ariyanti (2021) found through the FLE questionnaire that students' anxiety levels significantly decreased, and their learning participation increased after using QuillBot. This finding directly confirms the role of behavioral attribution in shaping emotional states. In addition, the study of functional characteristics.

At the methodological level, self-cognition theory guided the qualitative data analysis direction of this study. In the process of literature coding, the researchers focused on the self-evaluation statements of students after using QuillBot, and classified such data into sub-themes of "confidence enhancement" or "anxiety relief" (Nowell et al., 2017). For example, when analyzing the interview data of Ukrainian doctoral students by Kramar et al. (2024), the statement "After using QuillBot, I am more confident in workplace English communication" was coded as "self-efficacy improvement", reflecting the theory-driven analysis logic.

It is worth noting that there is a synergistic interpretation space between self-cognition theory and TAM. When students continue to use QuillBot due to its high "perceived usefulness", their successful experience will further strengthen their positive evaluation of the tool through self-attribution, forming a virtuous cycle of "tool adoption, behavioral feedback, and cognitive reinforcement" (Taoufiq, 2024). For example, Pham (2024) found that ELS graduate students' recognition of the ease of use of QuillBot's interface was significantly positively correlated with the increase in their confidence gained through the tool, indicating that TAM and self-cognition theory work together on the multi-level mechanism of user behavior.

3.3. Connectivism Theory

Connectivism theory was first proposed by Siemens in 2004 and further expanded by Downes in 2007. Its core view emphasizes the importance of building knowledge networks through node connections in digital environments (Siemens, 2004; Downes, 2007). The theory believes that learning is not an isolated accumulation of knowledge, but a cross-network knowledge integration formed through technical tools, social platforms, and dynamic information flows. In subsequent research, Dabbagh and Kitsantas (2012) proposed the "Personal Learning Environment" framework, applied connectivism to educational technology design, and emphasized that learners can autonomously construct cognitive systems through tool interaction (Dabbagh & Kitsantas, 2012). This development provides a theoretical basis for analyzing how AI writing tools promote knowledge networking. In this study, connectivist theory offers a key perspective for understanding how QuillBot enhances the writing skills of EFL learners. QuillBot helps students connect fragmented language knowledge points into a systematic knowledge network through real-time feedback. For example, Kurniati and Fithriani (2022) found in their study of English postgraduates in North Sumatra that students effectively integrated knowledge points, such as synonyms and complex syntactic structures, through QuillBot's paraphrasing function, significantly improving the logical coherence of their texts. This process directly reflects the core mechanism of connectivism. In addition, Hasnah's (2024) longitudinal study further verified the long-term effect of knowledge connection, and students who continued to use QuillBot showed stronger knowledge transfer ability in academic writing.

At the methodological level, the connectionist theory guided the design of coding rules in the theme analysis of this study. The researchers extracted initial labels such as "lexical networking" and "grammatical integration" through open coding and classified them into sub-themes of the

"writing skills improvement" dimension (Braun & Clarke, 2006). For example, when analyzing the quantitative data of Mustapha and Adam (2024), "students discovered the connection between grammatical rules through QuillBot" was coded as "knowledge connection strengthening", highlighting the direct impact of connectionism on data analysis.

It is worth noting that there is a synergistic interpretation space between connectionism and TAM. When students frequently use QuillBot due to its high "perceived usefulness", the technical mediation of the tool accelerates the dynamic expansion of the knowledge network (Siemens, 2004). For example, Rafida et al. (2024) found that EFL learners' reliance on QuillBot's grammar-checking function was significantly positively correlated with the syntactic knowledge network they built through the tool, reflecting the complementarity of TAM and connectionism in explaining user behavior.

3.4. Conceptual Framework

The conceptual framework of this study is based on the integration of the Technology Acceptance Model, Self-Perception Theory, and Connectionism Theory, and a systematic analytical model is constructed to comprehensively evaluate the multidimensional impact of QuillBot in EFL academic writing. The framework contains four core dimensions, each of which is directly related to at least one theoretical foundation.

In the dimension of writing skill improvement, TAM's "perceived usefulness" (Davis, 1989) and connectionism theory (Siemens, 2004) jointly explain how QuillBot promotes language proficiency development through instant feedback and knowledge networking. Research shows that QuillBot improves language proficiency through instant feedback, a process that reflects both the usefulness of the tool (Mustapha & Adam, 2024) and the construction of knowledge networks (Kurniati & Fithriani, 2022). It is worth noting that different disciplines have different requirements for writing skills. The humanities and social sciences emphasize the ability to interpret, while the natural sciences focus more on logical rigor (Tran & Nguyen, 2022), requiring the tool functions to be adaptable to the discipline.

The emotional impact dimension is mainly supported by the theory of self-cognition (Bem, 1967). When students complete writing tasks using QuillBot, they attribute this success to the improvement of their abilities, thereby increasing their confidence and reducing anxiety (Ariyanti, 2021). This impact varies among students of different English proficiency levels. Beginner learners are more easily motivated by tool feedback, while advanced learners may be more concerned with autonomy (Mohammad et al., 2024). It is worth noting that this dimension interacts with the improvement of writing skills, and emotional improvement may further motivate students to use the tool more actively, forming a virtuous circle.

The user experience and accessibility dimension is mainly based on TAM's "perceived ease of use" (Davis, 1989) but is also influenced by the concept of "technology-mediated environment" in connectionist theory. The study found that interface friendliness and technology accessibility jointly determine the user experience, and the functional differences between the free and paid versions may exacerbate the problem of resource inequality. This dimension pays special attention to the barriers to use in areas with low technology penetration. These findings together reveal the complex relationship between tool design and the socio-technical environment.

The problem and challenge dimension integrates the perspectives of three theories. Self-cognition theory explains the risk of capability degradation caused by over-dependence, connectionism theory analyzes the obstacles to knowledge construction caused by technological limitations, and TAM provides ideas for solving user acceptance barriers. This multi-theoretical integration enables the framework to comprehensively capture the potential problems in the QuillBot application.

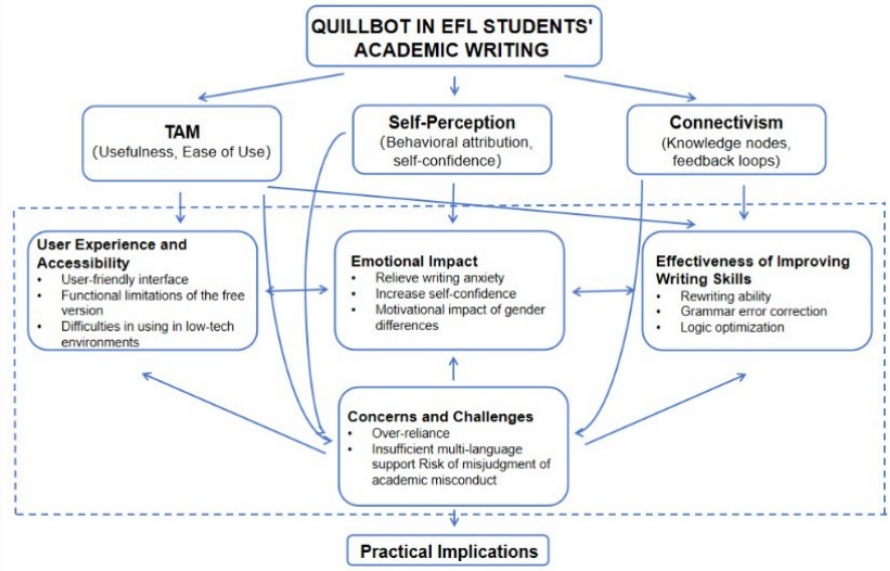

Figure 1: Theoretical framework of this study

Figure 1 illustrates the conceptual framework of this study, which integrates the Technology Acceptance Model, Self-Perception Theory, and Connectivism Theory to analyze the multidimensional impact of QuillBot on EFL academic writing. The four core dimensions of writing skill improvement, emotional impact, user experience, accessibility, and concerns and challenges, are dynamically related. A positive user experience can enhance skill development, while over-reliance may weaken self-perception abilities. The framework emphasizes both theoretical synergies and practical contradictions. The model offers a comprehensive perspective for thematic analysis and aligns with the research objectives.

The innovation of this framework lies in the first integration of three theoretical systems for analyzing AI writing tools, clarifying the dynamic relationship between dimensions, and providing operational measurement dimensions for subsequent research. These characteristics enable it to transcend the limitations of the previous single theoretical perspective and provide richer theoretical guidance for the integration of AI tools in EFL education.

3.5. Summary

This study integrates the technology acceptance model, self-perception theory and connectionism theory to construct a multidimensional framework to systematically analyze the impact of QuillBot on EFL academic writing. TAM explains users' evaluation of QuillBot's functional practicality and ease of operation from the perspective of tool adoption, while self-perception theory reveals how tool use reshapes students' writing confidence and anxiety levels through behavioral attribution mechanisms (Bem, 1967; Davis, 1989). Connectionism theory further explains how QuillBot promotes the networked integration of language knowledge through real-time feedback. It is worth

noting that the synergy of the three theories is particularly significant in the "challenge" dimension. Users with high technology acceptance may weaken their ability to construct autonomous knowledge due to over-reliance on tools (Franklin, 2024), which reflects the contradiction and balance needs between theories.

The innovation of this framework lies in the integration of tool adoption, psychological mechanisms and knowledge construction theory for the first time, clarifying the dynamic relationship of "skill improvement-emotional support-technical constraints". Interface friendliness increases the frequency of use, thereby accelerating knowledge networking; however, excessive use may lead to self-perception bias. This provides a theoretical basis for the educational integration of AI writing tools. Future research can further explore the boundary conditions of theoretical synergy, such as the difference in the weight of TAM and connectionism among students of different language proficiency levels.

4. Methodology

Based on the research model, the researcher designed the research methods of this study. Through a research design that included data sampling, data collection, and analysis, the researcher examined 15 peer-reviewed studies to explore the advantages and limitations of QuillBot in academic writing, thereby achieving the research objectives.

4.1. Research Design

This study employs a qualitative research design, utilizing the critical literature review and thematic analysis methods, to thoroughly explore the impact of QuillBot on EFL academic writing (Creswell & Creswell, 2017). The primary reason for choosing qualitative methods is that they can explore the deep meaning and complex relationships underlying the phenomenon (Nowell et al., 2017), which is particularly suitable for examining students' and teachers' subjective experiences, emotional changes, and behavioral feedback on QuillBot (Sovacool et al., 2023).

This study strictly follows the six-stage process of thematic analysis proposed by Braun and Clarke (2006) and incorporates a theoretically driven framework to enhance the depth of analysis.

1. 15 high-quality articles focusing on QuillBot and EFL academic writing from 2020 to 2024 were selected through purposive sampling.
2. The content of the articles was line-by-line coded, and initial labels such as "writing anxiety relief" and "version difference impact" were extracted from the original data.
3. The labels were clustered into four major themes, including "emotional impact" and "user experience," through an inductive approach.
4. Check whether the extracted themes are consistent with the presupposed dimensions of the Technology Acceptance Model, Self-Perception Theory, and Connectionist Theory.

To improve the credibility of the research, this study uses investigator triangulation. All coded data were archived in Excel spreadsheets and marked with original literature page numbers to ensure that the analysis process was traceable and reviewable (Nowell et al., 2017). Although qualitative analysis software such as NVivo was not used, the risk of subjective bias was significantly reduced by manually checking the coding item by item and verifying it with other researchers.

The limitation of the research design is that there is a gap between the efficiency of manual coding and software tools; however, some measures are taken to compensate for this. First, the researcher regularly reviewed the coding table to correct the classification inconsistencies. Second, the researcher directly quoted the original literature to support the generation of themes. Finally, the researcher shared the results of the data analysis with a tutor for review.

4.2. Data Sampling

This study adopted a purposive sampling method, strictly limiting the publication time of the literature to 2020 to 2024, and following the four stages of the PRISMA framework (Moher et al., 2009):

1. Preliminary screening. Through Google Scholar, 40 articles were obtained by searching with the keywords "QuillBot", "academic writing", and "EFL".
2. Database screening. Literature from non-authoritative databases was excluded, and 26 articles were retained.
3. Title and abstract screening. Literature that did not focus on the core functions of QuillBot was eliminated, and 22 articles were retained.
4. Full-text content evaluation. Literature with "research conclusions are too repetitive" was eliminated, and 15 high-quality papers were finally retained.

Literature screening process (PRISMA framework)	
① Initial screening records (n=40)	Database search results
↓	
② Database evaluation (n=26)	Reasons to exclude: • Low quality database (n=12)
↓	
③ Title and abstract screening (n=20)	Reasons to exclude: • Non- QuillBot studies (n=6)
↓	
④ Full-text content evaluation (n=15)	Reasons to exclude: • The research conclusions are too repetitive (n=5)
↓	
⑤ Final sample (n=15)	

Figure 2: PRISMA Flow Chart

The sampling criteria are divided into two categories, inclusion and exclusion. The inclusion criteria emphasize:

1. The research topic must directly analyze the advantages and limitations of QuillBot.
2. The methodology must include qualitative, quantitative or mixed methods.
3. The publication time is limited to the past five years to reflect the latest developments in technology.

The exclusion criteria exclude:

1. Literature that only studies other AI tools.
2. Papers that are not included in high-impact databases.
3. Studies with repeated conclusions or no new insights.

To enhance the representativeness of the sample, this study focuses on disciplinary diversity, encompassing students from both the liberal arts and the sciences. This study also examines the

differences in English proficiency among EFL students, encompassing both beginner and advanced learners. More importantly, this study focuses on regions covering multilingual environments, such as Asia and the Middle East.

Although some literature was lost due to data management issues in the early stage, the repeated sampling process ensured that the final sample could still fully reflect the multidimensional impact of QuillBot.

However, this study still has limitations. The small sample size of 15 articles may affect the generalizability of the conclusions (Nurmayanti & Suryadi, 2023). However, the purposeful sampling compensated for the lack of quantity by providing in-depth coverage of the core research questions (Nowell et al., 2017). Future research can expand the sample size to verify cross-cultural applicability (Rafida et al., 2024).

Table 5: Summary of Database Sources for Reviewed Literature

No.	Writer	Indexed databases
1	Ariyanti (2021)	Sinta, Crossref
2	Kramar et al. (2024)	Scopus, Eric, DOAJ, Crossref
3	Mohammad et al. (2024)	CNKI, ResearchGate, Scopus
4	Mohammad et al., (2024)	Scopus
5	Mustapha and Adam (2024)	Web of Science, DOAJ, ProQuest
6	Mohammad et al. (2023)	Scopus, DOAJ, Eric, ProQuest
7	Rafida et al. (2024)	Scopus, Web of Science, ResearchGate
8	Hasnah (2024)	Sinta, DOAJ, Crossref
9	Kurniati and Fithriani (2022)	Sinta, Crossref
10	Pham (2024)	Crossref, ResearchGate
11	Tamilselvi et al. (2023)	IEEE Xplore
12	Narayan (2024)	Scopus, Eric (Garuda)
13	Thangthong et al. (2024)	Eric
14	Franklin (2024)	ProQuest
15	Fitria (2022)	Sinta, DOAJ, Crossref

Table 5 summarizes the 15 high-quality, relevant studies that the researcher selected from many search results after rigorous screening. These articles are included in multiple influential authoritative databases, including Scopus, Web of Science, ERIC, CNKI, etc., ensuring the authority of the literature review.

4.3. Data Collection and Analysis

During the data collection phase, the researchers systematically searched for literature from 2020 to 2024 through Google Scholar, using keyword combinations such as "QuillBot", "academic writing", and "EFL" to initially screen out 40 relevant articles (Xuyen, 2023). Subsequently, based on the pre-established inclusion and exclusion criteria, 15 articles were selected as the analysis sample through a journal quality review, title and abstract review, and full-text evaluation (Moher et al., 2009). To enhance transparency, the reasons for selecting each article were fully recorded and archived for future reference. It is worth noting that, although the research model is guided by the Technology Acceptance Model, Self-Cognition Theory, and Connectionist Theory, the data analysis process strictly follows the openness principle of thematic analysis (Braun & Clarke, 2006).

Coding is divided into three stages:

1. The open coding stage extracts original labels line by line to avoid theoretical presuppositions.
2. The axial coding stage summarizes initial labels into 14 primary categories, at which time

only the patterns naturally presented by the data are observed.

3. The selective coding stage maps categories to the four dimensions of the theoretical framework. This process ensures that the themes reflect both actual data and can dialogue with the theory (Nowell et al., 2017).

   To minimize subjective bias, the researcher selected 15 articles at two-week intervals. The final coding was reviewed and determined by a researcher, and the original coding table was retained for review.

4.4. Data trustworthiness

To ensure the rigor of this study, the researchers strengthened the credibility of the literature review through the following measures:

1. External Audit. Invite a researcher to review the logical consistency of the topic classification and the classification of representative literature and modify the coding framework based on feedback.
2. Audit Trail. All coded data are archived in Excel spreadsheets, with the original literature source and extracted sentences marked. Ensure that the analysis process is transparent and can be reviewed by a third party (Lincoln & Guba, 1985).
3. Systematic literature screening. Strictly follow the PRISMA framework (Moher et al., 2009), record the complete process from initial screening to final inclusion, and avoid selection bias.
4. Dynamic calibration of theory. During the coding process, if unpredicted sub-themes are found, the concept of "digital divide" in connectionist theory is used to supplement the explanation, rather than forcibly classifying them into the original framework. This strategy balances the flexibility of theory guidance and data-driven (Braun & Clarke, 2006).

The limitations of this study include the potential for publication bias due to reliance on published literature, the limited sample size that restricts in-depth analysis of different groups, and the possibility of subtle errors in manual coding. Future research can further enhance the reliability and validity of the study by increasing the sample size, employing mixed methods, and utilizing qualitative analysis software.

4.5. Summary

This study employed thematic analysis to systematically examine 15 peer-reviewed articles, aiming to reveal the impact of QuillBot on EFL academic writing. Based on the research model, the researcher identified content related to four core research dimensions in the literature review. During the data analysis process, the researcher manually coded and summarized key variables through continuous comparative analysis to ensure the consistency between the research objectives and the research methods.

In summary, the research methods employed in this study provide a reliable and effective framework for achieving the research objectives. The researcher can understand the educational potential of QuillBot and the challenges that need to be addressed, and then make appropriate suggestions based on this, while also clarifying specific future research directions.

5. Discussion

5.1. Critical Discussion of the Emotional Impact

Based on a horizontal comparison of literature from 2020 to 2024, this thematic study found that QuillBot has a significant impact on the emotional and behavioral aspects of EFL learners. Based on self-cognition theory (Bem, 1967), when students complete writing tasks using QuillBot, they are likely to attribute their success to the improvement of their abilities, thereby enhancing self-confidence and reducing anxiety (Ariyanti, 2021; Kramar et al., 2024). This confirms the core idea of self-cognition theory, which posits that the successful experience of tool use will reshape learners' cognition of their abilities (Bem, 1967).

However, the current study has three key limitations. First, Mohammad et al. (2024) found that gender differences may affect the universality of emotional effects; however, they did not explain whether this difference is related to subject background or language level. Second, most studies only focus on short-term effects and fail to verify the sustainability of emotional improvements. Finally, the emotional experiences of students in resource-poor areas have been neglected, and the connectionist theory (Siemens, 2004) suggests that differences in technology accessibility may lead to an uneven distribution of emotional effects.

Future research should combine a longitudinal design and cross-cultural samples, such as tracking students' emotional changes in using QuillBot over a school year or comparing behavioral differences among students in regions with varying technology penetration rates. In educational practice, teachers can design step-by-step tasks based on self-cognition mechanisms, first using QuillBot to complete low-difficulty rewriting and then gradually transitioning to independent writing, thereby balancing tool dependence and ability development (Bem, 1967).

5.2. Critical Discussion of the Effectiveness of Improving Writing Skills

Based on a horizontal comparison of literature from 2020 to 2024, this thematic study found that QuillBot's emotional and behavioral effects on EFL learners showed three significant characteristics, and these findings revealed deeper mechanisms through theoretical integration. Based on the "perceived usefulness" dimension of TAM (Davis, 1989), learners' positive evaluation of QuillBot in rewriting, grammar correction, and vocabulary expansion directly affects their willingness to use and actual effects. These findings confirm the core idea of TAM that when learners believe that technology tools are helpful to their learning goals, they are more likely to continue using them and obtain actual benefits (Davis, 1989).

However, there are three main limitations of current research. First, most studies rely on learners' subjective feedback, lacking objective evaluation methods, such as standardized writing tests. Second, although Kurniati and Fithriani (2022) compared the effects of QuillBot with other AI tools, the sample was limited to graduate students familiar with the tool, and the results may not be generalizable to a broader audience. Third, connectionist theory (Siemens, 2004) emphasizes the importance of knowledge network construction, but existing research has failed to fully explore how QuillBot helps learners build a systematic language knowledge network.

Future research should adopt a mixed-methods approach, combining quantitative analysis of pre-tests, post-tests, and qualitative feedback from learners, to more comprehensively evaluate the

actual effect of QuillBot. In terms of educational practice, it is recommended that teachers position QuillBot as a "writing aid tool", allowing students to complete the first draft independently, and then use QuillBot to modify and optimize it to balance the use of the tool with the development of ability.

5.3. Critical Discussion of User Experience and Accessibility

Based on a horizontal comparison of literature from 2020 to 2024, this topic study found that existing research generally focuses on QuillBot's performance in user experience and accessibility. Based on the "perceived ease of use" dimension in TAM (Davis, 1989), it was found that ELS graduate students generally believed that QuillBot had a friendly interface and was easy to operate. This positive user experience directly promoted the frequency and effectiveness of the tool's use. However, the functional differences between the free version and the paid version significantly affected the consistency of the user experience, which to some extent, weakened the positive impact of tool usability on willingness to use emphasized by TAM. The digital divide problem is particularly prominent in the use of QuillBot. In areas with low technology penetration, students have significant differences in familiarity and frequency of use of QuillBot. This finding confirms the view of connectionist theory (Siemens, 2004) that differences in the accessibility of technology tools will lead to unequal opportunities for knowledge acquisition. It is worth noting that learners with low English proficiency are more likely to be confused when using QuillBot, which shows that language barriers are also an important factor affecting tool accessibility.

However, there are three important limitations in the current research. First, for students in areas with low technology penetration, the digital divide will significantly affect their acceptance of QuillBot, but most studies do not consider this variable. Second, existing studies focus on short-term usage experience and lack tracking of interface adaptability and functional satisfaction in long-term use. Third, digital inclusion theory (Selwyn, 2004) emphasizes that technology tools should consider the needs of users with different language backgrounds, and QuillBot currently does not provide enough support for non-native English speakers.

Future research needs to adopt a longitudinal tracking method to examine the changes in users' experience of QuillBot at different learning stages. In practice, it is recommended for resource-poor areas to improve the accessibility of the tool (Venkatesh et al., 2003; Selwyn, 2004). Educators can conduct digital literacy training to help students overcome barriers to technology use.

5.4. Critical Discussion of Concerns and Challenges

Based on a horizontal comparison of literature from 2020 to 2024, this topic study found that although QuillBot provides many conveniences for EFL learners, existing research also reveals several issues and challenges that deserve attention. Based on the theory of academic integrity (Bretag, 2016), some EFL students were misjudged as plagiarists after rewriting texts using QuillBot, which highlights the potential risks of AI-assisted writing tools in academic norms. In addition, low-level English students are often confused by language barriers when using QuillBot, which confirms the view of the language cognitive load theory (Sweller, 2011) that when the complexity of tool operation exceeds the learner's language ability, it will increase cognitive burden.

However, there are three important limitations in the current research. First, although many studies have pointed out the risk that over-reliance on AI tools may weaken students' creativity, they have failed to propose specific preventive measures. Second, QuillBot occasionally generates sentences that do not conform to language rules, but there is a lack of systematic analysis of the types of errors. Third, the digital ethics framework (Cooperman and Brandão, 2024) emphasizes that technological tools should promote rather than replace human thinking, and existing research has not yet reached a consensus on how to balance the use of tools with academic autonomy.

Future research should establish a more comprehensive evaluation system, including the development of a dedicated plagiarism detection algorithm to distinguish between AI-assisted and plagiaristic behavior. At the practical level, it is recommended that educators design an "AI-assisted writing evaluation scale" to help students use QuillBot reasonably (Bretag, 2016). Tool developers should optimize the error prompt system and provide additional grammatical explanations for non-native users (Cooperman and Brandão, 2024). Addressing these challenges requires the collaborative efforts of developers, educators, and policymakers. Most importantly, the current research model falls short of fully explaining the issue of academic integrity, and in the future, it is necessary to integrate ethics-related theories to provide a more comprehensive analytical perspective.

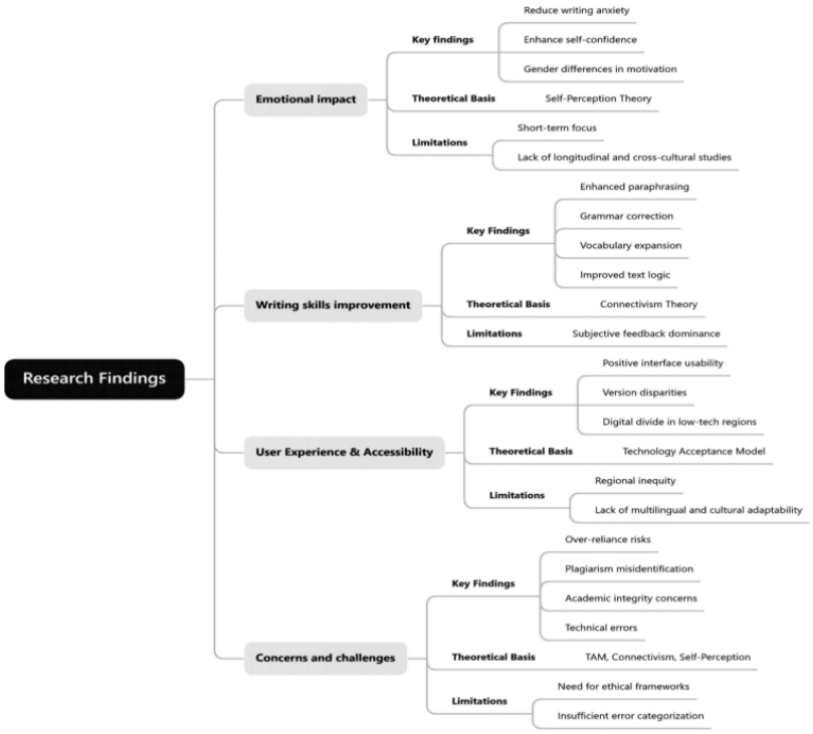

Figure 3: Summary of Research Findings

This figure systematically summarizes the four-dimensional impact of QuillBot on EFL academic writing, specifically its emotional impact, improvement of writing skills, user experience, and accessibility, as well as potential challenges. The chart clearly presents the key findings of each dimension and their interrelationships, providing a visual framework for understanding the comprehensive educational value of the tool.

6. Conclusion

6.1. Summary of Research Findings

This study systematically analyzed 15 papers published between 2020 and 2024 to reveal the multidimensional impact of QuillBot on EFL academic writing. First, for research question 1, the study found that QuillBot significantly alleviated learners' writing anxiety and improved their confidence at the emotional level, but individual characteristics moderated this effect. At the skill improvement level, the tool performed well in terms of rewriting ability, grammar correction, and vocabulary expansion; however, its effects varied depending on the user's English proficiency. User experience was polarized, and interface friendliness was widely recognized, but version differences and technology gaps constituted major obstacles. Second, for research question 2, theoretical integration showed that the "perceived usefulness" and "perceived ease of use" of the technology acceptance model explained user adoption behavior; self-cognition theory revealed how tool use reshaped self-efficacy through "behavioral attribution"; and connectionist theory explained how QuillBot promoted the networked integration of language knowledge through real-time feedback. Finally, for research question 3, academic integrity risks and over-dependence issues were the most prominent, requiring stakeholders to work together to address them. It is worth noting that the current study has limitations such as a small sample size and reliance on subjective feedback, which may affect the generalizability of the conclusions.

6.2. Implications

The theoretical significance of this study lies in deepening the explanation of the mechanism of action of AI writing tools. The technology acceptance model verifies that the user acceptance behavior of QuillBot is driven by both functional practicality and interface friendliness, while the self-cognition theory reveals how the successful experience of the tool enhances learner confidence through the "attribution mechanism". In addition, the connectionist theory fills the gap in the study of AI tools in knowledge construction, indicating that QuillBot can promote the systematic integration of language knowledge through real-time feedback.

At the practical level, based on the research findings, the study provides specific guidance for stakeholders. Educators can design a phased task of "independent draft, QuillBot optimization, autonomous revision" to balance tool assistance and capacity development. Developers need to optimize multilingual support and academic integrity marking functions to reduce the risk of misjudgment of plagiarism. Policymakers should promote the fair distribution of technology resources and provide infrastructure support for low-tech penetration areas.

6.3. Future Research Directions and Practical Suggestions

Future research needs to make further breakthroughs in the diversity of methods and objects. The current limitations of relying on subjective feedback and short-term effects can be compensated for by a longitudinal tracking design, such as evaluating the long-term impact of QuillBot through mixed methods. In addition, it is necessary to expand cross-cultural samples, especially focusing on the differences in learner use in areas with scarce technical resources, to verify the universality of the conclusions. At the technical evaluation level, it is recommended to develop a standardized AI writing tool evaluation scale that covers dimensions such as language accuracy, creativity retention, and academic norms.

For practical applications, the study provides actionable strategies through a multi-level.

At the technical level, developers should incorporate "academic integrity protection" features to

clearly attribute AI-generated content, thereby enhancing academic integrity and meeting diverse learner needs. In addition, developers should implement multilingual interface enhancements to meet the needs of non-native English speakers. In addition, developers can provide real-time grammatical explanations to help users understand the corrections, thereby promoting deeper learning.

At the teaching level, teachers can design a "from tool-assisted to autonomous writing" framework, where students first draft independently, then use QuillBot to revise, and finally complete the revision without AI assistance, thus balancing tool dependence and skill development. In addition, teachers should also provide clear training on the ethics of tool use, emphasizing the critical evaluation of AI-generated suggestions to reduce risks such as plagiarism or a decline in creativity. At the policy level, policymakers should commit their funding programs to the fair use of advanced versions of QuillBot in resource-limited areas to narrow the digital divide. Additionally, academic integrity policies should be updated to include specific provisions for AI, clarify acceptable use cases, and outline the consequences of misuse.

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