Foresight Study on the Influence of ChatGPT In Peruvian Universities Towards 2033

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Abstract: This article investigates how the integration of ChatGPT could transform Peruvian universities by 2033. Twenty drivers were identified, including digital competencies, critical thinking, academic performance, and motivation. Using a foresight approach, possible future scenarios were generated. The methodology consists of four stages: (1) Exploration of the system to identify key drivers; (2) Validation of the information by applying the Delphi method in real time to confirm these drivers; (3) Construction of scenarios using Schwartz axes and structural analysis; and (4) Validation of scenarios using the Probability, Desirability and Governance (PDG) method. The analysis revealed that the most important and uncertain drivers are related to 'training in critical thinking, feedback through intelligent tutoring, and the development of technological infrastructure,' located in Schwartz's Quadrant III. These drivers are crucial to building four scenarios, including the target scenario dubbed "Overcoming Challenges with Innovation and Technology".

Keywords: Foresight study, Future scenarios, University, ChatGPT

1. Introduction

Technological advances, particularly in the field of artificial intelligence (AI), have opened new pathways for progress across all sectors and have revolutionized global education due to their rapid integration and the widespread attention they have received (Brunner and Tedesco, 2003). This research focuses on the study of generative artificial intelligence such as ChatGPT, which was selected for this research because among the many artificial intelligence algorithms this Open AI application is revolutionizing the academic field, generating challenges and opportunities.

ChatGPT has been applied in fields such as software engineering, health sciences, social sciences, agriculture, and marketing, among other sectors. However, in the education sector, it has offered more personalized and interactive learning (Sallam, 2023). Its integration into these fields not only promotes innovation but also fosters creative opportunities and solutions. It enables the creation and design of more personalized learning experiences for students and educators (Ali, et al. 2024). Its potential use in education lies in the personalization of learning, the automation of personalized tutorials, and the optimization of pedagogical feedback. However, its implementation in higher education poses several challenges, including ethical concerns, changes in teaching-learning dynamics, and the need for teacher training in these new technologies (Kuleto, et al. 2021).

In the Peruvian context, integrating artificial intelligence (AI) in Peruvian universities offers both opportunities and obstacles, and there has been a growing interest in digital transformation in recent times. However, institutions face disparities in relation to technological infrastructure and especially in internet access, limiting the benefits of technological resources, especially in rural areas (Luna, 2023).

This implies that there must be an improvement in digital inclusion to close the educational gap and improve the quality of education in the country.

The SITEAL and UNESCO report (2023) shows that 43% of Peruvian public universities lack adequate access to digital platforms, which creates a disparity between urban and rural institutions (Alfaro and Del Río, 2018). Other barriers in technological adoption, identified by Vidaurre et al. (2024), include the resistance to change among some teachers in using technological resources and lack of literacy or training in Artificial intelligence.

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AI has great potential to improve learning. However, regulatory frameworks must be developed to promote its ethical use. These frameworks should ensure a balanced approach, combining adoption with pedagogical strategies that foster critical thinking and ethical AI usage (Guadalupe et al., 2023).

On the other hand, the COVID-19 pandemic has highlighted the technological gaps in Peru. Areas with lack of internet access in many cases do not have adequate devices for virtual education, weakening equitable and quality access. The Peruvian education system faces challenges in terms of National education policies must ensure inclusive, equitable, and high-quality education (SITEAL and UNESCO, 2023).

Academic staff and students should be trained to prioritize critical thinking and ethical use. Studies highlight critical thinking as a skill rather than a disposition, showing greater effectiveness with instrumental strategies that align teaching competencies with the needs of students, providing didactic tools for future teaching performance (Andreucci-Annunziata, et al. 2023). To support the development of critical thinking, it is important to have different versions or points of view, allowing for multiple perspectives. In this sense, tools like ChatGPT provide valuable support by facilitating different approaches to topics, enhancing students' cognitive skills.

Given this panorama, this study seeks to investigate how the integration of ChatGPT can be transformed into Peruvian universities by 2033. To this end, possible future scenarios are generated, through a prospective approach, identifying factors of change that guide strategic decisions in the educational field. Through the Delphi method in real time and the construction of scenarios based on uncertainty axes Based on this, the necessary conditions for an effective implementation of AI in Peruvian higher education are analyzed.

The methodology involves four main stages: (1) Exploration of the system to identify the drivers; (2) Validation of information through the application of the Delphi method in real time (Astigarraga, 2003); (3) Construction of scenarios using Schwartz's axes and structural analysis, referring to ten years of study to systematically analyze the importance and uncertainty of the drivers, generating various scenarios (Schwartz, 1991). These axes are grouped into two main categories: "Promotion of critical thinking" and "Advanced technological infrastructure", essential for academic and professional development. (4) Validation of scenarios through the Probability, Desirability and Governance method (PDG). Finally, backcasting was used to formulate strategies and target scenarios, providing a solid framework for long-term strategic planning and policy development towards 2033 (Höjer and Mattsson, 2000).

2. Literature Review

2.1 Scenarios

In strategic planning, scenarios are valuable tools that allow organizations to explore and understand possible futures by generating scenarios to anticipate opportunities and identify risks. Scenarios are not predictions, but narratives that describe different possible futures based on trends. Scenarios are crucial for imagining futures and understanding individual and organizational change. This exploration helps to envision desirable futures and provides a framework for understanding change at the organizational level. In addition, scenarios are integrated with other methods, such as strategic forecasting, to provide a deeper understanding of the issue at hand (Inayatullah, 2008).

The value of scenarios lies in their ability to outline future outcomes that provide clarity and improve decision-making, transforming them into a tool for problem-solving (Wack, 1985). Integrating learning and planning from the outset is essential, with methods that consider the different perspectives of stakeholders and their evolution over time. Scenario generation increases awareness of upcoming changes, early warning signs, and new opportunities, while enriching participants' understanding of the issues (Graham, 2009). From an educational point of view, scenarios play a key role in the formulation of strategies for the adoption of new technologies, such as artificial intelligence, ensuring a more informed and adaptive approach in their implementation.Generative Artificial Intelligence (GAI) in Higher Education in Latin America

2.2 Generative Artificial Intelligence (GAI) in Higher Education in Latin America

Latin American countries are increasingly integrating Generative Artificial Intelligence (GAI) technology into their government strategies and economies. These initiatives will improve administrative efficiency, offering more personalized user services for the whole of society. However, the ill-intentioned use of (GAI) for process automation and decision-making presents many ethical and safety challenges, as it will compromise the security of society (Vinogradova, 2023). The application of GAI in higher education has shown potential to improve

learning through the personalization of content and the automation of administrative processes (Guerrero-Quiñonez, et al. 2023).

However, the adoption of (GAI) is not without its challenges. Despite the digital transformation and the opportunities, it offers, concerns persist about data privacy, teaching automation, and the lack of specific regulation in the Latin American context (Andreoli, et al. 2024). While AI can improve learning and motivation, its growing use in Latin America presents challenges that demand proactive strategies to manage benefits, ethical concerns, and privacy issues. Therefore, the ability to expect medium- and long-term challenges is crucial to effectively address these changes (Rivera and Malaver, 2006). Reflecting on the past helps to interpret the present and manage desirable futures (Duque, Gonzáles and Santisteban, 2023).

2.3 Challenges of ChatGPT in Peruvian University Education

The language model developed by OpenAI, ChatGPT, is a Natural Language Processing (NLP) model capable of generating high-quality argumentative texts and engaging in realistic conversations. According to King (2023), it is the most powerful GAI platform that provides user-centric conversational experiences. ChatGPT has the potential to transform education by offering personalized learning experiences to improve students' language skills.

According to a recent study, 71.3% of Peruvian university students use ChatGPT as a support in their academic activities, improving their productivity and access to relevant information. Despite these benefits, its implementation in higher education requires a structured strategy to avoid excessive dependence and ensure its ethical use (Castillo, Palacios and Silva, 2023).

According to Velíbor and Indrasen (2023), ChatGPT should be used as a complement in learning and not as a substitute for critical thinking and human interaction in educational processes.

In addition, it is essential to establish clear guidelines on its application in teaching to avoid problems related to misinformation and the automatic generation of content without academic supervision (Rathore, 2023).

Many studies have addressed the application of Artificial intelligence in higher education at a global level (Zawacki-Richter et al., 2019). However, the literature on its impact in the Peruvian context remains limited. Most research focuses on countries with high technological infrastructure, leaving aside the specific challenges faced by universities in developing countries. In addition, the future scenarios and strategies necessary to ensure an ethical and effective implementation of AI in Peruvian universities have not been explored in depth. This study bridges that gap by applying a forward-looking approach to investigate how the integration of ChatGPT can transform Peruvian universities by 2033.

3. Methodology

The methodology is based on a theoretical foundation, which includes conceptual frameworks to initiate the stages of the research process.

3.1 Strategic Foresight

Foresight, initiated by Berger (1957), seeks to understand and influence the future through present decisions, creating possible futures. Foresight is a rigorous discipline that illuminates present actions with desirable futures. Integrating future perspectives into education is essential to help students guide and plan their personal and social projects, allowing them to imagine and work towards desirable and fair futures (Medina and Ortegón, 2006). Seeing the future as hopeful and full of possibilities allows young people to fully develop and be themselves (Duque, Gonzáles and Santisteban, 2023).

Strategic foresight analyzes the long-term future of science, economics, and society to identify emerging technologies that generate economic and social benefits (Gavigan, 2001). Iden, Methlie, and Christensen (2017) and the European Commission (2001) describe five rules that form the basis for foresight to achieve better results. Communication must be established with all the actors in the Research and Development (R+D) system involved in the prospective study. The focus should be on the long term to address forecast tasks. This must be followed by coordinated actions, consensus on the vision of the object of study and, ultimately, commitment to the results achieved.

3.2 Delphi Method

This tool is suitable for research because of its ability to structure the collection of expert responses. It has allowed the validation of impellers and has ensured the deliberation of experts in real time (Weaver, 1971). This

method addresses complex problems through a structured group communication process based on rounds of surveys conducted by independent experts (Pätäri, 2010). This method facilitates collective contribution through feedback, evaluation of group judgment, and review of individual opinion (Rowe and Wright, 1999). To ensure success, addressing challenges such as mitigating bias and encouraging expert participation is essential (Linstone and Murray, 1975). Although the future is unpredictable, some argue it can be estimated with some accuracy by people who have a good understanding of current conditions and can imagine possible future scenarios (Calleo & Pilla, 2023). The real-time Delphi method is an essential tool in technology forecasting. It is widely used in technological corporations and in the management of complex problems (Hirschberg and Rescher, 1960).

However, the Delphi method has weaknesses and limitations to consider. It is assumed that the experts participating in the Delphi have equivalent knowledge and experiences, which may not be true, as the knowledge of the panelists could be uneven. This could make the process more difficult (Chia-Chien and Sandford, 2019). The Delphi technique, performed in rounds, is time-consuming to complete the research process, as days and weeks can pass between rounds. While rounds improve the accuracy of results, they also increase the demand for more time to complete the process (Cunliffe, 2002). Therefore, for this study, the Delphi technique is applied in real time to optimize results, reduce biases and accelerate expert responses (Astigarraga, 2003), as well as to develop an active role of the researcher to ensure response rates and accuracy of results (Ludwig, 1997).

This article adopts a quantitative approach with a cross-sectional design, allowing for the objective collection of numerical data at a given time. This approach is ideal for measuring and analyzing experts' perceptions of ChatGPT's effects without manipulating variables, providing an accurate snapshot of the current context (Hernández, Fernández and Baptista, 2014; Hernández-Sampieri and Mendoza, 2018).

4. Results

The study aims to generate possible scenarios on the impact of ChatGPT on Peruvian universities by 2033. To achieve this objective, four stages were followed based on the foresight approach: (i) exploration of the system to identify drivers, (ii) validation of information to confirm drivers using the Delphi method in real time, (iii) construction of scenarios using Schwartz axes and structural analysis, and (iv) validation of scenarios through the Probability method, Desirability and Governance (PDG) and backcasting to develop strategies that lead to the target scenario towards 2033 (see Table 1).

A brief description of the current situation of Peruvian universities is presented to characterize the sample, noting that the number of students from various socioeconomic levels has increased in recent years. However, this process did not coincide with an improvement in the quality of the education offered (Ruíz-Gonzáles and Briceño-Cotrina, 2020). Peruvian universities face challenges, including improving the quality of teaching and applied research, and often lack a robust infrastructure. There are significant gaps that affect education, such as economic disparities that show a marked difference in infrastructure, budgetary resources, and higher quality education in the capital's universities compared to remote regions.

4.1 Data Analysis

The study selected a sample of 44 experts from public and private universities in Perú, the sample was chosen through non-probabilistic sampling (Hernández, Fernández and Baptista, 2014). Before distributing the surveys, an academic was consulted, and the pilot test was carried out with 10 experts. Based on their feedback, adjustments were made to improve the quality and accuracy of the instrument. To mitigate potential biases in expert input, multiple rounds of validation were conducted to ensure that the responses were transparent. In addition, three types of expert profiles were considered, which generated a variety of opinions and perspectives derived from homogeneous views, according to Winkler and Moser (2016). In the application of the Delphi survey in real time, three areas were established: education, technology and pedagogical management. The experts come from different professional fields: public sector (27.3%), private sector (50%), academia (13.6%), civil society (2.3%) and others (6.8%). The latter group includes experts with experience in related fields, whose perspective complements the interdisciplinary approach of this study. Regarding the experience of the experts, 47.7% have 2 to 5 years in the area of education, 36.4% have 6 to 10 years in technology, 9.1% have 11 to 15 years in pedagogical management and 6.8% have 16 or more years of experience in areas such as computer engineering, information economics and information technology. The samples size suffices to identify the relevant drivers and build prospective scenarios.

The research methodology follows the sequence outlined in the studies of Keenan and Popper (2008) and Medina and Ortegón (2006), as shown in Table 1.

Table 1: Stages of the prospective methodology process

Stages	Methodological tools
System Scan	Identifying drivers
Information Validation	Driver validation with the real-time Delphi survey app
Scenario construction	Schwartz axes and structural analysis
Scenario validation	Probability, Desirability and Governance (PDG) Method and Backcasting

4.2 System Scan

4.2.1 Identifying drivers

According to Ortega (2016), factors of change are driving variables that directly influence the subject of study, significantly shaping the construction of future scenarios. Twenty drivers are proposed for the prospective study of ChatGPT in Peruvian universities, based on bibliometric analysis and reviewed literature, as shown in Table 2. Each driver has a statement that serves as the basis for the construction of the Delphi survey in the later stage. These statements are derived from the influence of each driver. There are four areas that group the drivers: Educ (education area) which encompasses the first nine drivers, Tec (technology) which encompasses five drivers and GestP (pedagogical management) which encompasses six drivers.

Table 2: Drivers with their statements and references

Drivers	Declarations	References
Development of digital competences in university students	Students' digital skills will increase by 70%.	(Bozukarpan, Laoha and Jantakun, 2023)
Training students with critical thinking	The mastery of critical thinking will increase by 60%.	(García-Peñalvo, 2021)
Increased student academic performance	Students' academic performance will increase thanks to the use of digital technologies.	(Sánchez-Caballé, Gisbert-Cervera, and Esteve-Mon, 2020)
Feedback to students through intelligent tutoring	Cognitive feedback through intelligent tutoring will increase by 70%.	(Peters, et al., 2022)
Using ChatGPT for Academic Skills Development	Skills and abilities will increase with the use of ChatGPT by 70%.	(Fernández-Luque, Ramírez-Montoya, and Cordón-García, 2021)
Motivation	The use of ChatGPT will generate motivation and active participation in university teachers and students.	(Starkey, 2019)
Personalized and constructive education through ChatGPT	Personalized education through ChatGPT will increase by 70%.	(Colás-Bravo, Conde-Jiménez, and Reyes-de-Cózar, 2021)
Generation of scientific articles	The production of scientific articles involving teachers and students will increase by 40%.	(Harith et al., 2022)
Digital literacy of teachers in the teaching-learning process	The digital literacy rate of teachers and students will reach 70%, ensuring their competence in the effective use of digital technologies.	(Fernández-Batanero et al., 2021)
Use of ChatGPT in students with disabilities	The accessibility to the use of ChatGPT translates into a 40% increase in its usefulness for people with disabilities.	(Pérez-Jorge and Martínez-Murciano, 2022)
Integrating ChatGPT into Pedagogical Performance	The integration of ChatGPT in pedagogical performance will be 70%.	(Litiņa and Miltuze, 2023)
Technological infrastructure	There will be an advance in technological infrastructure by 2033, exceeding 50% implementation.	(Fernández-Batanero, et al., 2020)
Rethinking classroom methodology with ChatGPT	The teaching methodology in the classroom will improve with the incorporation of ChatGPT by 60%.	(Esteve-Mon, Llopis-Nebot, and Adell-Segura, 2020)

Drivers	Declarations	References
Use of ChatGPT to improve technological and training activities	There will be an improvement in technological and training activities, allowing them to perform more efficiently by 60%.	(Gutiérrez-Ángel et al., 2022)
Managing educational innovation using ChatGPT	Institutional educational innovation strategies will be designed at 50%.	(Ostanina et al., 2023)
Development of didactic skills in teachers	The development of teaching skills in teachers will be increased by 50%.	(Fernández-Luque, Ramírez-Montoya, and Cordón-García, 2021)
Use of ChatGPT for the design of class sessions and methodological strategies	The development of class sessions with the support of ChatGPT will be 60%.	(Martínez-Murciano, 2022)
Curricular integration according to new technological trends	Update curriculum design by promoting methodological innovations for the classroom and learning experiences.	(Litiņa and Miltuze, 2023)
Adapting careers to new technologies	80% of professional careers aligned with new technological trends will be implemented.	(Excluding Naumeca and Āboliņa, 2023)
Economic financing for the improvement of technological infrastructure	Funding will be obtained for the technological improvement of the university, plus 50%.	(Starkey, 2019)

4.3 Information Validation

4.3.1 Driver validation using the real-time Delphi survey

The real-time Delphi survey validates the drivers by consulting a group of experts individually through a questionnaire. This method aims to collect the opinion of experts on a topic related to future overtime (Rowe and Wright, 1999). The statements in the table above are part of the Delphi survey, composed of 20 statements derived from the influence of each driver. The survey was conducted using Google Forms, measuring importance based on three criteria: high, medium and low; and uncertainty based on five criteria as shown in Table 3. After conducting the Delphi survey with the 44 experts, the results are converted into percentage value to define our score. The results of the Delphi survey will facilitate the selection of the drivers that belong to quadrant III.

To determine the level of importance (high, medium, and low) and the level of uncertainty, the Pareto principle was applied, which states that 80% of problems stem from 20% of causes. This principle is used to improve reliability by identifying the components with the greatest need (Ortega, 2016). In this context, the high and medium levels were grouped, establishing a threshold of 80% or higher in both dimensions. This allowed the identification of the key drivers: critical thinking skills, cognitive feedback through intelligent tutoring and technological infrastructure, which were identified as the most important and uncertain and will serve as the basis for the construction of scenarios.

From the results of the survey, the level of importance (high, medium, low) of "critical thinking skills" indicates that 61.36% and 31.82% (grouped high and medium level together make more than 80%) of the experts consider it very important. These results exceed 80%, so it is considered "very important", that is, the level of response exceeds 80% due to its majority nature, which shows a significant consensus among the respondents. For the level of uncertainty, 43.18% of respondents believe that event could occur between 2023 and 2027, which does not exceed 80%, so it is considered "very uncertain". Similarly, the other two drivers (feedback to students through intelligent tutorials and technological infrastructure) with similar results are considered "very important and very uncertain". The level of importance has a total sum of 100%, referring to the total number of respondents (44 experts), and the same applies to the level of uncertainty.

Based on these criteria, key drivers with high importance and high uncertainty were selected. According to the results, these drivers are the most critical for the system under study and have a highly unpredictable behavior. Identifying and prioritizing these drivers is critical because they significantly influence the design of future scenarios. The three drivers that meet these characteristics are essential for strategic planning and decision-making, as their impact and volatility can determine several possible scenarios. These key drivers make it possible to anticipate and prepare responses to different situations, providing a solid foundation for the construction of robust and adaptive scenarios.

Table 3: Delphi Survey Results

Drivers of change	Importance (Level of importance of each statement)			*80 %*	Uncertainty Period during which the event is estimated to develop or occur)					*50%*
Mark each item (importance, experience, and uncertainty) with an X	**High**	**Middle**	**Low**	**Importance**	**It's over**	**It will happen between 2023-2027**	**It will occur between 2028-2032**	**This will happen after 2033**	**That will never happen**	**Uncertain**
Students' digital skills will increase by 70%.	63,64%	31,82%	4,55%	+	0,00%	54,55%	29,55%	11,36%	4,55%	-
The mastery of critical thinking will increase by 60%.	61,36%	29,55%	9,09%	+	0,00%	43,18%	40,91%	11,36%	4,55%	+
Students' academic performance will increase thanks to the use of digital technologies.	52,27%	40,91%	6,82%	+	6,82%	54,55%	20,45%	15,91%	2,27%	-
Cognitive feedback through intelligent tutoring will increase by 70%.	63,64%	27,27%	9,09%	+	2,27%	47,73%	36,36%	13,64%	0,00%	+
Skills and abilities will increase with the use of ChatGPT by 70%.	65,91%	34,09%	0,00%	+	9,09%	63,64%	22,73%	2,27%	2,27%	-
The use of ChatGPT will generate motivation and active participation in university teachers and students.	63,64%	27,27%	9,09%	+	2,27%	38,64%	52,27%	6,82%	0,00%	-
Personalized education through ChatGPT will increase by 70%.	34,09%	54,55%	11,36%	+	0,00%	54,55%	29,55%	9,09%	6,82%	-
The production of scientific articles involving teachers and students will increase by 40%.	63,64%	29,55%	6,82%	+	2,27%	50,00%	15,91%	31,82%	0,00%	-

Drivers of change	**Importance** (Level of importance of each statement)			***80 %***	**Uncertainty** Period during which the event is estimated to develop or occur)					***50%***
Mark each item (importance, experience, and uncertainty) with an X	**High**	**Middle**	**Low**	**Importance**	**It's over**	**It will happen between 2023-2027**	**It will occur between 2028-2032**	**This will happen after 2033**	**That will never happen**	**Uncertain**
The digital literacy rate of teachers and students will reach 70%, ensuring their competence in the effective use of digital technologies.	61,36%	22,73%	15,91%	+	0,00%	52,27%	38,64%	4,55%	4,55%	-
The accessibility to the use of ChatGPT translates into a 40% increase in its usefulness for people with disabilities.	68,18%	27,27%	4,55%	+	9,09%	56,82%	25,00%	9,09%	0,00%	-
The integration of ChatGPT in pedagogical performance will be 70%.	75,00%	20,45%	4,55%	+	2,27%	72,73%	18,18%	6,82%	0,00%	-
There will be an advance in technological infrastructure by 2033, exceeding 50% implementation.	59,09%	36,36%	4,55%	+	9,09%	43,18%	34,09%	11,36%	2,27%	+
The classroom teaching approach will be enhanced by incorporating ChatGPT.	77,27%	15,91%	6,82%	+	2,27%	50,00%	31,82%	15,91%	0,00%	-
There will be an improvement in technological and training activities, allowing them to perform more	77,27%	22,73%	0,00%	+	2,27%	59,09%	25,00%	11,36%	2,27%	-

Drivers of change	Importance (Level of importance of each statement)			*80 %*	Uncertainty Period during which the event is estimated to develop or occur)					*50%*
Mark each item (importance, experience, and uncertainty) with an X	**High**	**Middle**	**Low**	**Importance**	**It's over**	**It will happen between 2023-2027**	**It will occur between 2028-2032**	**This will happen after 2033**	**That will never happen**	**Uncertain**
efficiently by 60%.										
Institutional educational innovation strategies will be designed at 50%.	70,45%	25,00%	4,55%	+	2,27%	72,73%	20,45%	2,27%	2,27%	-
The development of teaching skills in teachers will be increased by 50%.	79,55%	18,18%	2,27%	+	2,27%	68,18%	20,45%	9,09%	0,00%	-
The development of class sessions with the support of ChatGPT will be 60%.	59,09%	36,36%	4,55%	+	0,00%	72,73%	22,73%	2,27%	2,27%	-
Update curriculum design by promoting methodological innovations for the classroom and learning experiences.	79,55%	18,18%	2,27%	+	4,55%	75,00%	15,91%	4,55%	0,00%	-
80% of professional careers aligned with new technological trends will be implemented.	75,00%	20,45%	4,55%	+	9,09%	52,27%	34,09%	2,27%	2,27%	-
Funding will be obtained for the technological improvement of the university, plus 50%.	61,36%	36,36%	2,27%	+	6,82%	54,55%	29,55%	9,09%	0,00%	-

4.4 Scenario Construction

4.4.1 Schwartz Axes

The level of importance and uncertainty are fundamental in the 2x2 matrix to select drivers and build scenarios. Importance refers to how essential a driver is to the studied system under study, while uncertainty relates to

the degree of unpredictability associated with its behavior (van't Klooster and van Asselt, 2006). The drivers in quadrant III (+ important and + uncertain) significantly influence the development of various scenarios, making them key drivers with the most significant future impact.

Axes are used to classify factors based on their level of importance and uncertainty. Quadrant I, labeled "Environment", contains the least uncertain and most important factors. The most important and least uncertain factors are placed in quadrant II, "Baseline". The more uncertain and more important factors are identified in quadrant III, called Diversity. The elements in this quadrant create diversity or differences between scenarios and are, therefore, the most commonly used for scenario construction. The factors in quadrant III form the most important and probable basis for the construction of scenarios. Finally, the least uncertain and most important factors are located in quadrant IV, "Detail", and only affect a few scenarios (Schwartz, 1991).

Table 4 shows that the drivers "Training students with critical thinking skills, Feedback to students through intelligent tutorials and Technological infrastructure" present high levels of importance and uncertainty, belonging to quadrant III.

Table 4: Ranking Key Factors by Quadrant

Identification	Conductor	Importance	Uncertainty	Quadrant
Educ2	Training students with critical thinking skills	+	+	III
Educa4	Feedback to students through intelligent tutoring	+	+	III
Tec3	Technological infrastructure	+	+	III

These drivers are grouped into two axes: the first axis is called "Promotion of critical thinking", which includes two drivers, and the second axis is called "State-of-the-art technological infrastructure", as shown in Table 5.

Table 5: Drivers of change and axes of uncertainty.

Identification	Drivers of change	Axes of uncertainty
Educ2	Training students with critical thinking skills.	Fostering critical thinking
Educ4	Feedback to students through intelligent tutorials.	
Tec3	Technological infrastructure.	State-of-the-art technological infrastructure

Identifying the driving factors is crucial to building favorable scenarios, such as:

- Training students with critical thinking skills is essential for academic and professional development. This factor will drive the need for innovative pedagogical methods that stimulate reflection and analysis in students, preparing them to face the cognitive challenges to come (Glen, 1995).
- Personalized feedback from intelligent mentoring is essential to improving the quality and accessibility of education. It will allow students to adapt to the learning process, meeting individual needs and fostering various skills. It also improves the effectiveness of the educational process by providing personalized support to each student, resulting in more comprehensive and meaningful learning (Kulik and Fletcher, 2016).
- Technology infrastructure is critical to preparing students for a digital world. It will provide tools and resources to improve teaching and learning, enabling access to diverse information and facilitating collaboration. Key factors include the implementation of digital classrooms, training teachers in the effective use of technology, and investment in digital educational resources (Lamb and Weiner, 2021).

4.4.2 Structural analysis

The structural analysis examines the relationship of dependence and influence between the elements of quadrant III of the Schwartz axis, providing a visual representation of their impact on the construction of future scenarios, as shown in Figure 1.

According to Table 6 the correlation coefficient r = + 0.85 indicates that there is a positive relationship since the greater the dependence, the greater the influence of the drivers Furthermore, 71.71% of the variability of

"influence" is explained by "dependence" in the regression model, suggesting a moderate to strong relationship between both variables.

In this sense, the"Educ2" (Educating students with critical thinking) engine of change is highly dependent on other factors, which indicates that by itself this variable does not drive large actions, which leads to having a low impact. "Educ4" (Intelligent Tutoring) has a medium level of dependency, indicating that feedback through tutoring is influenced by various factors, such as barriers in the Peruvian context or limitations in teacher training. However, it does not cease to have a significant impact on the system. Finally, "Tec3" (Technological Infrastructure) has a low dependency, so it does not depend on other factors, therefore it is a key factor that serves as an effective strategy to strengthen the educational system.

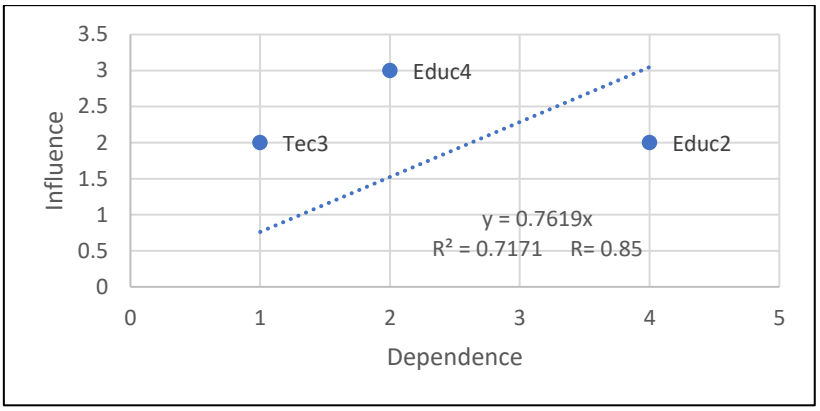

Figure 1: Relationship of structural analysis in the plane of dependence-influence of the drivers

Table 6: Structural Analysis Matrix

	Educ2	Educ4	Tec3	∑ Dependency
Educ2	---	2	2	4
Educ4	2	----	0	2
Tec3	0	1	----	1
∑ Influence	2	3	2	5

In Table 7, the scenarios are derived from the combination of positive and negative signs (+ -) that reflects a behavior that enhances or decreases the elements represented on each axis. Positive values (+) indicate behavior that emphasizes the characteristics of the elements, while negative values (-) indicate actions that reduce their impact. With two axes of uncertainty, four different scenarios are generated. Once the possible scenarios have been described, an internal consistency analysis is performed to ensure that there are no conflicts between the combinations of poles in each scenario. According to the analysis carried out, it is observed that all scenarios have consistency with the combination of critical factors.

Table 7: Scenarios derived from structural analysis

Scenarios	Axis III: "Promoting critical thinking"	Axis III "State-of-the-art technological infrastructure"	Stage Name	Consistency Analysis
1	+	+	Digital mentoring and integrated technology	Coherent
2	+	-	Technological advances and challenges	Coherent
3	-	+	Overcoming challenges with innovation and technology	Coherent
4	-	-	Educational Challenges 2033	Coherent

4.4.3 Scenario design

For the generation of the scenarios, the key drivers of the result of the Delphi Method are considered, as they have high levels of importance and uncertainty, belonging to quadrant III of the 2x2 matrix, including 'Training of students with critical thinking skills, Feedback to students through intelligent tutoring and Technological infrastructure'. Based on these 3 drivers, the scenarios are generated.

Scenario 1: Digital mentoring and integrated technology

This scenario reflects a genuine commitment to developing individuals with critical thinking skills essential to success in an ever-changing world. Intelligent tutoring adapted to the specific needs of each student represents a significant advance in personalized education, allowing for more effective and comprehensive academic development. Tightly integrated into the educational environment, advanced technological infrastructure democratizes access to high-quality digital resources, reducing learning gaps and promoting educational equity. This combination of factors represents a realistic evolution towards a more inclusive and dynamic education system, preparing students to face the challenges of the 21st century with confidence and competence.

Scenario 2: Technological advances and challenges

In the projected scenario towards 2033, the educational approach prioritizes the development of critical thinking and the implementing intelligent tutorials to provide personalized and effective feedback to students. However, important challenges related to technological infrastructure limit the full integration of digital tools into the educational process. These obstacles can generate gaps in access to digital education and affect the quality of learning. Despite these challenges, it is important to note that the educational landscape shows crucial advances for a more complete and fair development. There are opportunities to address technological challenges and improve the effectiveness of the education system, promoting a dynamic and adaptive learning environment for all students.

Scenario 3: Overcoming challenges with innovation and technology

The year 2033 presents important challenges in the training of students in critical thinking and personalized tutoring. However, technological infrastructure has become a key strength, providing advanced tools that improve connectivity and access to digital resources. Integrating technology in higher education has also provided opportunities for international collaboration and knowledge sharing, democratizing access to education and allowing people from diverse backgrounds to take part in educational programs, all under the development of an ethical regulatory framework.

Scenario 4: Educational challenges towards 2033

In this scenario, the development of critical thinking is hindered by a traditional educational approach that prioritizes memorization over analysis and reflection. Feedback to students needs to improve because of a lack of resources and adequate training for educators, which limits the quality and personalization of feedback. Technological infrastructure experiences significant setbacks because of a lack of investment and upgrades, resulting in limited access to digital tools and an outdated learning environment. These factors combined create a challenging educational landscape that is less conducive to the integral development of students.

4.5 Scenario Validation

4.5.1 Probability, Desirability, and Governance (PDG) method

In this section, scenario validation was carried out with the participation of 16 experts, using the criteria of probability, desirability, and governance for each scenario. Each scenario was assigned values according to the aforementioned criteria using a Likert scale, where 1 represents less likely, desirable or governable, and 4 represents more likely, desirable or governable. The highest total value determines the target scenario for strategy development. According to the results, Scenario 3, "Overcoming challenges with innovation and technology", was identified as the target scenario, as shown in Table 8.

Table 8: Results of the criteria of probability (P), desirability (D) and governance (G)

Scenarios	P	D	G	Total
1: Digital mentoring and integrated technology	36	72	44	152
2: Technological advances and challenges	53	52	54	158

Scenarios	P	D	G	Total
3: Overcoming challenges with innovation and technology	63	54	59	176
4: Educational challenges towards 2033	45	26	48	119

4.5.2 Retrospection: Strategy formulation

The retrospection method was used to develop strategies leading to the target scenario (Höjer and Mattsson, 2000). Retrospection is a methodology that starts with a desired future goal and works backwards to identify the actions needed to achieve it. It provides a solid framework for strategic planning and long-term policy development (Soria-Lara and Banister, 2017). This approach helps to visualize a desired future and develop retroactive strategies to reach the goal, involving multiple stakeholders in the planning process. Table 9 outlines strategies aimed at addressing digital challenges and promoting the effective adoption of technologies such as ChatGPT in universities, maximizing their benefits to enhance educational quality.

Table 9: Strategy formulation: retrospection

Year	Milestone	Strategy
2023	Present	Organize interactive workshops and seminars for educators and students aimed at enhancing the benefits of integrating ChatGPT into education. Establish student and faculty engagement committees to gather opinions and concerns, fostering a collaborative approach to decision-making.
2024	Milestone 5: Needs and resource assessment	Conduct a comprehensive assessment of the institution's technological needs. Hire consultants specializing in educational technology to evaluate existing infrastructure and propose improvements.
2026	Milestone 4: Strategic investment	Acquire and implement advanced educational software and tools that facilitate personalized feedback and the development of critical thinking. Establish ongoing training programs for teachers and students, focusing on the effective use of ChatGPT and addressing initial concerns about the loss of analytical skills. Organize training courses in educational technology and digital ethics that encourage responsible and effective use of this algorithm.
2028	Milestone 3: Continuous monitoring and adjustment	Establish a monitoring system to assess the impact of integrating ChatGPT into education. Develop a curricular plan where the use of emerging technologies is incorporated into the teaching-learning process, with a proactive approach by adapting a practical methodology in teaching. Continuously adjust infrastructure and training programs based on feedback and results achieved.
2030	Milestone 2: Developing innovative educational content	Collaborate with pedagogical and technological experts to develop innovative educational content that maximizes ChatGPT's capabilities. Integrate this content into the curriculum to enhance educational experience.
2032	Milestone 1: Expansion of training programs	Expand training programs to include not only teachers and students but also parents and members of the educational community. Evaluate the success of your ChatGPT implementation, analyzing metrics such as academic performance, student engagement, and teacher feedback. Continue to foster a culture of continuous learning and adaptability, preparing the educational community to face future technological changes.
2033	Meta Scenario: Overcoming challenges with innovation and technology	Achieve the target scenario.

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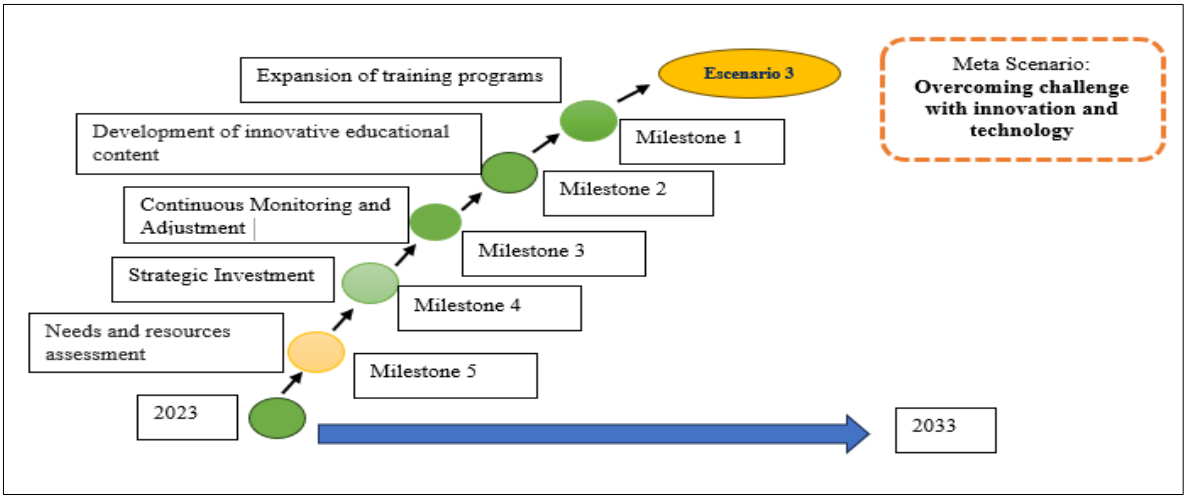

Figure 2: Temporal milestones in backcasting

5. Discussion and Conclusions

5.1 Discussion

The findings of this study highlight the importance of adapting to the ever-evolving academic environment by incorporating digital tools, such as ChatGPT, fused with human intellect. This integration will lead to a profound change in the dynamics of academic performance.

According to Castillo, Palacios and Silva (2023), although the use of ChatGPT improves students' productivity and access to relevant information, its implementation in higher education requires clear strategies to avoid over-reliance and ensure its ethical use. Velíbor and Indrasen (2023) argue that this tool should be used as a complement to learn, without replacing critical thinking and human interaction, an aspect that reinforces the need for an ethical framework that regulates its use.

In addition, Guadalupe et al. (2023) highlight that, while ChatGPT offers opportunities to personalize learning, the risk of misinformation and bias persists, requiring responsible and regulated integration. This research contributes to the debate by proposing ethical management strategies, aligning with Andreoli et al. (2024), who underscore the importance of addressing privacy and data security concerns to protect students and educators.

This research shows that integrating ChatGPT in Peruvian universities represents a significant opportunity to innovate in the classroom. This is affirmed in the outcome of the target scenario, where the integration of critical thinking skills and feedback through intelligent personalized tutorials is strengthened by an advanced technological infrastructure. Democratizing access to education and allowing the participation of students and teachers from various backgrounds in academic programs, all under an ethical framework where a responsible use of artificial intelligence in the academic field is guaranteed.

In the context of Peru's digital transformation, Law N°. 31814 was introduced to promote the use of artificial intelligence through a regulatory framework that ensures its responsible, ethical, and transparent implementation in both public and private sectors (Gobierno de Perú, 2025). However, its implementation faces challenges related to infrastructure and personnel training, which are essential for the proper use of these technologies.

The study advocates for the implementation of management strategies and ethical guidelines that uphold academic integrity and prioritize the well-being of students and educators, ensuring that tools like ChatGPT are used appropriately and in alignment with existing regulations.

- Ethical risks. - Risks in the educational environment are related to academic integrity and indiscriminate access to these tools (Peng and Zhao, 2024) foster academic dishonesty, by allowing students to generate information without any control (Cotton, Cotton and Shipway, 2023). The

research recommends that the university at the academic level adopt a proactive and ethical approach in the use of this tool, that is, that they make changes in the curriculum, incorporating courses on digital ethics and promoting the responsible use of artificial intelligence.

- Ethical barriers. - Algorithmic biases are a barrier in using ChatGPT, since it can influence the generation of responses presenting inequalities and affecting the clarity and objectivity of the information (Ferrara, 2023). In the literature review of this research, Velibor and Indrasen (2023) argues that this problem can be minimized, as long as ChatGPT is used as a complement and not as a substitute for critical thinking and human interaction. Therefore, it is essential to adopt a balanced approach that integrates the use of AI with critical thinking analysis, ensuring a more objective and ethical use of technology.
- Concerns. - In contrast to the review of the literature, several authors agree that the ethical and educational concerns derived from the implementation of the Constitution. According to Guadalupe et al. (2023), although ChatGPT provides many opportunities to personalize learning, there is a risk of reproducing biases and misinformation, which affects the quality of information.

On the other hand, according to the theory, Kuleto et al. (2021) shows where they warn about the impact on the teacher's role, pointing out that automation can reduce pedagogical interaction and affect personalized teaching.

5.2 Conclusion

The identification and validation of the 20 drivers through the Delphi method in real time have confirmed the importance and relevance of influencing ChatGPT in Peruvian universities. This process has provided a solid foundation for decision-making and the development of scenarios that effectively integrate ChatGPT into the educational process.

The validation of these drivers supports the understanding of the key elements that influence the successful implementation of ChatGPT in Peruvian universities.

The selection of the driving factors, such as the training of students in critical thinking, feedback through intelligent tutorials and the development of technological infrastructure, is closely related to the influence of ChatGPT on Peruvian universities by 2033.

However, it is important to mention that implementing milestone retrospection strategies must be a structured process that requires adaptive and critical management. In this regard, funding for its implementation is crucial, as without sufficient technological and financial resources, the strategies may be inadequate. Resistance to digital change represents an obstacle that must be managed with a comprehensive approach. In addition, it is important to recognize and overcome digital literacy gaps, which can exacerbate inequalities in other universities that do not have the same resources.

The target scenario highlights the advances and challenges that could arise in the way of more effective and technologically advanced education. In addition, it stresses the importance of addressing ethical aspects in using tools such as ChatGPT, promoting its responsible implementation to guarantee academic integrity, protect user privacy, and foster authentic learning, where technology acts as support and not as a substitute for critical thinking and personal effort.

Technology, applied with a solid plan and commitment to quality education, can be key to learning and personal development. The goal for 2033 is to overcome challenges through innovation and technology, with awareness-raising, feedback and continuous training programs. It is essential to implement effective technological strategies and to constantly monitor educational content and the development of innovative programs.

Future research may explore other generative AI algorithms, to provide a deeper and more comprehensive understanding of the use of these tools in academia.

Statement Of Artificial Intelligence: An artificial intelligence tool was used specifically to support grammar correction and proofreading in the translation of the document. The content generated with the tool was edited and validated by the authors.

Statement Of Ethics: This article does not require ethical approval, as no human subjects were involved.

Future Lines of Research: This research lays the groundwork for numerous promising lines of future study. In view of the dynamic nature of AI technologies and their potential influence on higher education, two key areas deserve further exploration:

Longitudinal studies are essential for tracking the evolutionary impact of ChatGPT and similar GAI technologies on universities, as they provide empirical data that can refine forecasting scenarios and strategies. These studies allow researchers and policymakers to compare actual results with predictions. In addition, future research should address the ethical implications of AI in education, focusing on privacy, data security, and its role in widening or narrowing the digital divide. Addressing these issues is crucial to developing ethical guidelines and policies that protect both students and educators.

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