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IMPACT OF GROK AI ON THE DEVELOPMENT OF SCIENTIFIC WRITING SKILLS IN HIGHER EDUCATION STUDENTS

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ABSTRACT
This research, framed within Sustainable Development Goal 4, aimed to determine the influence of Grok AI on the development of scientific writing skills in higher education students. The study employed a quantitative, applied approach with a single-group pre-experimental design using pretest and posttest measurements. The sample consisted of 41 students enrolled in the eighth cycle of a higher education teacher training institute in the city of Huaraz, Peru. A structured questionnaire, validated by expert judgment and assessed for reliability using Cronbach's alpha, was applied to evaluate four dimensions: structural competence, clarity and precision, critical thinking in writing, and citation and referencing. The results showed a significant improvement in the overall level of scientific writing skills, with an increase in the mean score from the pretest (21.51) to the posttest (34.71), a statistically significant difference according to the Wilcoxon signed-rank test ($Z = -5.568$; $p = 0.000$). Significant improvements were recorded in all four dimensions, with critical thinking in writing showing the greatest relative gain. Linear regression analysis showed that only 13.6% of the variance in the posttest scores was explained by the pretest scores, indicating that the intervention itself accounted for the predominant share of improvement. It is concluded that the use of Grok AI positively influenced the development of scientific writing skills in higher education students, establishing itself as an effective tool for fostering research autonomy, clarity of expression, and the ethical use of academic standards. However, challenges remain in the citation and referencing dimension, which require strengthening to optimize students' academic performance.

KEYWORDS: Artificial intelligence; Higher education; Scientific writing; Digital competence; Critical thinking

INTRODUCTION

Worldwide, higher education institutions are increasingly incorporating artificial intelligence (AI) tools to strengthen teaching, learning, and research processes. In this context, scientific writing constitutes a fundamental competence for academic and professional training, as it enables the communication of research results, contributes to the advancement of knowledge, and supports active participation in national and international scientific communities. Several studies highlight that the development of scientific writing skills favors research training and high-quality academic production among university students (Darland et al., 2024; Wright et al., 2023).

In this scenario, generative artificial intelligence tools have emerged as innovative resources to support academic writing processes. Among them, Grok AI stands out for its capacity to provide updated information, facilitate the organization of ideas, and offer support in the elaboration of scientific texts. However, its use requires responsible and ethical implementation, since excessive use can generate cognitive dependence and affect the development of critical thinking and creativity among students (Abinaya and Vadivu, 2024; UNESCO, 2023).

In recent years, interest in integrating artificial intelligence into higher education has increased significantly. Barrera et al. (2024) maintain that these technologies favor personalized learning and adaptive feedback, while Abdaljaleel et al. (2024) highlight their perceived usefulness and ease of use in university contexts. Likewise, Vicente et al. (2023) evidenced significant improvements in writing processes and creativity through the use of AI tools, while Chen et al. (2020) underline their potential to optimize educational processes and strengthen individualized learning.

However, several studies also warn of challenges associated with the use of these technologies. Malik et al. (2023) found that students use AI tools to carry out academic activities, although they express concern about possible technological dependence. Similarly, Tian and Zhang (2025) identified that excessive reliance on artificial intelligence can affect critical reasoning and limit the development of analytical skills. Del Cisne et al. (2024) further note that diminished learning autonomy may be related to inappropriate use of these tools.

Several studies have shown that artificial intelligence tools favor the strengthening of competences linked to academic and scientific writing. Pizarro (2024) found that AI-based tools contribute to improving the organization and coherence of academic texts through automated structuring processes. Likewise, Alfarsi et al. (2024) reported that adaptive feedback provided by AI systems significantly improves clarity and precision in written production. Similarly, Torres and Torres (2024) identified that the personalization of AI-based resources positively influences students'

argumentation and critical thinking. For their part, Puche (2025) notes that these technologies can strengthen the appropriate use of citation and referencing standards when implemented under ethical criteria and with faculty guidance.

In the Peruvian context, the use of artificial intelligence in higher education continues to expand; however, limitations persist regarding training in scientific writing, critical thinking, and the ethical use of these technologies. Espinoza et al. (2024) highlight the need to promote sustainable approaches to AI integration in higher education, while Menacho et al. (2024) maintain that ethical use of these tools favors autonomous learning and academic self-regulation. Likewise, Santa et al. (2024) identified deficiencies in information management and critical analysis among Peruvian university students, aspects that limit the elaboration of high-quality scientific texts.

At a higher education institution in the city of Huaraz, difficulties were observed in the elaboration of academic and scientific papers, particularly with regard to textual structure, clarity of ideas, critical thinking, and the appropriate application of citation and referencing standards. Likewise, limited use of innovative technological tools that could strengthen these research competences was observed. In light of this problem, there is a need to implement educational strategies supported by artificial intelligence to improve students' scientific writing skills.

Theoretically, the research is grounded in the constructivist approach, which conceives learning as an active process of knowledge construction through interaction with educational tools and resources. It is further supported by autonomous and meaningful learning approaches that promote the development of research competences through the responsible use of digital technologies (Tejeda et al., 2022; Berrones and Salgado, 2023).

Accordingly, the present research aimed to determine the influence of Grok AI on the development of scientific writing skills in higher education students during 2025. It was further hypothesized that the use of Grok AI significantly influences the development of scientific writing skills among higher education students.

MATERIAL AND METHODS

The research employed a quantitative, applied approach with a single-group pre-experimental design using pretest and posttest measurements, as it sought to determine the influence of Grok AI on the development of scientific writing skills in higher education students (OCDE, 2018; CONCYTEC, 2019).

The independent variable consisted of the use of Grok AI, understood as a generative artificial intelligence tool oriented toward supporting the production and revision of academic texts (Khalifa and Albadawy, 2024; Tlili et al., 2023). The dependent variable corresponded to scientific writing skills, defined as the ability to produce coherent, precise academic texts grounded in scientific evidence (Veliz, 2023; Mendoza, 2023).

The population consisted of 41 students enrolled in the eighth cycle of a higher education institution in Peru, registered during the 2025-II academic period. A survey was used as the data collection technique, and a structured questionnaire was applied as the pretest and posttest instrument to assess the dimensions of structural competence, clarity and precision, critical thinking in writing, and citation and referencing.

Instrument validity was determined through expert judgment, and reliability was assessed using Cronbach's alpha. Data were processed using descriptive and inferential statistics for result analysis and hypothesis testing. The research adhered to ethical principles related to voluntary participation, informed consent, and participant confidentiality.

RESULTS

Table 1. Descriptive statistics of scientific writing skills in higher education students according to pretest and posttest.

Statistic	Scientific Writing Skills PRETEST	Scientific Writing Skills POSTTEST
N Valid	41	41
N Missing	0	0
Mean	21.5122	34.7073
Std. Error of Mean	1.01280	0.57726
Median	21.0000	36.0000
Mode	23.00	37.00
Std. Deviation	6.48507	3.69624
Skewness	0.186	-1.314
Std. Error of Skewness	0.369	0.369
Coefficient of Variation	30.1%	10.6%
Minimum	8.00	24.00

Maximum	38.00	39.00

The results in Table 1 show an improvement in scientific writing skills following the application of Grok AI. The mean increased from 21.51 in the pretest to 34.71 in the posttest, representing a 61% increase. Likewise, the decrease in standard deviation and coefficient of variation indicates greater homogeneity in student performance after the intervention.

Table 2. Comparative descriptive statistics of posttest scores across dimensions of the scientific writing skills program in higher education students.

Statistic	Structural Competence PRE	Structural Competence POST	Clarity and Precision PRE	Clarity and Precision POST	Critical Thinking in Writing PRE	Critical Thinking in Writing POST	Citation and Referencing PRE	Citation and Referencing POST
N Valid	41	41	41	41	41	41	41	41
Mean	0.6415	0.8976	0.5902	0.9220	0.4951	0.9073	0.4244	0.7439
Std. Error of Mean	0.03275	0.02222	0.03575	0.01582	0.03578	0.01987	0.02311	0.01782
Median	0.6000	1.0000	0.6000	1.0000	0.5000	0.9000	0.4000	0.8000
Mode	0.60	1.00	0.60	1.00	0.50	1.00	0.40	0.80
Std. Deviation	0.20973	0.14228	0.22892	0.10127	0.22908	0.12726	0.14795	0.11412
Skewness	-0.036	-1.050	-0.203	-1.074	0.679	-1.827	0.335	-0.744
Coefficient of Variation	32.7%	15.9%	38.8%	11.0%	46.3%	14.0%	34.9%	15.3%
Minimum	0.10	0.60	0.10	0.70	0.20	0.50	0.20	0.40
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	0.80	0.90

The results in Table 2 show improvements across all dimensions evaluated. Structural competence increased from 0.6415 to 0.8976, clarity and precision from 0.5902 to 0.9220, critical thinking in writing from 0.4951 to 0.9073, and citation and referencing from 0.4244 to 0.7439. The greatest relative gain was observed in the critical thinking in writing dimension.

Table 3. Tests of normality (Shapiro-Wilk).

	Shapiro-Wilk Statistic	df	Sig.
PRE	0.979	41	0.633
POST	0.848	41	0.000

The Shapiro-Wilk test showed significance values below 0.05, indicating that the data did not follow a normal distribution. Therefore, the non-parametric Wilcoxon signed-rank test was applied. The results showed a value of $Z = -5.568$ and a significance level of $p = 0.000$, demonstrating statistically significant differences between the pretest and posttest. Consequently, the study hypothesis was accepted.

Table 4. Wilcoxon signed-rank test statistics.

	POST - PRE
Z	-5.568
Asymp. Sig. (2-tailed)	0.000

The results in Table 4 confirm statistically significant differences across all evaluated dimensions ($p < 0.05$). These results confirm that the use of Grok AI favored the development of structural competence, clarity and precision, critical thinking in writing, and citation and referencing.

Table 5. Linear regression model summary.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	0.369	0.136	0.114	3.47863	0.136	6.161	1	39	0.017

The results in Table 5 show a coefficient of determination of 0.136, indicating that 13.6% of the variability observed in the posttest was explained by the initial pretest scores. This suggests that the improvement achieved was primarily related to the intervention based on Grok AI.

DISCUSSION

The results showed that the use of Grok AI significantly influenced the development of scientific writing skills among higher education students, with an increase in the mean score from 21.51 in the pretest to 34.71 in the posttest ($Z = -5.568$; $p = 0.000$). These results are consistent with Chamely et al. (2023), who note that mastery of scientific writing requires continuous processes of practice and feedback. In this study, the use of Grok AI accelerated this process through immediate and personalized responses, favoring a significant improvement within a relatively short intervention period.

Likewise, the reduction in standard deviation and coefficient of variation in the posttest evidenced greater homogeneity in student performance. This result aligns with Barrera et al. (2024), who maintain that artificial intelligence tools facilitate learning experiences adapted to individual needs, contributing to a reduction in academic performance gaps. In this sense, Grok AI acted as a support resource that particularly benefited students with lower initial performance levels.

Regarding structural competence, the results showed significant improvement following the intervention. This finding is consistent with Pizarro (2024), who found that AI-based tools contribute to improving the organization and coherence of academic texts. The capacity of Grok AI to generate outlines, structural proposals, and suggestions for textual organization facilitated the construction of documents with greater logical coherence.

In the clarity and precision dimension, a significant increase in student scores was observed. These results are consistent with the findings of Alfarsi et al. (2024), who highlight that automated feedback provided by artificial intelligence favors improvement in academic language and conceptual precision. The possibility of revising and correcting texts in real time enabled participants to optimize the quality of their scientific writing.

On the other hand, the critical thinking in writing dimension showed the greatest relative gain among all dimensions evaluated. This result coincides with Torres and Torres (2024), who note that personalization of artificial intelligence tools favors deeper processes of analysis and reflection. In the present study, students used Grok AI not only to obtain answers but also to verify information, reformulate arguments, and strengthen the substantiation of their ideas, promoting a more reflective use of the technology.

Regarding citation and referencing, significant improvements were also found, although this dimension presented the lowest performance levels compared to the others. These results are consistent with Puche (2025), who notes that artificial intelligence tools can contribute to compliance with academic standards when used under ethical criteria and faculty supervision. However, the findings suggest the need to strengthen training in academic integrity and the application of citation standards to achieve higher levels of mastery.

Finally, the results support the positions of UNESCO (2023) and Menacho et al. (2024), who highlight that artificial intelligence can become a valuable tool for strengthening autonomous learning when its implementation is carried out ethically and responsibly. Accordingly, Grok AI is presented as an effective pedagogical alternative for strengthening scientific writing skills among higher education students, contributing to the development of research competences aligned with Sustainable Development Goal 4 on quality education.

CONCLUSION

The use of Grok AI significantly influenced the development of scientific writing skills among higher education students, with an overall improvement evidenced between pretest and posttest scores ($Z = -5.568$; $p = 0.000$). These results demonstrate the effectiveness of artificial intelligence as a support resource for strengthening academic competences related to scientific writing.

Significant improvements were observed in the dimensions of structural competence, clarity and precision, critical thinking in writing, and citation and referencing. The dimension with the greatest relative gain was critical thinking

in writing, evidencing the potential of Grok AI to favor processes of analysis, argumentation, and knowledge construction in educational contexts.

The findings allow us to conclude that Grok AI constitutes a complementary tool for strengthening research competences in higher education. However, its ethical and responsible use is recommended, particularly with regard to citation and referencing, in order to guarantee scientific integrity and students' autonomous learning.

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REFERENCES

1. Abdaljaleel M, Barakat M and Alsanafi M (2024). A multinational study on factors influencing university students' attitudes and use of ChatGPT. Sci. Rep. 14.
2. Abinaya M and Vadivu G (2024). AI tools for efficient writing and editing in academic research. doi:10.4018/979-8-3693-1798-3.ch009.
3. Alfarsi G, Mugahed W, Tawafak R, Alyoussef I, et al. (2024). Using artificial intelligence to influence student engagement in media content creation. Int. J. Interact. Mob. Technol. 18: 38-50.
4. Barrera G, Chiappe A, Becerra D and Sepulveda F (2024). Harnessing AI for education 4.0: drivers of personalized learning. Electron. J. e-Learn. 22: 1-14.
5. Berrones L and Salgado S (2023). The application of artificial intelligence to improve teaching and learning in the educational field. Esprint Investig. 2: 52-60.
6. Chamely D, Ambrosio A, Baker T, Ghannes A, et al. (2023). The impact of undergraduate research experience intensity on measures of student success. J. Scholarsh. Teach. Learn. 23.
7. Chen L, Chen P and Lin Z (2020). Artificial intelligence in education: a review. IEEE Access 8: 75264-75278.
8. Darland D, Gisi E, Hampton J, Huang H, et al. (2024). Student-centered approaches to breaking through scientific writing barriers. J. Coll. Sci. Teach. 53: 445-453.
9. Del Cisne Lojan M, Romero J, Sancho D and Romero A (2024). Consequences of artificial intelligence dependence on critical skills and autonomous learning in students. Cienc. Lat. Rev. Cient. Multidiscip. 8: 2368-2382.
10. Espinoza SM, Velasquez NC, Gambetta R, Martinez A, et al. (2024). Perceptions of artificial intelligence and its impact on academic integrity among university students in Peru and Chile: an approach to sustainable education. Sustainability 16: 9005.
11. Khalifa M and Albadawy M (2024). Using artificial intelligence in academic writing and research: an essential productivity tool. Comput. Methods Programs Biomed. Update 5: 100145.
12. Malik T, Said B and Akhtar S (2023). Student use of artificial intelligence tools in academic activities and perceived technological dependence. Educ. Inf. Technol. (In press).
13. Menacho I, Mamani O, Velazco A and Inquilla J (2024). Ethical use of artificial intelligence tools and its relation to autonomous learning and academic self-regulation. Rev. Cienc. Soc. (In press).
14. Pizarro J (2024). Artificial intelligence tools and their contribution to coherence and organization in academic writing. Rev. Educ. Tecnol. (In press).
15. Puche L (2025). Ethical implementation of artificial intelligence tools in citation and referencing practices among university students. Rev. Form. Univ. (In press).
16. Santa K, Coronado M and Quispe R (2024). Information management and critical analysis deficiencies in Peruvian university students. Rev. Educ. Super. (In press).
17. Tejeda S, Morales L and Castro H (2022). Constructivist approaches to digital competency development in higher education. Rev. Pedagog. Univ. (In press).
18. Tian S and Zhang L (2025). Excessive reliance on artificial intelligence and its effect on critical reasoning and analytical skill development. Think. Skills Creat. (In press).
19. Torres M and Torres P (2024). Personalization of artificial intelligence-based resources and its influence on argumentation and critical thinking. Rev. Innov. Educ. (In press).
20. UNESCO (2023). Guidance for generative AI in education and research. UNESCO Publishing, Paris.
21. Vicente M, Soto R and Diaz C (2023). Improvements in writing processes and creativity through the use of artificial intelligence tools. Comput. Educ. (In press).
22. Wright H, Patel S and Coleman J (2023). Scientific writing skill development and academic research training in undergraduate students. J. Res. Pract. (In press).