## Academic Writing Issues in the AI Era: Opportunities and Challenges for Applied and Social Sciences in Pakistan

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### ABSTRACT

*The integration of Artificial Intelligence (AI) into academic writing is significantly transforming how students, educators, and researchers approach scholarly work in Pakistan. In a setting where access to digital resources and academic support remains uneven, AI-powered tools such as ChatGPT, Grammarly, and Turnitin offer both valuable opportunities and serious challenges. These tools assist students in enhancing grammar, generating content, and supporting research, particularly benefiting those facing language barriers or lacking formal academic guidance. However, their growing use also raises important concerns, including academic dishonesty, over-reliance on technology, reduced critical thinking, and ethical issues related to authorship and originality. Additionally, the presence of misinformation and bias in AI-generated outputs further complicates their academic use. This review paper examines the multifaceted impact of AI on academic writing practices in Pakistan, particularly within the applied and social sciences. It evaluates how higher education policies address these developments. It emphasizes the need for ethical integration of AI tools while preserving academic standards. The paper offers practical recommendations for educators, students, and policymakers to ensure that AI serves as a supportive tool rather than a replacement for genuine intellectual effort. Ultimately, the study highlights that a balanced and well-regulated use of AI is essential for fostering integrity and responsible academic growth.*
***Keywords:*** *Academic Writing; Artificial Intelligence; Applied Sciences; Social Sciences; AI Tools; Higher Education Policy; Academic Integrity; Plagiarism; Ethical AI Usage.*

## INTRODUCTION

### Origin of AI

Artificial Intelligence (AI) originated in the mid-20th century when scientists and mathematicians began exploring ways to replicate human intelligence through machines. The term "AI" was officially introduced in 1956 at the Dartmouth Conference by pioneers John McCarthy, Marvin Minsky, and Alan Newell. In Pakistan, AI has gained significant momentum over the past two decades, opening new avenues in education, technology, research, and innovation (Adidi, 2024). Prominent institutions such as National University of Science & Technology (NUST) and Commission on Science and Technology for Sustainable Development in the South (COMSATS) have established dedicated AI research centers and launched specialized degree programs to advance the field. The governmental efforts have been important as well, especially the Presidential Initiative for Artificial Intelligence & Computing (PIAIC), created in 2018, which is directed at advancing AI education and training. Also, the creation of the National Centre for Artificial Intelligence (NCAI) has helped the research and implementation of AI into major industries, such as agriculture, healthcare, and cyber security.

The other case is the formation of the National Centre of Artificial Intelligence (NCAI), which carried out research on AI and applied it in agriculture, health, and computer security. In recent times, Pakistani start-ups and IT companies have been embracing AI-enabled solutions, contributing to other sectors like e-commerce, fintech, and automation. Even though the country faces challenges from limited infrastructure to funding, there is steady progress regarding AI research and implementation, giving it a developing position in the global AI horizon (Mushtaq et al, 2024)

### AI in Academic Writing

AI has transformed academic writing by making it more efficient, accurate, and accessible for students, researchers, and educators. AI-based tools such as Grammarly, ChatGPT, QuillBot, and Turnitin help with grammar correction, content generation, paraphrasing, and plagiarism detection, thus streamlining the writing process and making it error-free. These technologies help non-native English speakers enhance their academic writing skills and aid researchers in organizing their papers, summarizing literature, and handling citations. Additionally, AI can analyze vast datasets to generate insights, helping scholars produce high-quality research with greater speed and precision. Nonetheless, fears of overuse of AI, along with ethical authorship and research integrity, have been expressed and have led to deliberations on the ethical use of AI. Since critical thinking and originality are crucial in academic writing, a balanced stance should be reached where AI is used as an assistant and not as an alternative to intellectual work (Dergaa et al, 2023).

Benefits of Artificial Intelligence in the medical science discipline include the way Artificial Intelligence-based hardware can increase the level of clinical decision-making, medical research, and patient services. AI-based algorithm helps to diagnose the disease, predetermine the effectiveness of treatment, and individualize the work with the patients based on medical data from large volumes. Machine learning, deep learning, and natural language processing (NLP) are transformative technologies in radiology, pathology, and robotic-assisted surgeries, making healthcare solutions more accurate and efficient. AI also makes it easier for healthcare professionals to draft scientific papers, summarize literature, and make documentation easier. AI chatbots and virtual assistants also improve the interaction between the patient and healthcare provider by offering preliminary diagnoses and mental health support. However, there are ethical issues, especially data privacy and bias in AI models, along with human oversight. A balance is bound to be developed that will not replace human judgment but rather aid medical practitioners.

Technology will thus improve healthcare quality, along with maintaining the standards set by ethics and professionalism (Farooq, 2024).

Artificial Intelligence is changing the face of chemical sciences by accelerating research, precision, and optimization of complex processes in chemicals. AI-based algorithms assist chemists in drug discovery, material design, reaction prediction, and molecular modelling, which cuts down the experimentation time by many folds. Machine learning models scan large chemical databases to predict reaction outcomes, provide novel compounds, and optimize synthesis pathways, making research more efficient and cost-effective. AI-driven automation in laboratories enables high-throughput screening and real-time data analysis, improving the accuracy of chemical experiments. Moreover, AI furthers environmental sustainability by helping to design green chemistry solutions through designing eco-friendly catalysts and energy-efficient processes. However, data reliability and the need for validation via experts alongside ethics remain of significant importance. By integrating AI with human expertise, chemical science can achieve tremendous strides in pharmaceuticals, materials science, and industrial chemistry (Choudhary et al, 2022).

AI is changing the world in Applied Sciences, Social Sciences, Arts, and Languages through research, creativity, and problem-solving. In Applied Sciences, AI is changing the engineering, agricultural, and environmental sciences innovations through automation, data analysis, and predictive modelling. In Social Sciences, AI helps in behavioural research, policy analysis, and socio-economic studies by processing large datasets and identifying patterns in human interactions (Robila & Robila, 2020). In the Arts, AI is being used to boost the development of digital art making, music writing, and creating literature, opening greater avenues for creativity while violating the old theories of creativity. In Languages, AI-based translational, recognition, and composition tools help improve linguistic research in cross-cultural contexts and language learners. AI can also transform Business, Healthcare, Education, and Law, for instance, when applied, more processes are transformed to become very efficient and information-based, while developing new questions, both ethical and societal, toward automation and human-AI teamwork (Chao et al., 2023).

**AI Tools for Beginners and Professionals**

**AI Beginners**                                                              **AI Professional**

| | AI Beginners | | AI Professional | |
|---|---|---|---|---|
| **Models** | GPT-3.5    Bing    YOU You.com    Bard | | GPT-4    GPT-4 V    Perplexity    HuggingFace    Claude 2 | |
| **Writing** | Jasper    Copy.ai    Quillbot    Hemingway | | ZimmWriter    Koala.sh    SmartSEO    Claude 2 | |
| **Analysis** | Wolfram Alpha Plugin    GPT-4 | | GPT-4 Advanced Data Analysis    GPT for Sheets | |
| **Prompts** | PromptBase    PromptPerfect    "1000+ GPT Prompts" | | SmartGPT    Jina.ai    AIPRM    Custom Prompts | |
| **Graphics** | Canva    Microsoft Designer    Bing    DALL·E 2 | | DALL·E 3    Adobe    Ideogram    Midjourney    RunwayML Gen 2 | |

**Source: https://getsmartgpt.com/professional-ai-tools-list/**

Students and new researchers rely on free and unregistered tools for academic writing and research, such as using the free version of ChatGPT, basic Grammarly, and QuillBot for paraphrasing. These tools are

crucial for grammar correction, content generation, and simple editing, thus making AI accessible to students and novice researchers. Advanced, registered AI tools, on the other hand, are used by professionals and experienced academics for more refined features suited for scholarly work. Subscriptions to AI-powered platforms such as Grammarly Premium, ChatGPT Plus, and Turnitin offer deeper text analysis, plagiarism detection, citation management, and refined content optimization. By using these professional AI tools, researchers can improve writing efficiency, ensure academic integrity, and enhance research productivity while maintaining originality and adherence to ethical guidelines (Tredinnick, 2017).

**AI Tools Existing**
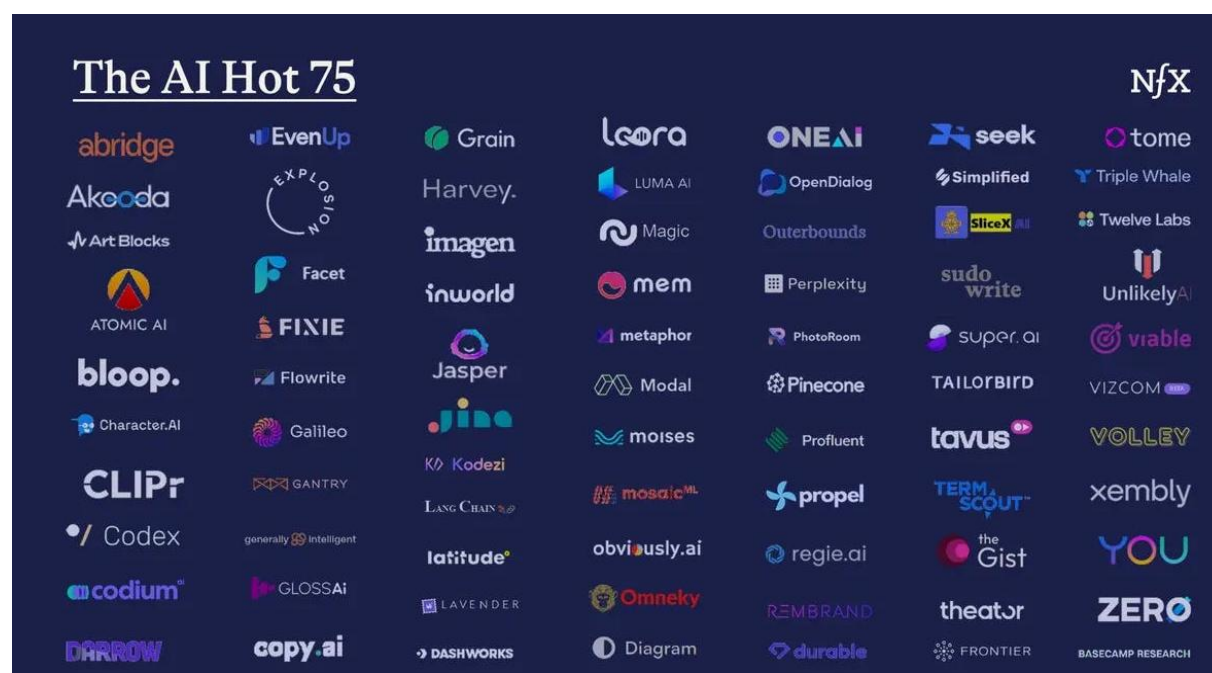


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**REVIEW OF RECENT LITERATURE ON AI**

This review highlights the transformative role of Artificial Intelligence in improving academic writing efficiency in Pakistan. It critically examines ethical concerns, including plagiarism, misinformation, and the potential decline in critical thinking skills. The findings may offer practical insights for students, educators, and policymakers on the responsible and ethical use of AI tools in academic settings. Ultimately, the review may contribute to the development of institutional policies aimed at fostering academic integrity and ensuring originality in AI-assisted writing practices. The following concerns were kept in consideration in doing the literature review:

1. How do AI-powered writing tools impact the academic writing skills of students and researchers in Pakistan?

2.  What are the key challenges and ethical concerns associated with AI-assisted academic writing in Pakistan?
3.  How can educational institutions develop policies to ensure ethical and responsible AI integration in academic writing?

Mhlanga (2023) addresses the questions of ethical application of the AI language model Chat GPT by Open AI in the education sector, as well as what responsible application of this tool in society would involve. It aims to pave the way and further explore the implications of the inclusion of these technologies in learning environments. It uses a broad open heuristic to outline a series of considerations (pikas), which may be seen as a guiding aspect of privacy and fairness, discrimination, and transparency. The findings indicate that honouring and embracing these values are crucial in terms of ethical and decent utilization of ChatGPT in international education. Sutomo & Turmudi (2025) explore the introduction of artificial intelligence in the teaching of mathematics as a move to adopt a radical form of teaching mathematics and to reform the way students learn by acquiring teaching methods using new technological tools. Here is a systematic review of important recent studies which seek to identify various methodologies in education through AI techniques, and more so, the game-based approach strategy in junior high school learning. The review highlights how AI could succeed in preparing adaptive and interactive learning, which will be the groundwork for future research and future innovation of AI in teaching/learning.

**AI in Applied Sciences**

*   Wang (2022) research investigate how students think about and use computer assisted review tools and compare the reliability of both types of ratings on improving English writing skills. Applying Expectancy Disconfirmation Theory (EDT) and Intelligent Computer-Assisted Language Learning (ICALL) principles, the researchers used observation, interviews and questionnaires to study the results of four essays completed through three online AEE systems. Data were used to compare how teachers and the system evaluated each other. From the outcomes, students were found to trust the tools, see computer feedback as better than teacher feedback and use new methods of studying and writing. Based on the results, students' expectations and their actual learning outcomes were positively related.
*   Zhao's (2023) research investigates the abilities of Word tune to aid EFL writers as they produce written texts. Unlike almost all digital tools, which centre on editing, Word tune helps users express their ideas clearly by suggesting changes in wording and how long their text should be. According to the study, Word tune makes it easier for EFL writers to maintain their writing fluency and improve their English skills.
*   Huang et al (2024) measured ChatGPT versions 3.5 and 4 to find out how useful they are in checking EFL writing in the context of education. It aimed to test how accurate and reliable the ChatGPT essay scores are when evaluated next to those given by college English teachers. The same essay prompt was used to evaluate 30 essays written by students who are not English majors by both versions of ChatGPT and four teachers. Despite having lower reliability than teachers, ChatGPT 3.5 did better than them. Both models gave more suitable and meaningful feedback on language, content and Organisation than humans, suggesting they could benefit teaching programs in the field of EFL writing assessment.
*   Lu et al (2024) investigated the application of ChatGPT as an ancillary tool in addition to instructor assessment in Chinese academic writing education. With a mixed-methods design involving 46 undergraduate students, the study determined the agreement between ChatGPT and teacher grading and the contrast between feedback quantities and types they gave. It was shown that there was moderate to good agreement in grading and considerable diversity in feedback quantity and type. From qualitative data, ChatGPT supplemented teacher marking by enhancing

students' insights into feedback, promoting critical analysis, and promoting autonomous revision. The results bring to the forefront the strength of a combined evaluation strategy to improve writing pedagogy in higher education.

- Faisal & Carabella's (2023) small-scale survey examined English Language Education (ELE) students' attitudes towards utilizing Grammarly as an automatic grammar checker in the process of academic writing. Adopting a questionnaire from Novianti (2020), the survey revealed that 73.3% of students had a positive attitude towards Grammarly, highlighting its effectiveness in correcting errors, enhancing writing, and enhancing confidence. Nevertheless, there were some students with negative attitudes who gave reasons for concern over the relevance and contextual appropriateness of the feedback. Such mixed opinions were attributed to Grammarly's real-world usability and inability to offer detailed feedback. The research recommends more investigations of students' attitudes, writing anxiety, and general effects of Grammarly utilizing diverse research methodologies.

- Barrot's (2022) study examines Grammarly, a web-based tool that covers writing errors in grammar, vocabulary, mechanics and style, plus materials that are plagiarised. It highlights that Grammarly helps people learning English as a second language (ESL and EFL), which is why it matters for teachers and students. Still, while Grammarly makes writing better, the review points out some areas where further changes can serve language learners better.

- Nova (2018), a study investigated how Grammarly functions as an automatic writing assessment tool, with input from interviews and analysis of documents written by three Indonesian postgraduate students. Investigations indicated that the software works well, with clear colour-coded feedback, is easily accessible, reaches results swiftly and charges no fee for use. Still, the research found a number of constraints such as false feedback, insufficient English and reference materials and no consideration of context or content.

- Lo et a (2024) study used a systematic review of 70 published studies to examine the use of ChatGPT for teaching ESL/EFL using the Technology-based Learning Model. The review stresses that ChatGPT makes it possible for students to explore new topics, get help adapted to them, enjoy teachers' support, but also be aware of challenges such as access to misleading information, privacy breaches and dishonesty. There was a main emphasis on student skills in writing tasks, but researchers did not study much about how students perform or stay motivated or other skills like reading, speaking and listening. The authors suggest that future research, using formal and validated data, should be carried out to determine how ChatGPT can support learning English.

- Almuhur (2024) discusses that Mathematics plays a very important role in the development of artificial intelligence (AI), as it forms the basis for models and algorithms that enable cognitive tasks. Some of the key mathematical concepts include linear algebra, probability, and statistics, which are crucial for machine learning applications, such as data classification, regression, and clustering. These principles are therefore important for researchers and innovators to advance AI systems and overcome emerging challenges in the field.

- Rasheed et al.'s (2021) study integrates EEG, socio-demographic and home environment data for the effectiveness of early screening for identifying children at risk of failure in school in Pakistan. The results show that although sensitivity did not vary dramatically between models, the addition of EEG to the socio-demographic and home environment variables improved specificity, especially with language assessments. However, more validation is recommended to ensure proper accuracy in screening methods based on EEG for early academic performance predictions in children. This would then help prevent grade failure at a very early age and improve strategies for intervention.

- Choudhary et al (2022) Artificial intelligence (AI) study researches that the application of Artificial intelligence (AI) in chemistry is now more significant, especially in the context of organic synthesis and drug discovery, which are instrumental tools to predict molecular properties, validate retro synthesis, and forecast reaction outcomes. The costs and time limits of drug development have been cut, making the drug development process quite efficient because of its integration. Nevertheless, in chemistry, the potential of AI is underutilized, which requires additional studies on its capabilities to be carried out.

- Baum et al.'s (2021) study indicates that the application of artificial intelligence in chemistry has increased manifold, with a notable increase in journal and patent publications since 2015. Analytical chemistry and biochemistry are found to have the highest AI integration, and interdisciplinary research trends reveal emerging associations across various subfields. Topic analyses and substance classifications further indicate AI's growing role in life sciences and analytical chemistry, providing insights into current developments and future research directions.

- Kutyniok's (2022) research mentioned that Artificial intelligence has achieved remarkable success in science and public life, yet its mathematical foundations remain underdeveloped. Deep neural networks, the core of modern AI, serve as a primary focus of theoretical investigation. This survey explores key theoretical advancements, exemplary results, and open challenges, emphasizing the need for a more rigorous mathematical framework.

- Durrani et al's (2024) qualitative research explores the cognitive processes influencing ESL students' skills in speaking by using data from 28 ESL teachers. In-depth interviews served as a basis of research, focusing on how memory, attention, individual learning styles, and socio-cultural factors influence language acquisition. The results are consistent with what has been established in previous literature; thus, the theories above are reinforced regarding the influence of cognition on oral communication development. Nonetheless, the quality of real classroom-based experiences involving teachers in this study lends it practical insights into how such cognitive processes play out in the everyday teaching process. The interplay between theory and practice is thus seen against the background of the ESL education discourse.

- Tschisgale et al (2023) showed that qualitative methods in PER help with the investigation of no numerical data that has the capability of uncovering patterns and contributing to theory. Still, this type of method comes with certain problems, such as validity, reproducibility, and scalability problems due to dependency on subjective judgment, and impracticality with huge datasets.

- Lo et al.'s (2024) study highlights that the integration of artificial intelligence (AI) in academia boosts attention with Chat-GPT and other advanced technology tools in English learning. Despite the growing interest in ChatGPT-assisted learning, the research has predominantly focused on its role in writing. Quantitative research is deficient in the effectiveness of its implementation on the students' performance and motivation. Furthermore, the reading, speaking, and listening aspects of language use are less well-known. Longitudinal studies based on sound designs, including quasi-experiments with objective sources, such as standardized tests, to better understand how ChatGPT will change long-term learning and acquisition of English.

- Abid et al (2019) study is about the attitude of medical students in Peshawar towards the integration of Artificial Intelligence (AI) in Undergraduate Medical Education. Despite the low previous knowledge about AI among the students, results showed a positive attitude toward using AI, particularly in areas like radiology and clinical practice. The study found that although the students acknowledge AI as useful and practical, they are also worried about the fact that it can replace human roles and burden individuals. However, the majority of them find optimism in implementing AI in training for medical professionals as it demonstrates the bright side of AI applications in medical education.

**Al in Social Sciences**

- A study by Ahmed et al (2021) evaluates the role AIA applications undertake in solving issues in education these days. Increasingly, AI technologies like social robots (SR), smart learning systems (SL), and intelligent tutoring systems (ITS) have been perceived as more powerful instruments to increase access and improve quality learning opportunities. The review suggests that the education sector has to be prepared to face these emerging technologies as a necessary step to maintaining relevance in the digital age. It emphasizes that AI integration should be a priority for educational organizations to modernize teaching methods and foster more efficient learning environments. Future research should test these findings statistically to provide a clearer and more generalizable understanding of AI's role in education.

- Qayyum et al.'s (2024) study explores the integration of AI into early childhood education and major stakeholders in this perspective, as this is a big challenge and a policy gap in Pakistan. Though AI has had significant promise internationally in making more personalized learning more effective and beneficial for the learners, there exist problems of fewer infrastructures, more cultural resistance, and more privacy issues of ethical concerns against it in incorporating in the ECE sector of Pakistan. Through the study, AI training for educators, investment in digital infrastructure, and the development of culturally relevant AI tools are recommended to take priority in education policies for more inclusive and equitable access to AI-enhanced learning opportunities.

- Ahmed et al, 2024, research focuses on A qualitative study on the influence of Artificial Intelligence on learning experience and teaching practice in the higher education institutions of Pakistan. This has made it easier for educators and students to engage in more effective and automated learning. Automated grading systems and problem-solving tools are one of the contributions of AI towards higher education that have revolutionized traditional teaching methods and allowed virtual access to learning activities.

- Asim et al (2023) focus on the application of AI in the libraries of Pakistani universities and adopted an explanatory sequential mixed-methods approach. It consisted of two phases. In the first phase, data were collected in the form of questionnaires and responses were collected from 237 university librarians. The second phase involved in-depth interviews of 10 purposefully selected librarians. The findings have ascertained that AI application in Pakistani university libraries is found to be restricted to text-to-speech, speech-to-text technologies, RFID systems for check out and security, and intelligent data analysis for the management of collections. Important drivers to the deployment of AI are integrated technological infrastructure, funding, and the requirement for collaboration among experts. The study determines major challenges in the form of the cost of AI technologies, budget constraints, and a lack of expertise among staff and provides insights on how to better adopt AI use in libraries in Pakistan and developing countries at large.

## DISCUSSION

This review paper reveals that AI has transformed academic writing by making it more efficient, accurate, and accessible for students, researchers, and educators. AI-based tools such as Grammarly, ChatGPT, QuillBot, and Turnitin help with grammar correction, content generation, paraphrasing, and plagiarism detection, thus streamlining the writing process and making it error-free. These technologies help non-native English speakers enhance their academic writing skills and aid researchers in organizing their papers, summarizing literature, and handling citations. Additionally, AI may assist researchers and scholars in conducting research in a vast field and producing high-quality material with efficiency and precision. However, there are serious concerns and discussions on the ethical authorship, reliance on AI,

and neglect of basic research. There is a need to maintain a balance in research and academic writing, as there is always a need for critical thinking and triangulation of value data.

Artificial Intelligence (AI) is also contributing to transforming the medical sciences, information technology and applied sciences for their integration. There is a presence of frontline tools for healthcare as well as biological research, mainly for developing countries like Pakistan. AI-based diagnostic systems, robotic surgical procedures, and predictive analytics enhance clinical decisions and care given to patients. Applied sciences receive support from AI for engineering solutions, environmental monitoring, and augmentation in all areas for efficiency and innovation. These two industries are improved through AI-based optimisation, quality control, and predictive maintenance towards productivity and sustainability. The involvement of AI in these fields would enable Pakistan and other developing countries to experience advanced healthcare, technology, and industries, thereby driving their economic and scientific growth.

AI has become an important tool for scholars, as it assists them to carry out research, write theses, dissertations, and complete their academic assignments. AI tools in literature reviewing, data analysis, citation management, and content organization help reduce the challenges that students face. The insights generated by AI improve the structuring of an argument and the quality of writing in coherence and clarity in academic work. These improvements somehow bridge the gap for non-native English-speaking people in terms of language proficiency and research output quality. It builds efficiency, accuracy, and enhances the quality of academic writings by integrating AI in research methodologies.

Saving time in research writing is one of the great contributions of AI to academia, which involves the automation of repetitive tasks and quick access to digital resources. AI-powered platforms offer e-books, digital libraries, and research databases, making knowledge more accessible to scholars in social sciences and applied sciences. AI tools help researchers summarize vast amounts of data, extract key findings, and generate well-structured reports, allowing them to focus on analysis and interpretation. By streamlining the research process, AI enables scholars to produce high-quality work more efficiently and effectively.

Various AI-based tools have modified academic writing into a more effective and accurate genre. ChatGPT, Grammarly, QuillBot, Zotero, and bibliometric analysis tools can be used to improve the writing quality, grammar checking, and citation management that are essential tools for beginners or early-career researchers to facilitate their academic writing. AI helps one detect plagiarism and paraphrase content, which gives the academic piece a higher-quality finish. As scholars leverage these AI-powered tools, they enhance their capability to do good research and enhance their writing prowess, thereby ensuring that academics are better run and accessed more effectively.

To this end, AI tools represent the innovation brought about by modern Chinese AI to the globally established academic software applications. Universities and other academic institutions must embrace and implement AI tools in their curricula to enhance research efficiency, writing quality, and overall academic integrity. The use of AI in academia ensures authenticity, accuracy, and professionalism, helping scholars maintain high academic standards while reducing manual workload.

AI is greatly contributing to the changes in the educational paradigm by enhancing accessibility, efficiency, and accuracy in education. It has streamlined various aspects of education like instructional delivery, assessment, and monitoring. Its implications for academic research and writing are only going to get stronger, and thus, institutions would need to adopt AI-driven solutions toward the betterment of education and research. Indeed, the government of Punjab has marked a milestone through the rollout of AI training at the school level, whereby not only are teachers but also students being equipped with core skills in the digital space. This is primarily an integrated training program; allowing students to practically learn how machine learning works through coding and the analysis of data.

AI plays a significant role in applied sciences like math, chemistry, physics, bio, and medical sciences. Similarly, it is frequently used in Social Sciences like education, psychology, art and humanities as well as languages. It is the need of the time to capture information technology and AI for betterment in education. Students and new researchers rely on free and unregistered tools for academic writing and research, such as using the free version of ChatGPT, basic Grammarly, and QuillBot for paraphrasing. These tools are crucial for grammar correction, content generation, and simple editing, thus making AI accessible to students and novice researchers.

## CONCLUSION

The influence of AI is becoming a significant part of changing academic writing by assisting in spelling, making the texts more logical, and increasing readability. In social sciences and applied sciences, ChatGPT helps scholars in the generation of ideas, content organization and debate refinement, thus simplifying research. Similarly, AI allows access to new information and research support in the medical and health science field in a cost-saving manner. Even though all these are perceived as benefits, it is imperative not to denude the end product of its impact on originality, critical thinking, and integrity in academics.

## RECOMMENDATIONS

The government must take concrete steps to ensure the practical implementation of AI tools in the education system. This would include integrating AI-based learning resources, training educators, and upgrading digital infrastructure in schools, colleges, and universities. AI-driven curricula, developed through collaboration with technology experts and academic institutions, would foster critical thinking, problem-solving, and research skills in students. The assessment, learning, and academic writing processes need to be supplemented with AI-powered platforms. HEC, Federal, and Provincial Governments should take it as a high priority for the integration of AI into academia to bring Pakistan's education system up to global standards. Investment in AI research centres, digital libraries, and AI-driven academic tools can improve the quality of higher education and research in Pakistan.

There is a need for collaboration and exposure of leading technology universities around the world by Pakistani students and institutions. This initiative will be helpful to minimize the gap of technology and innovation in Pakistan and developing countries. The federal government and provinces must invest in initiatives and AI-based research, but on ethical grounds, to build a knowledge-based economy. It may also acquire a place in educational policies and resource mobilization. There may be a bright future for students equipped with digital skills for future careers in science, innovation and technology at all levels of education in Pakistan.

In addition, teachers from all provinces should be trained in AI tools to create interactive and technology-driven learning environments. A national AI education framework will ensure uniform AI literacy and technological progress throughout Pakistan.

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