

# Impact of 3As of Generative Artificial Intelligence Tools on Scientific Academic Writing Skills: PLS-SEM Approach

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## **Abstract**

*One of the numerous developments in the digital world is generative artificial intelligence. This branch of artificial intelligence can be used to improve the academic writing skills of all professionals due to its ability to generate text, check grammatical errors, create a video, and plagiarism check among others. The study worked on the impact of awareness, accessibility and adoption of generative intelligence tools on academic writing skills. The target sample size for the study was 500 stakeholders comprising lecturers, postgraduate candidates, postgraduate and undergraduate students who are currently writing their final year research project on science education in Nigerian universities but only 189 valid responses were used for the analysis. A partial least square structural equation model approach was employed. The SmartPLS software version 4.0.9.2 was used to analyze the descriptive and inferential output of the study. The result of the study revealed that awareness, accessibility and adoption of generative artificial intelligence tools have weak, moderate and substantial impacts on the stakeholders' academic writing skills. The study recommended that the stakeholders, professionals and academic writers should adopt the usage of generative artificial intelligence tools and also observe the ethical practice to avoid academic theft.*

**Keywords:** Awareness, Accessibility, Adoption, Generative Artificial Intelligence Tools, Academic Writing Skills.

### **Introduction**

The improvement in artificial intelligence is based on the continuous development in present day information and communication technology. Hu (2022) views generative artificial intelligence tools as one out the numerous learning frameworks mainly designed for creation of new content, ideas with the inclusion of images, images with video, and text and code development. Jovanovic (2022) opined that generative artificial intelligence is a powerful kind of generative modeling that can produce artifacts and develop trust for user adoption. Ruiz-Real et al. (2020) submitted that the development of artificial intelligence has influenced the research activities which involve events and their correlation analysis and search for phenomena that cause general inferential and deductive rules relationship.

The continuous development of generative intelligence content posed a serious threat to the students' academic writing and would reduce the quality of their essay if fully adopted (Williams, 2023). Liebrez et al. (2023) posited that the usefulness of generative artificial intelligence tools like chat generative pre-trained transformer (chatGPT) are enormous but its impact on medical searches output is currently unknown. Eysenbach (2023) asserted that the introduction of chat generative pre-trained transformer (chatGPT) has shown vast potential in the area of medical education, medical research, and improvement in medical practice with the provisions of current medical problems and limitations. The scholar further concluded that generative artificial intelligence has the capabilities to generate virtual patient simulation, develop examination questions for medical questions, review of medical research outcome and comment on means to discover machine generated text so as to ensure academic integrity. Baidoo-Anu and Ansah (2023) outlined the benefit of generative artificial intelligence in advancing teaching-learning processes.

The authors asserted that generative artificial intelligence tools like chat generative pre-trained transformer (ChatGPT) have the potential of personalizing tutoring and gives students feedbacks based on their individual learning needs and achievement. Parts of the benefits of generative AI tools also includes automated essay grading, language translation, interactive learning and adaptive learning among others.

Salvagno et al. (2023) analyzed the influence of generative artificial intelligence chatbot on scientific writing. The authors mentioned among others the benefits of generative AI tools to include the ability to generate the initial draft of a scientific article, suggest title, providing raw information, composition of useable methodology, sample size justification, describe and suggest an appropriate data analysis technique(s). Possession of excellent academic writing skills does not only limit to scientific style writing knowledge but also include the ability to utilize the appropriate internet-based tools (Muhammadolimovna, 2023). These internet-based tools include Grammarly that can be used for grammar check and correction, plagiarism checker and Plagtracker that allows the user to check for possible point of view or self-plagiarism.

The encouragement of researchers in the field of wireless communication was leverage by the recent breakthroughs in computing and artificial intelligence (Yao et al., 2019).The future of generative artificial intelligence will advance the educational landscape and offer useful suggestions for the past, present and future (Bozkurt et al., 2023).Cao (2023) asserted that the significant features of the new generation of artificial intelligence in comparison with their lifelong multi-generation development is centered on their maturity as an independent field, bodies of knowledge, their cooperation and their universal acceptance in all other field of study and sector of economy.

Borzkurt (2023) opined that inclusion of generative artificial intelligence especially chat generative pre-trained transformer (chatGPT) in the dimensions of live like education represents a significant technological advancement. Tilli et al. (2023) asserted that the main functions of artificial intelligence was to mimic the human brain and conversation, its capabilities extend far beyond that, creation of literally new ideas and essay writing. The usage of artificial intelligence tools in the field of education are on the rise and have gain momentum and popularity because of its new numerous characteristics over the years and its influence on teaching-learning process improvement ( Zawacki-Richter et al., 2019).

Zhai (2023) posited that chatGPT as a generative artificial intelligence tool has help researchers in writing coherent, practically accurate, systematic and informative article. The author concluded that adjusting the learning goals is essential so as to allow students be able to use generative and other

artificial intelligence tools to conduct subject-domain tasks, improvement in creativity, critical thinking and accomplishment of learning tasks. The adoption of chatGPT and other open artificial intelligence tools by the learners, teachers/tutors and other concern stakeholders should be utilized in a manner that is fair, safe, and courteous so as to bring great benefits and avoid problems associated with ethics and responsibility (Mhlanga, 2023). Qadir (2022) asserted that generative artificial intelligence tools is constantly keep up with the recent breakthrough in technology and meet up with the need of engineering industry.

The author further asserted that the beauty of generative artificial tools in all field may block our views from the tools' biases, misinformation, potential for unethical use and potential unemployment of human who are made redundant by advancement of science and technology. Generative artificial intelligence tools like chat generative pre-trained transformer is capable of textual communication that involves providing answers to questions, paraphrasing in a unique manner. Thurzo et al. (2023) asserted that the adoption of artificial intelligence tools will improve patient-doctor communication and replaces the job of numerous copywriters through the creation of contents for web design.

Kumar (2023) opined that the benefits of generative pre-trained transformer artificial intelligence chatbot designed to generate text response could be misused for academic writing as the general notion of every researcher. The author observed the tool to be quick in giving response though the responses were found to be systematic, precise, original, lack quality and depth of academic writing, shortcomings in word count, referencing errors and lack of academic standard were also observed to be its challenges.

Artificial intelligence as part of the numerous advancements in technology makes the world of learning and teaching more convenient. Shidiq (2023) opined that generative artificial intelligence tool like ChatGPT has the ability to provide answer to different learning and teaching problems but the total adoption of it will not have positive impact in the development of several students' skill, especially excellent writing and thinking critically. The current growth and advancement of artificial intelligence technology influences academic writing skills in science like many other fields of knowledge. The challenges been faced by this development includes core

principles, methods, norms, and ethics (Dergaa, et al., 2023). The author further asserted that artificial intelligence progression in the area of research and academic writing may limit and also obscure researcher's contributions and thinking in the future research. Sajid and Siddiqui (2015) views academic writing skills as scientific writing skill that is characterized as structured research practice and also required by students, academic and researchers at all level of education.

Mallia (2017) outlined the challenges faced by many academic writers to include the problem of understanding the topic and subject matter, inability to take decision on the necessary essay type that involves sequence, description, cause and effect, comparison and contrast. Other challenges as raised by the author also includes development of essay problem statement, argument and discussion, and problem-solutions write-up.

### **Literature Review, Formulation of Research Questions and Hypotheses Development**

Kuleto et al. (2021) worked on awareness artificial intelligence and machine learning applications in higher education institutions of learning. The study was carried out among the master degree students' category of vocational studies at higher vocational school. 83 students of information technology school (ITS) were sampled. Questions identifying the students' awareness of some selected tools and their usage were raised and the findings of the study revealed that artificial intelligence tool (chat bots) that encourages personalization, and customization, analytics and performance reporting, virtual tutor and learning support has the highest number of users.

Alimi et al. (2021) searched on university students' awareness of artificial intelligence for learning. The study was a descriptive research design of the survey method that sampled 200 undergraduates across three universities using multi-stage sampling techniques. A structured questionnaire was used to collect the data which were rated on 3 likert scales. The findings of the study revealed that majority of the undergraduates were not aware of the artificial intelligence.

Yilmaz & Yilmaz (2023) carried out a search on the use of generative artificial intelligence-based tool on computational thinking skills, motivation and programming self-efficacy of students. The study was

quasi-experimental design with the pretest-posttest control group. 45 undergraduate students who undergo university programming course with the selection of 21 students into experimental group and 24 students into control group. The Chat pre-trained generative artificial intelligence (ChatGPT tool) was used as an intervention strategy for the experimental group. The finding of the study revealed that students exposed to ChatGPT tool (experimental group) had higher and significant learning outcome in computational thinking skills, motivation for programming lesson and programming self-efficacy.

Dessy et al. (2022) searched on leaders, practitioners and scientists' awareness of artificial intelligence in libraries. The study was a descriptive approach that engaged 38 participants. An online open-ended questionnaire prepared through Google form and shared through participants' WhatsApp chats session. The findings of the study revealed that most participants were fully aware and beliefs that artificial intelligence is an intelligent robot and also a computer program that can make decision.

### **Academic Writing Skills**

El Tantawi et al. (2018) searched on dental undergraduate's usage of gamification to develop academic writing. Two first year classes of dental undergraduate students were sampled. Pre-intervention assessment of students' academic writing skills was determined. The final result of the paper revealed that satisfaction with playing game significantly related to student academic writing skills.

Senel (2018) carried out a search on the integration of creative writing into academic writing skills. The study was a quasi-experimental pre-posttest design. The test was designed to ask the student short story by given set of words. T-test results of the study revealed the creative writing skill has significant effect on students' academic writing skills. Noor et al. (2020) search on exploring the connection between critical thinking skills and academic writing. The study was quantitative research that engaged 207 respondents. A questionnaire with 25 items measured on 5 likert scales was used to collect data. The finding of the study revealed that language proficiency had no influence on academic writing skills.

Kumar (2023) worked on analysis of ChatGPT tool to access the potential of its utility for academic writing in biomedical domain. The study raised five queries to assess the systematic approach of ChatGPT. The findings of the search revealed that ChatGPT tool response rate was very high and quick with the result of been precise and original. The findings further concluded that the tool generate 200–250-word texts output in less than 120 seconds of query. Dergaa et al. (2023) searched on potential threats of ChatGPT in academic writing and the prospects of artificial intelligence generated text. The quasi-qualitative approach was used to analyze the queries which involve reading and critically evaluating the sources and also identifying relevant data to support the research questions. The research uncover that ChatGPT and other natural language processing technologies have potential to enhance and promote academic writing skills and research efficiency.

Nazari et al. (2021) carried out a search on effect of writing assistant powered artificial intelligence on postgraduate students' English academic writing. The study was a quasi-experimental study. The used artificial intelligence powered writing assistant was Grammarly that offer AWE, AES and AWCF applications. One hundred and twenty (120) postgraduate students were engaged for the study while 60 students were exposed to the intervention and the post intervention result revealed that experimental group demonstrated statistically significant improvement in their scores.

Teng and Yue (2022) carried out a study on Chinese student academic writing performance. The study sample 664 third year student of a university located in mainland China, that cut across computer science, engineering, marketing, management and communication departments. The choice of the respondents was based on their English learning experiment of 10 years. Academic writing skill test was used to elicit data about the Chinese student academic writing performance. The study employed the usage of structural equation modeling and the result of the study revealed that meta-cognitive writing strategies predicted students' academic writing skill significantly.

### **Research Questions**

RQ1. What is the level of respondents' awareness of generative artificial intelligence tools?

RQ2. What is the level of respondents' accessibility to generative artificial intelligence tools?

RQ3. What is the level of respondents' adoption of generative artificial intelligence tools?

RQ4. What is the level of respondents' academic writing skills?

### **Hypotheses**

HO<sub>1</sub>. Awareness of generative AI tools significantly impacted respondents' academic writing skills;

HO<sub>2</sub>: Accessibility of generative AI tools significantly impacted respondents' academic writing skills;

HO<sub>3</sub>: Adoption of generative AI tools significantly impacted respondents' academic writing skills;

HO<sub>4</sub>. Awareness of generative AI tools significantly impacted respondents' academic writing skills when mediated by accessibility;

HO<sub>5</sub>. Adoption of generative AI tools significantly impacted respondents' academic writing skills when mediated by accessibility.

### **Research Methods**

This research was a co-relational study of descriptive type that used a multivariate statistical technique to analyze a correlation research investigation. Students pursuing their second degree, Ph.D. candidates who have completed or are currently completing their thesis proposals, academic lecturers, and undergraduate students that are currently writing their final-year scientific education academic projects made up the population for this study. The target population for this study comprises of all science education undergraduate, graduate students, Ph.D. candidates and lecturers. The analysis utilized 189 of the responses, compared to the planned and proposed sample size of 500, which was obtained in three weeks. A general criterion for sample size selection is encouraged by multivariate methods like structural equation modeling. The multiple-choice grid on a Google form with the build elements was uploaded, and the link was shared on WhatsApp with the responders' group.

The table 1 described the demographic profiles of the respondents. 54 respondents representing 28.6% were female while 135 respondents representing 71.4% were male. The categories of the respondents involve

87 undergraduate students representing 46.0% of the total respondents' size, 34 master's degree students representing 18.0%, 21 Ph.D. students and candidates representing 11.1% and 47 lecturers representing 24.9% of the total respondents.

**Table 1**  
*Demographic Profile of the Respondents*

Gender	N	%
Female	54	28.6
Male	135	71.4
Total	189	100

Categories of the Respondents		
Undergraduate	87	46.0
Master's Degree Students	34	18.0
Ph.D. Students and Candidates	21	11.1
Faculties/Lecturers	47	24.9
Total	189	100

**Measures of Construct**

This study determines the relationship between level of awareness, accessibility and adoption of generative artificial intelligence tools. The details of the constructs' meaning and items were shown and described in the table 1 below. The items of the constructs are 29 and were rated on 5 likert scales.

**Table 2**  
*Construct meaning, items code, description and source of the items' table*

Construct	Construct Meaning	Item Code	Item description	Source
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Awareness of generative artificial intelligence tools	The level of consciousness of subset of artificial intelligence that can generate ideas, create contents and develop textual communication	AWA1	I am fully aware of the existence of generative artificial intelligence tools	Self-Designed
		AWA2	I am familiar with different generative artificial intelligence tools	
		AWA3	I received training and update on generative artificial intelligence tools	
Accessibility of generative artificial intelligence	The level of accessing the subset of artificial intelligence that can generate ideas, create content and develop textual communication	ACC1	I have an account with generative artificial intelligence tools	Self-Designed
		ACC2	I can access the generative artificial intelligence tools in my computer and smart phone	
		ACC3	My institution makes generative artificial intelligence tools accessible in my campus	
		ACC4	Internet and power supply doesn't affect my access to generative artificial intelligence tool	
Adoption of generative artificial intelligence tools	The level of using the subset of artificial intelligence that can generate ideas, create content and develop textual communication	AD1	I have adopted the usage of generative artificial intelligence tools for educational purposes	Self-Designed
		AD2	Generative artificial intelligence tools has improve academic writing skills	
		AD3	Generative artificial intelligence tools has improve my content creation and technological knowledge	

		AD4	Adoption of generative artificial intelligence has make my research/academic work error free	
		AD5	I am considering integrating generative artificial intelligence to my teaching and learning	
		AD6	I belief generative artificial intelligence if well managed can aid student’s interest, motivation, curiosity and learning outcome	
		AD7	I will recommend generative artificial intelligence for future generation	
		AD8	Generative artificial intelligence tools reduce my phobia and anxiety on academic work	
Academic Writing Skills	Skills required by every academic writer s which include ability to write an article, a project/thesis writing, term paper, review of existing literature, and lots more	AWS1	I can write a good academic paragraph	Adapted from Vicente (n.d) Eastern Visayas State University
		AWS2	I can review previous literature	
		AWS3	I can write using an academic style	
		AWS4	I can use appropriate spelling, capitalization, punctuation and make summary of information	
		AWS5	I can write accurate and good research paper	
		AWS6	I can choose an appropriate academic research topic and control idea of paragraph	
		AWS7	I can raise and formulate appropriate research	

	objectives in line with research topic
AWS8	I can do in-text citation using different referencing formats
AWS9	I can make correct table using different referencing formats
AWS10	I can interpret research findings
AWS11	I can make a research report
AWS12	I can conclude, recommend and shows the implications of a study
AWS13	I can adhere strictly to latest referencing formats
AWS14	I can avoid academic theft

**Table 3**

*The results of the respondents level of awareness, accessibility, adoption of generative artificial intelligence tools and academic writing skills.*

Construct	Item Code	Item description	Mean	Standard Deviation
Awareness of generative artificial intelligence tools	AWA1	I am fully aware of the existence of generative artificial intelligence tools	3.019	1.081
	AWA2	I am familiar with different generative artificial intelligence tools	3.030	0.866
	AWA3	I received training and update on generative artificial intelligence tools	3.180	1.620
Accessibility of generative artificial intelligence	ACC1	I have an account with generative artificial intelligence tools	3.312	0.878
	ACC2	I can access the generative artificial intelligence tools in my computer and smart phone	3.349	0.932
	ACC3	My institution makes generative artificial intelligence tools accessible in my campus	3.113	0.706
	ACC4	Internet and power supply doesn't affect my access to generative artificial intelligence tool	3.537	1.438

Adoption of generative artificial intelligence tools	AD1	I have adopted the usage of generative artificial intelligence tools for educational purposes	3.212	0.723	
	AD2	Generative artificial intelligence tools haveimproved academic writing skills	3.267	0.668	
	AD3	Generative artificial intelligence tools haveimproved my content creation and technological knowledge	3.468	0.687	
	AD4	Adoption of generative artificial intelligence has made my research/academic work error free	3.333	0.693	
	AD5	I am considering integrating generative artificial intelligence to my teaching and learning	3.405	0.693	
	AD6	I belief generative artificial intelligence if well managed can aid student’s interest, motivation, curiosity and learning outcome	3.423	0.718	
	AD7	I will recommend generative artificial intelligence for future generation	3.362	0.766	
	AD8	Generative artificial intelligence tools reduce my phobia and anxiety on academic work	3.153	0.860	
Academic Skills	Writing	AWS1	I can write a good academic paragraph	2.971	1.008
		AWS2	I can review previous literature	3.283	0.726
		AWS3	I can write using an academic style	3.407	0.773
		AWS4	I can use appropriate spelling, capitalization, punctuation and make summary of information	3.201	0.740
		AWS5	I can write accurate and good research paper	3.364	0.618
		AWS6	I can choose an appropriate academic research topic and control idea of paragraph	3.476	0.901
		AWS7	I can raise and formulate appropriate research objectives in line with research topic	3.397	0.841
		AWS8	I can do in-text citation using different referencing formats	3.403	0.836
		AWS9	I can make correct table using different referencing formats	3.521	0.939
		AWS10	I can interpret research findings	3.400	0.884
		AWS11	I can make a research report	3.484	0.747
		AWS12	I can conclude, recommend and shows the implications of a study	3.291	0.871
		AWS13	I can adhere strictly to latest referencing formats	3.442	0.770

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AWS14 I can avoid academic theft 3.315 0.849

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The result in the table 3 explains that the respondents’ level of generative artificial intelligence tools’ awareness, accessibility and adoption, and academic writing skills’. The table answers all the research questions and the respondents’ level of generative artificial intelligence tools’ awareness, accessibility and adoption and academic writing skills were found to be moderate and average.

**Table 4**

*Fornell Larcker discriminant correlations of the constructs*

Construct	Academic writing skill	Accessibility of generative artificial intelligence	Adoption of generative artificial intelligence	Awareness of generative artificial intelligence
Academic writing skill	0.641			
Accessibility of generative artificial intelligence tools	0.625	0.618		
Adoption of generative artificial intelligence tools	0.718	0.450	0.700	
Awareness of generative artificial intelligence tools	0.473	0.568	0.294	0.747

**Table 5**

*Convergent Validity of the first order constructs’ measure*

Construct	Cronbach Alpha (CA)	Composite Reliability (CR)	Average Variance Extracted (AVE)
Academic writing skill	0.882	0.899	0.410
Accessibility of generative artificial intelligence tools	0.572	0.624	0.382
Adoption of generative artificial intelligence tools	0.847	0.850	0.490
Awareness of generative artificial intelligence tools	0.585	0.715	0.557

**Table 6**

*Relationship result of first order latent variables (3As of generative intelligence tools) and academic writing skills.*

Path Relationship	Path Coefficient	Coefficient Mean	Remark	t-value	p-value	Remark
Awareness of generative artificial intelligence tools -> Academic writing skill	0.143	0.156	Weak/Positive	3.247	0.001	H <sub>1</sub> Retained
Accessibility of generative artificial intelligence tools-> Academic writing skill	0.301	0.303	Moderate/Positive	5.911	0.000	H <sub>2</sub> Retained
Adoption of generative artificial intelligence tools -> Academic writing skill	0.541	0.533	Substantial/Positive	9.553	0.000	H <sub>3</sub> Retained

The table 6 above explains the direct relationship of respondents’ awareness, accessibility and adoption of generative artificial intelligence tools and academic writing skills. The path coefficient of awareness of generative artificial intelligence tools and academic writing skill was positive, weak and significant. The path coefficient of accessibility of generative artificial intelligence tools and academic writing skill was positive, moderate and significant. The path coefficient of adoption of generative artificial intelligence tools and academic writing skill was positive, substantial and significant.

**Table 7**

*Indirect Relationship result of first order latent variables (Awareness and Adoption of generative intelligence tools) and academic writing skill when mediated by accessibility of generative artificial intelligence tools.*

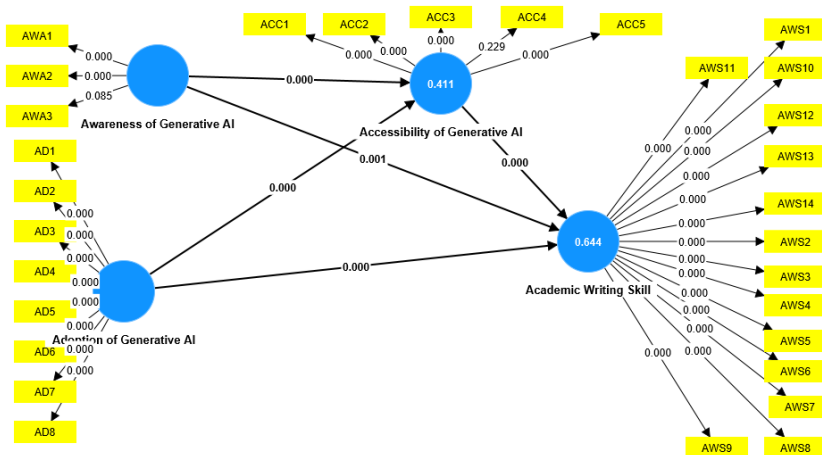
Path Relationship	Path Coefficient	Coefficient Mean	Remark	t-value	p-value	Remark
Awareness of generative artificial intelligence tools -> Accessibility of generative artificial intelligence tools -> Academic writing skill	0.093	0.094	Weak/Positive	3.621	0.000	H <sub>4</sub> Retained

Adoption of generative artificial intelligence tools - >Accessibility of generative artificial intelligence tools-> Academic writing skill	0.143	0.145	Weak /Positive	4.54	0.000	H <sub>5</sub> Retained
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The table 7 above explain the indirect relationship of respondents' awareness and adoption of generative artificial intelligence tools and academic writing skills when mediated of generative artificial intelligence tools. The path coefficient of awareness of generative artificial intelligence tools and academic writing skill was positive, weak and significant when mediated of generative artificial intelligence tools. The path coefficient of adoption of generative artificial intelligence tools and academic writing skill was positive, weak and significant when mediated by of generative artificial intelligence tools.

**Figure 1**

*The graphical output of the generative artificial intelligences' awareness, accessibility and adoption and academic writing skills.*



**Discussion & Conclusion**

The results obtained in the table 6 and 7 above indicated that the respondents awareness of the generative artificial intelligence tools has weak and significant impact on their scientific academic writing skills ( $\beta=0.143$ ,  $p<.05$ ), respondents' accessibility of the generative artificial

intelligence tools has moderate and significant impact on their scientific academic writing skill ( $\beta=0.301$ ,  $p<.05$ ), and the respondents' adoption of the generative artificial intelligence tools has substantial/large and significant impact on their scientific academic writing skill. The indirect result of this study revealed that the respondents' accessibility mediating role on the relationship between their awareness and adoption of the generative artificial intelligence tool was low/weak though significantly. The teaching-learning process, academic writing, and data analysis are just a few of the areas of life that generative artificial intelligence tools are transforming. In this digital age, fewer people than anticipated are aware of this most recent advancement. The ethical use of the generative AI tools will prevail and enhance the writers' academic writing and reduces the academic writing anxiety, nonetheless, with persistent sensitization and focused effort. The inference drawn from the findings showed that accessibility and adoption of generative artificial intelligence tools are significantly influenced and related to academic writing anxiety. The researchers came to the conclusion that the academic writer should take into account using generative artificial intelligence tools based on the results that were available.

The present study determined the impacts of respondents' awareness, accessibility and adoption of generative artificial intelligence on their scientific academic writing skills. The study found out that the awareness, accessibility and adoption of generative artificial intelligence tools has weak, moderate and substantial impacts on the respondents' scientific writing skill. The study recommended that the concern authorities should make the usefulness of the generative artificial intelligence tools more available, organizes workshops and seminars on different generative AI tools and their usage, and encourage the AI tools users to observe ethical practices.

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