

Evaluation of the Impact of ChatGPT on the Development of Research Skills in Secondary Education Students: An Experimental Approach

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Abstract—This study evaluates the impact of ChatGPT on the development of investigative competencies in regular basic education students, focusing on three key dimensions: functionality in information gathering, contribution to the generation of precise and relevant content, and usability in developing investigative skills. An experimental design was implemented with a sample of 100 students, divided into an experimental group ($n = 50$) that used ChatGPT and a control group ($n = 50$) that employed traditional methods. The students developed research projects evaluated based on six criteria: coherence, precision, originality, content depth, problem-solving ability, and source utilization. The results, obtained through descriptive and comparative statistical analysis, revealed that the experimental group outperformed the control group in coherence (3.6 vs. 2.8), precision (3.4 vs. 2.6), and originality (3.4 vs. 2.8). However, the control group showed better performance in source utilization (3.4 vs. 2.2), suggesting that traditional methods are more effective in managing bibliographic references. Regarding content depth and problem-solving ability, both groups achieved similar results, with a slight advantage for the experimental group. In conclusion, the use of ChatGPT enhances the coherence, precision, and originality of students' investigative work. However, it is recommended to combine this tool with traditional methods to optimize source management and ensure a comprehensive development of investigative competencies, promoting an ethical and effective use of technology.

Keywords—investigative competencies, ChatGPT, students, teaching, learning, education

I. INTRODUCTION

Information and Communication Technologies (ICT) have gained unprecedented relevance in today's society, playing a crucial role in the creation and development of countless digital tools that have transformed various aspects of daily life, including education [1]. This rapid technological evolution has created an urgent need for teachers to develop and possess appropriate digital competencies. These competencies are essential for teachers not only to effectively integrate into the digital environment but also to teach their students in a way that meets the demands and challenges of the 21st century. The ability to use these tools effectively allows educators to offer a more dynamic, interactive education that aligns with the emerging needs of contemporary society, thus preparing students to successfully navigate an increasingly digitalized world [2].

The insufficient development of investigative competencies in regular basic education students is due to several factors, such as traditional teaching methods that

prioritize memorization over inquiry [3], lack of resources and teacher training [4], rigid curricula that do not allow for creative activities [5], and low motivation and support in both school and family environments [6]. The use of ChatGPT can mitigate these issues by providing instant access to a wide range of information and academic sources, facilitating autonomous exploration [7]. Additionally, ChatGPT can guide students in hypothesis formulation, experiment design, and data analysis, enhancing their understanding of scientific processes [8], and foster critical thinking skills through interaction and instant feedback [9], thus creating a more dynamic and effective learning environment for developing investigative competencies.

The integration of emerging technologies in education has been a subject of study in recent decades [10]. AI tools like ChatGPT can support various phases of the investigative process, from information search to document writing [11]. However, literature on the specific impact of ChatGPT on the development of investigative competencies is still limited. This research fills that gap by providing a detailed evaluation of ChatGPT's functionality, contribution, and usability in the educational context. In the digital age, investigative competencies are essential for the academic and professional development of higher education students [12]. Effective research skills involve search, critical analysis, information synthesis, and communication of results. With advances in Artificial Intelligence (AI), tools like ChatGPT have emerged as potential resources to support these processes. This study explores how ChatGPT can be used to enhance investigative competencies in university students, a crucial aspect for their academic and professional success.

In recent years, many educational institutions have recognized the importance of digital literacy and implemented continuous training programs for their teachers. These programs include modules on the use of digital technologies in research, management of bibliographic databases, and data analysis tools, aiming to keep teachers updated with new technologies and research methodologies [13]. The availability of digital resources and online learning platforms has facilitated access to courses and educational materials on research skills, allowing teachers to learn and update their research techniques from anywhere. According to Bates [14], access to digital technologies has transformed teacher training, offering more flexible and personalized learning. Despite these efforts, there remains a significant digital divide among teachers in terms of access

and effective use of advanced research technologies. Some studies indicate that while some teachers are well-trained and use digital tools effectively, others lack the necessary skills. This variability may be due to factors such as lack of resources, generational differences, or insufficient initial training [10]. Tondeur *et al.* [15] indicate a significant disparity in teachers' digital competencies, influenced by contextual and personal factors. Furthermore, many teachers' digital training focuses on the use of technologies for teaching rather than for research. This means that although teachers may be trained in using digital tools for instruction and classroom management, they may lack the necessary competencies to conduct high-quality research using these tools [12]. According to Mishra and Koehler [16], effective integration of technology in education requires a balanced approach that encompasses both teaching and research. Although significant efforts have been made to improve teachers' digital training, the lack of investigative competencies remains a challenge. It is crucial that continuous training programs address this gap, ensuring that teachers are not only equipped to teach with technology but also to research and contribute to academic knowledge effectively.

In this context, ChatGPT, developed by OpenAI, emerges as an AI language model that uses advanced natural language processing techniques to generate responses to user queries or suggestions. This model has been trained with large amounts of text and is based on the GPT-3.5 family, considered one of the most advanced in the field of language models [17]. In March 2023, GPT-4, an improved version promising rapid advancements in capabilities, was released. The application of ChatGPT in education has broad and diverse potential, including drafting articles, stories, poems, and essays [18], generating summaries, expanding texts, and debugging original computer code [19]. However, its use has also generated controversy regarding its suitability for education. Some see ChatGPT as the future of teaching, learning, and educational research, while others consider it a threat that could limit the analytical skills of teachers and students. Among its main educational advantages are the ability to extend teaching reach, allow access to a greater variety and quantity of online educational resources, and provide personalized and automated feedback in the learning process [20, 21]. Many of these advantages can materialize with adequate knowledge of the tool's use, highlighting the importance of formulating specific and relevant questions to obtain coherent responses. Additionally, the implementation of ChatGPT as an educational tool will involve changes in many teaching aspects, such as adapting current evaluation methods and fostering creativity and critical thinking in students to maximize its benefits instead of limiting its use [22]. It can also reduce teachers' workload in evaluation and feedback tasks. Various authors, such as Morales-Chan [20], emphasize the need to conduct experiences using ChatGPT in the teaching context to identify effective practices and address the challenges of its educational application.

II. LITERATURE REVIEW

Fig. 1, as described by Slam and Islam [23], provides a

visual representation of the ChatGPT operational process, detailing the various components involved in generating responses and how they interact with each other.

Training on Supercomputers: The process begins with training on a supercomputer. At this stage, the ChatGPT model is trained using vast amounts of textual data. During the training, the model receives information from a wide range of sources to learn linguistic patterns, word relationships, and the meaning of phrases. This process is essential for ChatGPT to generate coherent and accurate responses across a wide variety of topics.

Output Generation: Once the model has been trained on the data, an initial output is generated. This output may include responses or predictions based on the input received during training. Although this is the first step toward creating a useful model, it is not yet fully optimized for efficient user interaction.

Fine Tuning: The next step in the process is the fine-tuning of the model. At this stage, the model undergoes additional adjustments to improve its responsiveness in specific scenarios. Fine-tuning allows the model to adjust to more detailed parameters, enhancing its accuracy and relevance in the generated responses.

Instruct GPT: After fine-tuning, the adjusted model is integrated into a structure called Instruct GPT, which further optimizes the system's responses. Instruct GPT receives more specific and detailed instructions to produce responses that are not only correct but also aligned with the expectations and needs of the user.

ChatGPT: Once the adjustment and optimization through Instruct GPT are complete, the system becomes ChatGPT, which is ready to interact with users. ChatGPT can receive queries from users and generate responses based on the information learned during training and the adjustments made in the previous stages.

User Interaction: When a user submits a query or asks a question, it is sent to the ChatGPT model. The response process goes through the aforementioned stages, where ChatGPT uses the capabilities of Instruct GPT and the generated outputs to provide an appropriate response to the user.

Response to User: Finally, the generated response is sent back to the user. This interaction cycle can repeat as many times as necessary, depending on the number of queries or questions the user submits.

This process illustrates the continuous interaction between the model's various components, ensuring that ChatGPT provides coherent and useful responses based on the user's queries.

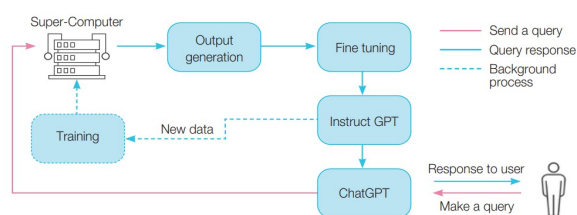


Fig. 1. ChatGPT operational process with the user or interlocutor [23].

According to the research developed by Alenezi *et al.* [24],

the contribution lies in its exploratory approach to the attitudes and perceptions of special education teachers of English as a Foreign Language (EFL) towards the use of ChatGPT as a learning tool. By employing a mixed-methods approach, the study not only quantifies attitudes, perceived effectiveness, barriers, and future willingness to use ChatGPT but also adds a qualitative dimension through follow-up interviews. The findings provide valuable insights for the implementation and development of ChatGPT in language teaching for special education students, highlighting the importance of considering inclusive gender approaches and overcoming practical challenges to enhance the effectiveness of this tool in educational contexts.

The research developed by Watrinhos *et al.* [25] provides a comprehensive overview of the emerging landscape of research on the integration of ChatGPT in education. Through a bibliometric analysis, the study maps publication trends, identifies influential works, and reveals key themes such as applications in higher education, pedagogical strategies, ethical risks, and implications for assessment. It highlights the rapid growth of publications since the launch of ChatGPT, uncovers significant research gaps, especially in K-12 education, and offers guidance for future research and practical implementation. The findings underscore the need for ethical and responsible integration of ChatGPT, continuous monitoring of its impact, and addressing under-researched areas to maximize benefits and minimize risks in educational contexts.

According to Marín-Guamán [26], the study on the advantages and disadvantages of ChatGPT highlights its high precision and continuous learning ability, as well as its versatility in a wide range of applications in higher education, despite certain limitations. ChatGPT ability to automate tasks makes it a valuable tool in the educational realm and other contexts. Based on a probabilistic sample in Ecuador and using an unsupervised learning approach, the study shows how ChatGPT can improve the quality and efficiency of online communication and virtual assistance applications. A key conclusion is that ChatGPT has the potential to be useful for both students and teachers in higher education, although it is crucial to recognize its limitations to address new topics critically and reflectively. The success of its integration in education will depend on its use and incorporation in teaching and learning processes. The article emphasizes the importance of leveraging ChatGPT advantages to produce content efficiently and in short times but also points out the disadvantage of a potential lack of ethical responsibility in some users' research productions.

According to Atencio-González *et al.* [27], the research developed analyzed the use of ChatGPT to promote critical thinking in university students. The descriptive and documentary study examined how ChatGPT influences the development of critical thinking, challenging traditional teaching practices by allowing the individualization of learning. Despite the controversy over its potential to facilitate plagiarism, it was concluded that proper use of ChatGPT can enrich research and enhance critical and analytical thinking, provided it is used ethically. The article highlights that any resource contributing to human development is valuable and that innovative technological

tools like ChatGPT play an essential role in digital education, promoting an ethical learning culture.

According to the research developed by Salvagno *et al.* [28], AI chatbots, particularly ChatGPT, appear to be useful tools in scientific writing, helping researchers and scientists organize material, generate initial drafts, and/or edit. There is no publication in the field of intensive care medicine prepared with this approach; however, this will be a possibility in the near future. ChatGPT work should not be used as a substitute for human judgment, and the outcome should always be reviewed by experts before being used in any application or critical decision-making. Additionally, several ethical issues arise regarding the use of these tools, such as the risk of plagiarism and inaccuracies, as well as a potential imbalance in accessibility between high- and low-income countries if the software becomes paid. For this reason, a consensus on how to regulate the use of chatbots in scientific writing will soon be necessary.

The influence of Artificial Intelligence (AI) in education has been the subject of various studies highlighting its transformative potential. As Navarrete-Cazales and Manzanilla-Granados [29] mentions, AI is revolutionizing education globally, with international guidelines guiding its proper use. Additionally, AI is expected to indirectly influence daily life through developments such as smart chips and autonomous transportation, significantly impacting the educational field.

Furthermore, Rama [30] points out that the implementation of 5G technology is driving virtual education and the use of AI. Each new generation of mobile technology has promoted advances in digital education, such as virtual platforms and simulators. 5G, in particular, facilitates communication between AI and the Internet of Things, allowing efficient data management crucial for AI development. This technology reconfigures work and business, directly impacting education by distributing tasks between humans and machines.

On the other hand, García-Sánchez [31] highlights the increasing use of online educational platforms and chatbots, like ChatGPT, which enhance the learning experience by providing personalized and detailed responses. While these tools transform teaching and foster student engagement, they also present ethical and practical challenges, such as information reliability and data privacy. García-Peñalvo [32] emphasizes the need to understand how students perceive and use these technologies before their widespread adoption.

According to the research developed by García-Peñalvo [33], there is a shift in social perception of AI following the advent of ChatGPT. Previously considered a technical tool, AI now demonstrates its humanoid and creative potential. García-Peñalvo [33] emphasizes the need to adapt education to use these tools ethically and effectively, fostering co-creation and collaboration between students and technology. Likewise, Juárez *et al.* [34] discusses how AI, exemplified by ChatGPT, has integrated into daily and professional life. The evolution of Large-scale Language Models (LLMs) like ChatGPT requires a reflective approach in teaching, addressing benefits, challenges, and ethical considerations through interdisciplinary collaboration.

In this same context, Vera *et al.* [35] studies the use of ChatGPT to improve English skills in university students.

Despite the challenges of traditional methodologies, ChatGPT has shown potential in enhancing English learning. However, the authors emphasize the need to improve the implementation of these tools to ensure ethical and effective use. Lara-Colón and Romo-Rodríguez [36], in their comparative study on the use of ChatGPT among Information Technology students at the University of Guayaquil, highlight how this virtual assistant enhances personalized learning experiences. Although its effectiveness and acceptance require further study, ChatGPT represents an innovative tool with the potential to transform higher education.

Additionally, Ciprés *et al.* [37] discusses the impact of AI generative language models in higher education, addressing the challenges and opportunities they present. Models like ChatGPT support various educational areas but also pose ethical and practical challenges, such as academic integrity and data privacy. Ensuring responsible and equitable use of these technologies in the educational environment is essential.

According to the research developed by Atlas [38], access to ChatGPT represents a significant advancement in managing diverse and complex tasks, offering substantial educational potential. A study integrating ChatGPT into Computer Engineering courses shows that most students (92.50%) find it useful and easy to use for academic tasks, though faculty support is lower (80%). Students point out challenges in verifying the accuracy of results and the generic nature of responses if prompts are not refined. Despite these issues, students with experience using ChatGPT find it beneficial for learning when used complementarily. ChatGPT generative AI capabilities allow it to produce content resembling human creation, enhancing text quality and handling large volumes of data, although it faces high computational demands and potential biases due to its training data. Overall, ChatGPT can significantly improve the learning experience in higher education when its strengths and limitations are properly managed [39].

III. METHODOLOGY

A. Research Design

This study follows a pretest-posttest experimental design with a control group, which allowed for the measurement of students' investigative skills before and after the intervention in both groups to compare the effects of the intervention (use of ChatGPT) on investigative competencies, ensuring a precise assessment of the tool's impact compared to traditional methods.

The sample consisted of 100 regular basic education students, randomly assigned to two groups: an experimental group ($n = 50$) that used ChatGPT and a control group ($n = 50$) that employed traditional methods. Randomization ensured that both groups started with similar skill levels. Additionally, a pretest was administered to assess the students' initial investigative competencies, ensuring that any observed differences in the final skills would be exclusively due to the intervention.

B. Statement of Objectives and Research Question

1) General question

To what extent does the use of ChatGPT impact the

development of investigative competencies in regular basic education students?

2) Specific questions

- What are the scores between the experimental and control groups?
- How do the scores vary between the experimental and control groups?
- How do the functionality, research content generation, and usability of ChatGPT enable the development of investigative competencies in students?

3) General objective

To evaluate the impact of using ChatGPT on the development of investigative competencies in regular basic education students.

4) Specific objectives

- To identify the scores of the control and experimental groups.
- To compare the scores between the control and experimental groups.
- To analyze the results regarding the investigative dimensions through the use of ChatGPT.

C. Population and Sample

The study population consisted of 300 students from the High-Performance School of Arequipa, Peru. To ensure data representativeness, a random sample of 100 students from various academic areas and levels was selected. These 100 students were divided into two groups: an experimental group consisting of 50 students and a control group also consisting of 50 students. The average age of the students is 16 years, with the experimental group comprising 30 women and 20 men, and the control group comprising 28 women and 22 men.

D. Data Collection Instruments

To evaluate the quality and accuracy of the content generated with and without the support of ChatGPT, a content analysis method was used, complemented by evaluation rubrics specifically designed for this study (Table 1). This instrument allowed for a detailed comparison of the research projects completed by the students. Written work from both groups (experimental and control) was collected and analyzed using a mixed-methods approach that combined both quantitative and qualitative analyses.

The projects were evaluated based on several key criteria: coherence in argumentative structure, accuracy in presenting facts and data, originality in the approach to the topic, and depth of content analysis. Additionally, a detailed analysis was included of the projects' ability to address and solve complex research problems, the fluency and clarity in written expression, and the correct use of sources and bibliographic references.

To ensure the validity of the instrument, pilot tests were conducted, and the rubrics were adjusted based on preliminary results. The evaluation was performed by a panel of experts in academic research, who applied the rubrics in a blinded manner to avoid biases. Each criterion was weighted according to its relevance to the study's objective, allowing for a balanced comparison between the experimental group

(those using ChatGPT) and the control group (those not using ChatGPT).

The three dimensions evaluated in the study. Functionality of ChatGPT in information gathering, Contribution to generating accurate and relevant content, and Usability in achieving research competencies were measured using a 5-point Likert scale, where 1 represented “Strongly Disagree” and 5 “Strongly Agree.” This scale allowed participants to express their level of agreement with statements related to their experience using ChatGPT. The reliability of the instrument was verified using a Cronbach’s alpha, ensuring internal consistency, and its validity was confirmed through content validation conducted by a panel of experts, ensuring that the evaluated dimensions accurately reflect the relevant constructs in the context of the study.

A validated rubric was used to evaluate investigative competencies across six criteria: coherence, precision, originality, content depth, problem-solving ability, and source utilization. The content validity index of the instrument was confirmed by a panel of experts in educational research, obtaining a validity index of 0.85, indicating high validity. The reliability of the instrument was measured using Cronbach’s alpha coefficient, yielding a value of 0.88, which reflects excellent internal consistency.

E. Description of Rubric Levels

Very Good: The work meets or exceeds all expectations in the evaluated criterion. The quality is exceptional, and the contributions are clear, precise, and well-founded.

Good: The work meets the expectations in the evaluated criterion, with some areas that could be improved. The quality is good and demonstrates a solid understanding of the topic.

Fair: The work partially meets the expectations in the evaluated criterion. There are significant areas that need improvement. The understanding and execution of the topic are limited.

Poor: The work does not meet the expectations in the evaluated criterion. The quality is low and shows a lack of understanding and appropriate application of the topic.

F. Procedure

1) Activities conducted with the experimental group

Table 2 organizes the sessions into three key phases, describing the activities, objectives, and duration of each session to ensure a structured and effective approach to using ChatGPT in the experimental group. The experimental session lasted 4 weeks.

Table 1. Proposed rubric for evaluating research works

Criterion	Very Good (4)	Good (3)	Fair (2)	Poor (1)
Coherence	Ideas and arguments presented clearly and logically.	Mostly coherent with minor issues.	Partially coherent with some disorganized ideas.	Lack of coherence, disorganized ideas and arguments.
Accuracy	Information and data are precise, without errors.	Mostly accurate with few minor errors.	Information with several errors and incorrect data.	Inaccurate information with numerous errors.
Originality	Highly original and innovative work.	Work with original ideas, some not as much.	Some original ideas, but many derived or common.	Lack of originality, mostly derived ideas.
Depth of Content	Deep and exhaustive analysis and discussion.	Adequate analysis, but some areas could be deeper.	Superficial analysis with some depth in certain areas	Very superficial analysis and lack of depth.
Ability to Address and Solve Complex Problems	Effectively identifies and solves complex problems.	Identifies and solves problems with some difficulties.	Identifies problems, but with limited solutions.	Unable to identify and solve complex problems.
Use of Sources and Bibliographic References	Correct and complete use of relevant and reliable sources.	Adequate use of sources with minor errors.	Sources used but with frequent errors.	Incorrect or insufficient use of sources and references

Table 2. Activity planning for sessions conducted with the experimental group

Phase	Session	Activities	Description	Objectives	Duration
Initial Phase	Session 1	Introduction to using ChatGPT	Presentation of the ChatGPT tool, its functionality, and its applications in research.	Familiarize students with ChatGPT and its capabilities.	1 h
	Session 2	Training on using ChatGPT	Practical workshop where students learn to interact with ChatGPT and ask questions.	Teach students how to effectively use ChatGPT to obtain relevant information.	2 h
Implementation Phase	Session 3	Assignment of research topics	Explanation of projects and distribution of topics to be investigated using ChatGPT.	Initiate the use of ChatGPT in specific projects to gather information and generate content.	2 h
	Session 4	Use of ChatGPT in research	Guided session to search for information, generate ideas, and develop project content.	Support students in integrating ChatGPT into their investigative processes.	2 h
	Session 5	Development and review of projects	Review and improvement of ongoing works with the help of ChatGPT.	Ensure the correct application of ChatGPT and improve the quality of investigative works.	2 h
Evaluation Phase	Session 6	Content analysis of the works	Evaluation of the final works using content analysis to measure quality and accuracy.	Determine the impact of ChatGPT on the quality of investigative works.	4 h
	Session 7	Feedback and discussion	Presentation of analysis results and discussion about the experience and learning.	Provide constructive feedback and reflect on the use of ChatGPT in future investigations.	2 h

2) Activities conducted with the control group

The control group conducted their research activities using traditional methods without the support of ChatGPT. Students

received specific research topics, conducted information searches in physical and digital libraries, and used books, scientific articles, and reports to gather data. They analyzed and synthesized the information, evaluated the credibility of

sources, and developed their works following an appropriate academic structure, including introduction, literature review, methodology, results, discussion, and conclusions. The final works were presented for evaluation using the same criteria as the experimental group. The objective was to evaluate how traditional research influences the quality and accuracy of investigative works, allowing comparison of the results with the experimental group to obtain a clear view of the benefits and limitations of using ChatGPT in the educational field.

G. Research Topics and Subtopics

Table 3 presents the distribution of topics and subtopics for each research group, both experimental and control, focusing on a specific aspect of the main assigned topic. This facilitates in-depth research and subsequent discussion and collaboration among group members.

Table 3. Research topics and subtopics.

Group	Topic	Subtopics
1	Software	Evolution of software
		Competitiveness in the software market
		Components and characteristics of software
		Use of educational software in the teaching-learning process
		Types of software and their educational applications
2	Software Cost and Complexity	Hidden costs associated with software development
		Consequences of software failures
		Software trust and reliability
		Software lifecycle: phases and considerations
		Strategies to minimize costs and complexity in software development
3	Pedagogical Characteristics of Educational Software	Adaptation to the user's learning pace
		Content freedom in software
		Educational content management
		Time management in educational software use
		Content planning: strategies and tools
4	Design of Educational Software	Pedagogical criteria in software design
		Interface design aspects for educational software
		Technological criteria in educational software design
		Tools and methodologies for designing educational software
		Creation and development process of educational software
5	Evaluation of Educational Software for Teaching-Learning	Methods and criteria for evaluating educational software
		Selection of software according to educational levels
		Evaluation of usability and effectiveness of educational software
		Evaluation of the educational impact of educational software
		Best practices for evaluating and selecting educational software

IV. ANALYSIS AND INTERPRETATION OF RESULTS

A statistical analysis of the research works of the 5 student groups was conducted, comparing the results of the experimental and control groups based on the implemented research rubric. The following steps were followed:

- Assign scores to each research work based on the rubric, scoring from 1 to 4 for each criterion (Very Good = 4, Good = 3, Fair = 2, Poor = 1).
- Calculate the average scores for each criterion in each group.
- Compare the averages of each group in each criterion to

identify significant differences.

- Tables and graphs are implemented to visualize the results in a clear and concise manner.
- Results are interpreted, highlighting significant differences between groups and offering relevant conclusions.

A. Analysis of the Evaluations of the Experimental Group's Work

Table 4 provides a comparative view of the performance of different experimental research groups across various evaluative criteria according to the established rubric. Overall, there is variability in the scores obtained by each group in each criterion, reflecting the diversity of approaches and capabilities among the groups. For example, while some groups excel in originality and depth of content, others stand out in precision and problem-solving ability.

Table 4. Scores of the experimental group

Criteria	Group 1	Group 2	Group 3	Group 4	Group 5	Average
Coherence	4	3	4	3	4	3.6
Precision	3	3	4	4	3	3.4
Originality	4	3	3	4	3	3.4
Depth of Content	3	4	3	3	3	3.2
Problem Solving Ability	4	3	3	3	3	3.2
Use of Sources	2	2	2	3	2	2.2

It is notable that Group 3 consistently received high scores in coherence, precision, and originality, indicating a clear and logical presentation of ideas and the generation of precise and original content. On the other hand, Group 4 and Group 2 demonstrated significant depth in their research content, while Group 1 and Group 5 exhibited strong capabilities in addressing and solving complex problems. However, areas for improvement were identified, such as the use of sources, where several groups scored lower compared to other criteria. Table 4 highlights both the strengths and areas for development of each group in their execution of research projects, providing a basis for reflection and continuous improvement in future academic work.

B. Analysis of the Evaluations of the Control Group's Work

Table 5. Scores of the control group

Criteria	Group 1	Group 2	Group 3	Group 4	Group 5	Average
Coherence	2	3	4	3	2	2.8
Precision	3	3	2	2	3	2.6
Originality	3	2	3	3	3	2.8
Depth of Content	3	3	3	3	3	3
Problem Solving Ability	3	3	3	3	3	3
Use of Sources	3	3	4	3	4	3.4

Table 5 shows that the control group had a fairly uniform performance, especially in the criteria of depth of content and problem-solving ability, where all groups received the same score. However, in coherence and precision, the results were more varied, indicating areas where some groups could

improve the clarity and accuracy of their information. The use of sources is the criterion where the control group performed best on average, suggesting strength in integrating relevant and reliable bibliographic references into their research work. In summary, while the control group showed consistency in certain aspects, it also revealed key areas for improving the coherence and precision of their work.

C. Comparative Analysis of the Evaluations of the Experimental and Control Groups' Work

Fig. 2 shows the comparisons of average scores between the experimental group and the control group for each criterion.

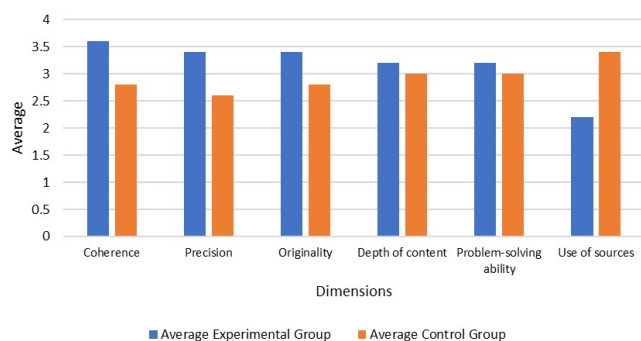


Fig. 2. Comparison of averages between the experimental and control groups.

The study results indicate that the use of ChatGPT has a positive impact on several dimensions of research competencies among basic education students. In terms of coherence, the experimental group, which used ChatGPT, obtained a significantly higher average (3.6) than the control group (2.8). This suggests that ChatGPT helped students present their ideas more clearly and logically. In precision, the experimental group also outperformed the control group (3.4 vs. 2.6), indicating that using ChatGPT allowed students to generate more accurate content with fewer errors.

Regarding originality, the experimental group showed better performance (3.4) compared to the control group (2.8), which may be due to ChatGPT ability to inspire novel ideas and creative approaches in students' work. In the dimension of content depth, both groups obtained similar scores, although the experimental group was slightly superior (3.2 vs. 3.0), suggesting that ChatGPT can also contribute to a deeper exploration of research topics.

Problem-solving ability showed similar averages between both groups, with the experimental group again slightly superior (3.2 vs. 3.0), indicating that ChatGPT can assist in identifying and solving complex problems. However, in the use of sources, the control group outperformed the experimental group (3.4 vs. 2.2). This suggests that while ChatGPT is useful in many aspects, traditional methods are still more effective for properly managing and referencing bibliographic sources, a crucial aspect in academic research.

In summary, the experimental group tends to achieve better averages in most evaluative criteria, except in the use of sources, where the control group shows superior performance. This highlights the need to combine the use of ChatGPT with traditional methods to maximize benefits in research education.

D. General Interpretation of the Results

Unlike previous studies that have focused on the general capabilities of ChatGPT in educational settings, this study offers a more specific analysis of its impact on the development of research competencies in regular basic education students. This methodological difference allows for a deeper exploration of how artificial intelligence can be integrated into the teaching-learning process of research at an educational level where critical skills are often in their early stages of development.

The results show that, in terms of coherence, precision, and originality, the experimental group outperformed the control group. This finding suggests that ChatGPT has a positive effect on the structure and clarity of thought in the research domain, which differs from previous studies that found AI tools to be more useful in simpler or repetitive tasks. Here, ChatGPT not only supports content generation but also facilitates logical organization of ideas and promotes the generation of novel insights. This impact suggests that, with proper guidance, ChatGPT can go beyond being a mere automation tool and become an active pedagogical assistant that enhances the quality of students' critical thinking.

However, in the area of source usage, the study reveals a significant limitation of ChatGPT compared to traditional methods, aligning with previous research highlighting AI models' inability to critically evaluate the relevance and quality of sources. Nevertheless, this study provides an innovative analysis by showing that this weakness is not only technical but also pedagogical, as the manual process of searching for and evaluating sources is an integral part of the development of research competencies. Therefore, while ChatGPT can be a powerful tool for improving certain aspects of research, it cannot replace the essential skills students need to develop for managing academic sources effectively.

Another innovative contribution of this study is that, although ChatGPT enhances aspects related to coherence and originality, it does not guarantee greater content depth or a significant improvement in solving complex problems. This finding is relevant because it highlights that while ChatGPT is efficient for generating quick, structured ideas, its ability to foster deep critical analysis is limited. Unlike previous studies that promote AI as a comprehensive solution for learning, this study offers a nuanced perspective: ChatGPT can be a valuable complement, but it does not replace the intensive cognitive processes required by traditional methods, which are essential for the formation of well-rounded researchers.

E. Statistical Analysis of the Scores of the Experimental and Control Group Work

Normality Assessment:

1) Experimental group

- Coherence: $p = 0.0065$ (Not normal)
- Accuracy: $p = 0.0065$ (Not normal)
- Originality: $p = 0.0065$ (Not normal)
- Depth of Content: $p = 0.0001$ (Not normal)
- Problem-Solving Ability: $p = 0.0001$ (Not normal)
- Use of Sources: $p = 0.0001$ (Not normal)

2) Control group

- Coherence: $p = 0.3140$ (Normal)

- Accuracy: $p = 0.0065$ (Not normal)
- Originality: $p = 0.0001$ (Not normal)
- Depth of Content: $p = 1.0$ (Normal)
- Problem-Solving Ability: $p = 1.0$ (Normal)
- Use of Sources: $p = 0.0065$ (Not normal)

To assess the normality of the data in this study, the Shapiro-Wilk and Kolmogorov-Smirnov statistical tests were employed. These tests are commonly used in statistical analysis to determine whether a sample follows a normal distribution.

Shapiro-Wilk Test: This test was applied to smaller samples, as it is more suitable and has greater statistical power in such cases. The test compares the observed data with a theoretical normal distribution. If the data significantly deviate from normality, the resulting p -value will be less than 0.05, indicating that the data do not follow a normal distribution.

Kolmogorov-Smirnov Test: This test was used as a backup to compare the empirical distribution of the data with a theoretical normal distribution. Similar to the Shapiro-Wilk test, a p -value less than 0.05 suggests that the data are not normally distributed.

Explanation of p -values: In this analysis, a p -value < 0.05 was considered to indicate that the data did not follow a normal distribution. This threshold is the widely accepted standard in statistical research for rejecting the null hypothesis of normality. A p -value below 0.05 means there is less than a 5% probability that the observed differences between the data distribution and the normal distribution are due to chance, justifying the decision to apply non-parametric tests instead of parametric ones in cases where normality was not met.

By including these tests and clarifying the interpretation of p -values and the normality threshold, we provide a solid and transparent basis for statistical evaluation, thereby strengthening the rigor and credibility of the methods and results employed in this study.

F. Statistical Test Results (Mann-Whitney)

Since many of the data were not normally distributed, the Mann-Whitney test was used to compare the groups.

Table 6 shows that there were no significant differences between the experimental and control groups in terms of coherence, accuracy, originality, depth of content, and problem-solving ability, suggesting that both groups have similar skills in these areas. However, a significant difference was found in the use of sources, where the experimental group showed lower performance compared to the control group, indicating a need for improved training or instruction in sourcing and managing references in the experimental group.

Table 6. Results of the statistical tests (Mann-Whitney)

Criterion	Test Type	Statistic (U)	p -value	Significant
Coherence	Mann-Whitney	19.5	0.1461	No
Accuracy	Mann-Whitney	20.5	0.0753	No
Originality	Mann-Whitney	19.0	0.1213	No
Depth of Content	Mann-Whitney	15.0	0.4237	No
Problem-Solving Ability	Mann-Whitney	15.0	0.4237	No
Use of Sources	Mann-Whitney	1.5	0.0189	Yes

G. Analysis of the Results Regarding Research Dimensions Through the Use of ChatGPT in the Experimental Group

Fig. 3 presents the average scores of the experimental group in three key dimensions related to the use of ChatGPT:

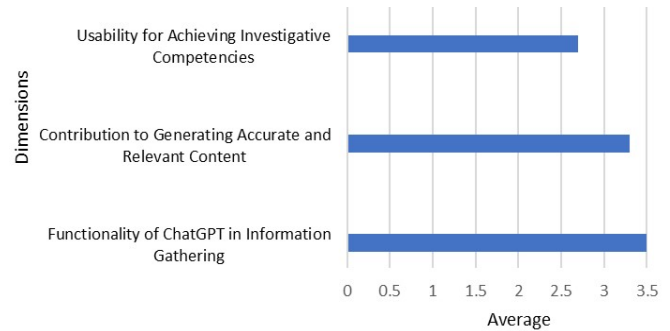


Fig. 3. Analysis of the results in terms of research dimensions through the use of ChatGPT in the experimental group.

1) Functionality of ChatGPT in information gathering

- Average Score: 3.5
- Interpretation: The experimental group rated ChatGPT's ability to gather information positively, noting that it adequately fulfills this function, though not exceptionally.

2) Contribution to generating accurate and relevant content

- Average Score: 3.3
- Interpretation: ChatGPT is perceived as useful in creating content that is generally accurate and relevant, although there is room for improvement to achieve a higher level of accuracy and relevance in the generated responses.

3) Usability for achieving research competencies

- Average Score: 2.7
- Interpretation: This dimension received the lowest score, suggesting that the experimental group found certain limitations in using ChatGPT to develop or enhance research competencies. This may indicate that, while the tool is useful, it is not fully adequate to meet all the needs related to research.

Overall, ChatGPT was rated relatively positively in terms of functionality and content generation, but its capacity to contribute to the acquisition of research competencies was seen as less effective. These results suggest that while ChatGPT is a useful tool in certain aspects, it may not be sufficient to support more complex or specific research processes without the intervention of complementary methods.

H. General Analysis of the Results Obtained

According to the analysis of the results obtained, some techniques that can improve the interaction between the user and ChatGPT include providing clear and specific instructions from the beginning, thus avoiding ambiguous instructions [34]. It is essential to provide the context and precise information about the prompts, determine the desired response format and structure, and specify the applicable scope and constraints. Additionally, it is recommended to

perform various iterations with the “divide and conquer” strategy until a satisfactory response is obtained. However, before its application in education, it is crucial to consider the limitations and risks to achieve effective and responsible implementation [35]. Some of the main limitations of ChatGPT refer to the type of text it generates; although it can produce coherent and sometimes surprising responses, they are not always accurate or reliable due to the lack of context and the limitations of its training [16]. To maintain academic integrity, students need to communicate their sources and the resources used in their work and exams. Furthermore, the increasing sophistication and accessibility of tools like ChatGPT raises concern about their potential use to commit acts of fraud in assessments [36]. Therefore, special attention must be paid to implementing measures to prevent plagiarism and ensure the authenticity of the work presented.

I. Proposed Activities to Develop Research Competencies Using ChatGPT

Students are encouraged to use ChatGPT as a tool to develop interactive research proposals. This process involves the formulation of hypotheses, defining clear objectives, and designing an appropriate methodology. By providing ChatGPT with a research topic and relevant context, the system assists students in generating hypotheses and refining their research framework. ChatGPT helps in structuring objectives and designing methodologies, while students continuously review and refine their proposals based on the system’s suggestions, enhancing their skills in academic writing and the development of research questions.

For data analysis and interpretation, students leverage ChatGPT to analyze their research data, identify patterns, and draw meaningful conclusions. This activity fosters competencies in data analysis, critical thinking, and information synthesis. Students input their data into ChatGPT, which generates insights and identifies key patterns. The students then evaluate the generated analysis critically, integrating the results into their own research findings, thus refining their ability to process and interpret data.

In conducting a collaborative literature review, ChatGPT assists students in gathering and summarizing relevant sources on a given topic. Students specify the topic, and ChatGPT provides key summaries and points from relevant literature. This exercise sharpens students’ abilities to perform comprehensive literature reviews, synthesize information, and enhance academic writing. The literature provided is reviewed and critically assessed by the students, ensuring that they engage with the material at a deeper level.

Students can also collaborate with ChatGPT in transforming their research findings into engaging infographics and visual presentations. This process supports the development of skills in visual communication, data synthesis, and presentation. By inputting their research data into ChatGPT, students receive suggestions for effective visualizations, including charts, tables, and diagrams. They then use these suggestions to create clear, visually appealing infographics and presentations with the help of design tools.

In practicing qualitative data collection, students conduct simulated interviews and focus groups with ChatGPT. This activity enables students to practice qualitative techniques,

improve their interview skills, and analyze content. By preparing interview scripts and discussion topics, students engage with ChatGPT, which acts as a participant, providing responses from various perspectives. These simulated interactions allow students to identify patterns and refine their qualitative data collection techniques through analysis of the generated responses.

V. DISCUSSION

The developed study confirms and expands on the findings of previous studies on the integration of ChatGPT in education, revealing both benefits and challenges. According to Watrinhos *et al.* [25, 26], ChatGPT shows significant advantages in higher education, improving coherence, precision, and originality of content, which is reflected in the superior scores of our experimental group in these criteria. However, similar to Atencio-González *et al.* [27, 28], we found that the use of ChatGPT presents ethical and practical challenges, especially in the proper use of sources, where our control group performed better, suggesting that traditional methods are still more effective for managing bibliographic references. Additionally, like Juárez *et al.* [34, 35], we observed that while ChatGPT facilitates the generation of precise and relevant content, its effective implementation requires overcoming limitations such as verifying accuracy and addressing the generic nature of responses if prompts are not refined. These findings underscore the need for continuous supervision and a critical and ethical use of ChatGPT to maximize its benefits in developing research competencies and minimize its risks in educational contexts.

The results obtained in educational contexts reveal several significant findings that highlight both its advantages and challenges. The results show that the experimental group, which used ChatGPT, obtained higher scores in coherence, precision, and originality compared to the control group, suggesting that this tool facilitates a more coherent and precise presentation of ideas as well as greater creativity in content generation. This aligns with previous studies highlighting the utility of ChatGPT in higher education [25, 26].

However, we identified that the proper use of sources is an area where the control group outperformed the experimental group. This suggests that traditional research methods remain more effective in managing bibliographic references, highlighting a limitation of ChatGPT in this aspect [27, 28]. Moreover, although ChatGPT contributed to the generation of precise and relevant content, its effective implementation requires a critical approach to refine prompts and verify the accuracy of responses, aligning with the challenges mentioned in previous studies [40, 41].

In terms of developing research competencies, ChatGPT proved to be a valuable tool by enhancing students’ coherence, originality, depth of content, and problem-solving abilities. However, the difference in the use of sources suggests that a combination of traditional methods and new technologies is essential to achieve an optimal balance in academic research.

The results showed that the experimental group using ChatGPT outperformed the control group in the criteria of coherence, precision, and originality. This can be attributed to

ChatGPT ability to generate structured and clear content quickly and efficiently. One of the strengths of this tool is its ability to present ideas logically, which may have facilitated the improvement of coherence in the students' projects. Additionally, by providing responses based on large volumes of information, ChatGPT is capable of offering precise data and generating novel ideas, which justifies its positive impact on the criteria of precision and originality.

However, ChatGPT weaknesses also clearly emerged in the results, particularly in the criterion of source utilization, where the control group performed better. This finding suggests that, although ChatGPT can generate relevant content, it does not necessarily provide the same depth in managing academic references as traditional methods. The students using traditional methods had to search for, evaluate, and cite sources manually, which allowed them to develop stronger skills in managing bibliographies and critically evaluating the sources used. This highlights one of ChatGPT main limitations: its inability to perform an exhaustive analysis of the quality and relevance of sources, and its tendency to provide responses without proper management of academic references.

Another aspect worth discussing is the fact that the criteria of content depth and problem-solving ability showed minimal differences between the two groups. Although the experimental group had a slight advantage, these results suggest that using ChatGPT does not guarantee deeper analysis or enhanced problem-solving skills. This may be due to the fact that, while ChatGPT facilitates access to information and quickly generates ideas, its ability to promote deep critical thinking is limited compared to traditional methods, which require greater cognitive effort from students as they manually search for, analyze, and synthesize information.

VI. CONCLUSIONS

The study on the impact of using ChatGPT on achieving research competencies in regular basic education students revealed significant findings in three key dimensions. Regarding the functionality of ChatGPT in information gathering, it was observed that although it facilitates quick access to information, its effectiveness in adequately managing bibliographic references is lower than that of traditional methods, as evidenced by the better performance of the control group in this aspect.

In terms of generating precise and relevant research content, ChatGPT proved to be highly effective, as the experimental group outperformed the control group in precision, coherence, and originality of the content produced, indicating its value in improving the quality of research work.

In terms of usability for developing research competencies, the experimental group performed better in coherence, originality, depth of content, and problem-solving ability, demonstrating that ChatGPT helps structure ideas and address complex problems more effectively. However, to maximize these benefits and overcome the limitations in information gathering, it is essential to integrate the use of ChatGPT with traditional teaching methods and rigorous research practices, ensuring an ethical and effective use of technology for

comprehensive development of research competencies in students.

The use of ChatGPT can enhance students' research competencies by facilitating information gathering and generating relevant content. However, its effectiveness depends on students' ability to use the tool critically and complement it with traditional research methods. The integration of ChatGPT into educational processes should be accompanied by appropriate training to maximize its benefits and minimize its limitations.

VII. LIMITATIONS AND FUTURE RECOMMENDATIONS

The research on the impact of ChatGPT in developing investigative competencies in students revealed several limitations and offered future recommendations. The effectiveness of ChatGPT depends on the quality of prompts, and it necessitates verification of generated information due to potential inaccuracies. Ethical and practical challenges, such as proper source attribution and the control group's better performance in managing bibliographic references, highlight the need for clear guidelines. Limited context understanding, resource availability, and instructor training are additional constraints. Future recommendations include enhanced training programs, a hybrid approach integrating traditional methods, ethical guidelines, improved verification processes, customization of AI models, equitable access to AI tools, ongoing research, and feedback mechanisms. These steps aim to maximize ChatGPT educational benefits while addressing its limitations and ensuring its ethical and effective use in academic settings.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest in relation to the research carried out.

AUTHOR CONTRIBUTIONS

Yovana Sonia Huamani Anco has reviewed the background and literature review including the discussion and conclusions and Benjamín Maraza Quispe has reviewed the methodology and analysis and interpretation of the results. Both authors had approved the final version.

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