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The impact of artificial intelligence on the personalization of learning and its effects on academic performance and educational inclusión

El impacto de la inteligencia artificial en la personalización del aprendizaje y sus efectos en rendimiento académico e inclusión educativa

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Abstract

The introduction of Artificial Intelligence (AI) in education is revolutionizing the The introduction of Artificial Intelligence (AI) in education is revolutionizing the personalization of learning, positioning it as a crucial tool for pedagogical progress. This article analyses how AI is transforming the field of education, facilitating the personalization of content and pedagogical strategies according to the individual needs of learners. Through a case study analysis in educational settings, the effects of AI on academic performance were explored, highlighting improvements in comprehension and retention of information. The study employed a quantitative approach with a quasi-experimental design to evaluate the contribution of AI to educational inclusion by providing personalized support to students with special needs and learning difficulties, promoting a more equitable environment. The findings highlight that the integration of this tool in the classroom can enhance academic performance by providing learning experiences tailored to the characteristics of each student. However, challenges are identified that need to be addressed, such as data privacy and bias in the algorithms. The article concludes with recommendations for effective implementation of AI in education and considers ethical and social implications for ensuring responsible integration in education.

Keywords: Feedback, artificial intelligence, academic performance, personalization of learning, inclusion

Resumen

La introducción de la Inteligencia Artificial (IA) en la educación está revolucionando la personalización del aprendizaje, posicionándose como una herramienta crucial para el progreso pedagógico. Este artículo analiza cómo la IA está transformando el ámbito educativo, facilitando la personalización de contenidos y estrategias pedagógicas según las necesidades individuales de los estudiantes. A través de un análisis de caso en entornos educativos, se exploraron los efectos de la IA en el rendimiento académico, destacando mejoras en la comprensión y retención de información. El estudio empleó un enfoque cuantitativo con diseño cuasi-experimental para evaluar la contribución de la IA a la inclusión educativa, proporcionando apoyo personalizado a estudiantes con necesidades especiales y dificultades de aprendizaje, promoviendo un entorno más equitativo. Los hallazgos destacan que la integración de esta herramienta en el aula puede potenciar el rendimiento académico al proporcionar experiencias de aprendizaje ajustadas a las características de cada estudiante. Sin embargo, se identifican desafíos que deben ser abordados, como la privacidad de datos y el sesgo en los algoritmos. El artículo concluye con recomendaciones para una implementación efectiva de la IA en la educación, y considera implicaciones éticas y sociales para asegurar una integración responsable en el ámbito educativo.

Palabras clave: Retroalimentación, inteligencia artificial, rendimiento académico, personalización del aprendizaje, inclusión

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Introduction

Education, in its constant pursuit of improving efficiency and equity, has undergone significant advancements with the incorporation of new technologies. In this context, Artificial Intelligence (AI) has emerged as a powerful and promising tool capable of transforming the educational landscape (Ortiz Muñoz, 2024). AI has the ability to process large volumes of data and learn from them, offering considerable potential to personalize learning, optimize academic outcomes, and promote educational inclusion (García Villaroel, 2021).

In recent years, as Navarrete-Cazales and Manzanilla-Granados (2023) mention, international organizations such as UNESCO and the OECD have promoted the integration of artificial intelligence in education as part of strategies to improve access, equity, and the quality of learning. However, it should not be considered a daily access point. In addition, various government policies have begun incorporating AI tools into curricula and teaching methodologies, evidencing a growing trend toward educational digitalization and automation.

In this regard, artificial intelligence emerges as an innovative solution to overcome these limitations, allowing for more effective personalization of learning through adaptive tools that dynamically adjust content and pedagogical methodologies according to students' performance and preferences. Moreover, its analytical and adaptive capabilities contribute to promoting educational inclusion by providing targeted support for students with diverse needs, ensuring equitable access to education (Morocho Cevallos et al., 2023).

The incorporation of Artificial Intelligence in this process offers a promising solution to overcome these limitations. Through the use of adaptive tools, AI enables dynamic adjustment of both content and pedagogical strategies based on each student's performance and preferences (O.-Y. Aparicio-Gómez & Aparicio-Gómez, 2024).

This study aims to analyze the impact of artificial intelligence on personalized learning, academic performance, and educational inclusion. It evaluates its effectiveness in comparison to traditional teaching methods. Through a quasi-experimental design, the study examines how the use of AI-based adaptive tools allows for dynamic adjustment of content and teaching strategies based on individual student performance and needs.

Literature Review

Artificial intelligence, defined as the ability of computer systems to perform functions that typically require human intelligence, has had a notable influence on various fields, including education (Moreno Padilla, 2019). It has become a fundamental tool for transforming teaching and learning processes in educational contexts, offering applications such as adaptive learning platforms, intelligent tutoring systems, and advanced educational data analysis tools that allow content and pedagogical strategies to be tailored to individual needs and student performance (Romero & Ventura, 2020).

Personalized learning, driven by artificial intelligence, is considered one of the most innovative and promising areas of contemporary education, as this approach aims to align educational content and teaching methodologies with each student's unique characteristics. For example, tools like ChatGPT, where Kirwan (2023) provides initial reflections on teaching academic integrity in the era of large language models.

This personalization by different AI systems is made possible through the use of algorithms that analyze complex data on academic performance, dynamically adjusting the difficulty level and content of tasks (Holmes et al., 2019). These systems collect real-time data, such as chat bot interactions, response times, interaction patterns, and survey answers, enabling personalized recommendations and adjustments that optimize the learning process for each individual (Alshahrani, 2023).

Beyond its benefits in personalized learning, artificial intelligence also plays a key role in educational inclusion. By adapting content and pedagogical strategies to individual needs, AI facilitates more equitable access to education, allowing students with learning difficulties or special needs to receive personalized support and progress at their own pace (Xu et al., 2019).

To illustrate these benefits, two relevant case studies can be considered. The first involves an analysis of an adaptive learning platform focused on mathematics that adjusts exercises based on students' competency levels. This study found a 15% improvement in students' academic performance compared to conventional methods (Pane et al., 2015).

In addition to its influence on academic performance, AI is fundamental in promoting educational inclusion, as AI-based systems can adapt content and pedagogical strategies to individual needs, contributing to the creation of more inclusive educational environments. As Cotton et al. (2024) explain, it is also crucial to preserve academic integrity in the ChatGPT era.

Furthermore, AI systems can provide specialized support to students with special educational needs, enabling a more accessible and equitable learning experience (Kabudi et al., 2021). Technologies such as screen readers and voice recognition applications facilitate more efficient access to educational material for students with visual impairments or writing difficulties (Khan & Khusro, 2021).

Adaptive systems have the ability to provide personalized resources that allow students to progress at their own pace, encouraging greater participation and reducing learning barriers (Zhang et al., 2020). Additionally, the possibility of offering continuous, individualized feedback ensures that students with special needs receive the necessary support in real time, significantly improving their educational experience (Desmond et al., 2018).

Some examples of effective implementation include adaptive reading applications that adjust difficulty levels based on students' abilities and offer personalized feedback, which has proven effective in improving reading skills in students with specific difficulties (Muñoz et al., 2022). Another example is the development of accessible educational material in multiple formats—text,

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audio, and video—facilitating learning for students with various disabilities (Crisol-Moya et al., 2020).

Despite the substantial benefits that artificial intelligence offers in the education sector, there are also important ethical challenges that must be addressed. Data privacy, algorithmic mining, and increasing dependency on technology are among them (Hoofnagle et al., 2018). Collecting data on student academic performance raises serious concerns regarding privacy and data security, highlighting the need for clear policies and the implementation of comprehensive security measures (Chassignol et al., 2018).

AI systems can reflect biases present in the data they were trained on, potentially disadvantaging specific student groups (Gallent-Torres et al., 2023). To mitigate this risk, it is crucial to use a variety of data sources and conduct regular audits to identify and correct any discrepancies. Moreover, excessive dependence on technology could hinder the development of critical skills, such as critical thinking and problem-solving. Therefore, it is essential to integrate AI tools with traditional teaching methods (Selwyn, 2019).

Methodology

2.1. Research Design

This study employed a quantitative approach to explore the effect of artificial intelligence on personalized learning, academic performance, and educational inclusion based on empirical study data. A quasi-experimental design was developed to analyze the influence of AI tools. Two study groups were selected: one composed of students and teachers using AI-based adaptive learning platforms, and a control group composed of students and teachers using traditional teaching methods. The comparison between these two groups allowed for the measurement of the effects of AI-driven personalized learning on students' academic performance and the promotion of educational inclusion.

2.2. Sample

For this research, the selected participant was the Unidad Educativa del Milenio APCH: San Miguel, located in the city of Bolívar. The sample used for the analysis and development consisted of two classes from the institution, each with 35 students, for a total of 70 students. Within the institution, the two study groups were identified: the experimental group (using AI systems for personalized learning) and the control group (using traditional pedagogical methods).

2.3. Data Collection

To collect quantitative data, three main instruments were used, providing a comprehensive assessment of the impact of artificial intelligence on personalized learning and its effects on academic performance.

First, standardized academic assessments were conducted at the beginning and end of the study period, focusing on key subjects such as mathematics, science, and language. These assessments were designed to maintain equivalence in difficulty and content, allowing for accurate and consistent comparison of students' results, thus providing an objective measure of academic performance changes throughout the study.

In addition, satisfaction surveys were administered to students and teachers to capture their perceptions of the effectiveness and impact of AI tools on learning and teaching. The surveys included questions about the ease of use of the tools, the quality of feedback provided, and the general perception of personalized learning, offering a broad perspective on user experience with the implemented AI tools.

Finally, interaction data was collected by tracking student activity on adaptive learning platforms, including study time, frequency of access, and interaction patterns. The information provided by the AI platforms was used to assess the effectiveness of personalized learning and to identify how student interactions with the platforms influenced their educational experience.

Observations also focused on the two analyzed samples: the experimental group, which used AI-based online platforms such as the free and paid versions of ChatGPT, Gemini, and Copilot to personalize learning; and the control group, which used traditional pedagogical learning methods. The purpose of these observations was to document the implementation of AI tools in the teaching and learning process within these groups. Special attention was given to student-teacher interactions, the use of AI technologies in educational activities, and the general classroom dynamics.

2.4. Data Analysis

To evaluate differences in academic performance between the experimental group, which used AI tools to personalize learning, and the control group, which used conventional pedagogical methods, comparative statistical analyses were performed. Independent sample t-tests and an analysis of variance (ANOVA) were applied to verify the statistical significance of the observed differences. These methods facilitated the identification of whether the use of AI in the educational process produced significant improvements in the evaluated subjects, providing a solid basis for comparing the educational impact of both pedagogical strategies in the selected sample.

Results

The group statistics results are presented in Table 1, which shows significant differences between the experimental group, which used artificial intelligence tools, and the control group, which used conventional pedagogical methods, across several key dimensions.

Before the intervention, both groups had very similar academic performance means (7.26 for the experimental group and 7.23 for the control group), with closely aligned standard deviations

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and standard errors, indicating that the groups were well balanced before the implementation of artificial intelligence.

However, after the intervention, the academic performance of the experimental group experienced a substantial increase, reaching a mean of 9.00, while the control group's performance decreased to 6.60. This result highlights the significant impact of the intervention on the academic performance of the experimental group.

Improvements in understanding and the perceived quality of feedback were notably higher in the experimental group compared to the control group. In the experimental group, the mean improvement in comprehension was 4.26, in contrast to just 1.37 in the control group, underscoring that AI facilitated a deeper understanding of academic content. Similarly, knowledge assimilation was better perceived by the experimental group, with a mean of 4.23, while the control group scored only 1.40.

The low standard deviations in these measurements emphasize consistency in responses within each study group, reinforcing the effectiveness of the intervention in these areas.

Table 1

Group Statistics – Results

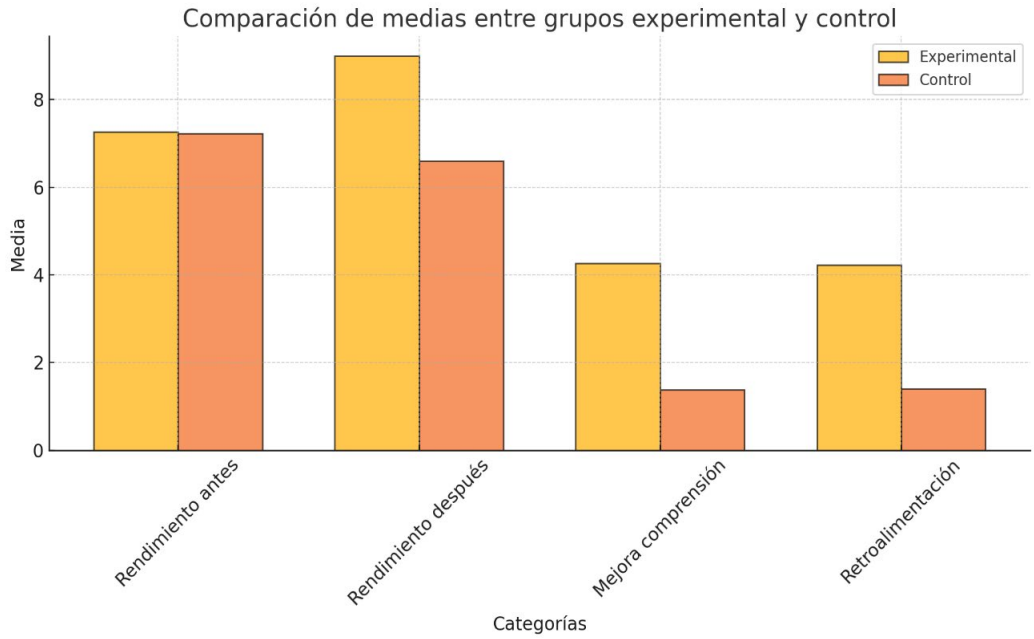
Estadísticas de grupo					
	Es	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Performance Before	Experimental	35	7.2571	1.12047	0.18939
	Control	35	7.2286	1.16533	0.19698
Performance After	Experimental	35	9.0000	0.93934	0.15878
	Control	35	6.6000	1.41837	0.23975
Comprehension Improvement	Experimental	35	4.26	0.657	0.111
	Control	35	1.37	0.646	0.109
Feedback	Experimental	35	4.23	0.770	0.130
	Control	35	1.40	0.497	0.084

The comparative analysis shows that the experimental group exhibits significantly higher performance than the control group in the evaluated categories after the intervention, highlighting a notable improvement in understanding and feedback. This reflects that the strategies applied to the experimental group generated a measurable positive impact, while the initially similar performance

between both groups confirms that starting conditions were homogeneous, allowing the results to be attributed to the AI-based learning interventions.

Figure 1.

Comparison of Means Between Experimental and Control Groups



The independent samples test in Table 2 shows that, in terms of academic performance before the intervention, there were no statistically significant differences between the experimental and control groups. Levene's test for equality of variances yielded F = 0.026 and Sig. = 0.872, indicating that the variances are homogeneous. Similarly, the t-test (t = 0.105, df = 68, Sig. = 0.917) shows a minimal difference in means between the two groups (0.02857), which is not statistically significant, as confirmed by the 95% confidence interval ranging from -0.51671 to 0.57385. These results suggest that both study groups were balanced in terms of academic performance before the intervention.

Regarding academic performance after the intervention, results show a considerable improvement in the experimental group compared to the control group. Levene's test revealed a significant difference in variances (F = 7.974, Sig. = 0.006), indicating that equal variances should not be assumed. The corresponding t-test (t = 8.346, df = 59.013, Sig. = 0.000) shows a significant mean difference of 2.40000. The 95% confidence interval for this difference ranges from 1.82460 to 2.97540, reinforcing the conclusion that the intervention (use of AI) had a significant impact on the experimental group's performance.

Likewise, improvement in understanding and feedback were significantly higher in the experimental group. For improvement in understanding, Levene's test showed variances could be assumed equal (F = 0.064, Sig. = 0.801), and the t-test (t = 18.531, df = 68, Sig. = 0.000) indicated a mean difference

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of 2.886, with a 95% confidence interval ranging from 2.575 to 3.196, highlighting a substantial improvement in the experimental group compared to the control.

Similarly, for feedback, Levene's test revealed a variance difference (F = 7.509, Sig. = 0.008), and the t-test (t = 18.255, df = 58.132, Sig. = 0.000) reported a mean difference of 2.829, with a 95% confidence interval ranging from 2.518 to 3.139. These results indicate that the experimental group perceived more effective academic feedback than the control group.

Table 2

Independent Samples Test – Results

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	gl	Sig. (2-tailed) l	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Upper	Superior
Performance Before	Equal variances assumed	.026	.872	.105	68	.917	.02857	.27326	-.51671	.57385
	Equal variances not assumed			.105	67.896	.917	.02857	.27326	-.51672	.57386
Performance After	Equal variances assumed	7.974	.006	8.346	68	.000	2.40000	.28756	1.82619	2.97381
	Equal variances not assumed			8.346	59.013	.000	2.40000	.28756	1.82460	2.97540
Improvement in Understanding	Equal variances assumed	.064	.801	18.531	68	.000	2.886	.156	2.575	3.196
	No se asumen varianzas iguales			18.531	67.978	.000	2.886	.156	2.575	3.196
Feedback	Equal variances assumed	7.509	.008	18.255	68	.000	2.829	.155	2.519	3.138
				18.255	58.132	.000	2.829	.155	2.518	3.139

ANOVA Analysis – Results

The ANOVA analysis reveals significant differences between the groups across several key dimensions, highlighting the relevance of the adopted approach.

Regarding improvement in understanding, the sum of squares between groups is 113.230 with 6 degrees of freedom (df), resulting in a mean square of 18.872. The F-value of 19.378 with a significance (Sig.) of 0.000 indicates a statistically significant difference in comprehension ability between groups, evidencing a substantial impact on student learning following the intervention.

For the sense of inclusion, the sum of squares between groups is 26.144 with 6 degrees of freedom, producing a mean square of 4.357. The F-value of 2.781 and a significance of 0.018 reveal meaningful differences in the perception of inclusion among the various groups within the educational setting. This underscores the importance of considering not only academic outcomes but also student well-being and integration in the learning process.

On the other hand, the participation variable did not show significant differences between groups, with a sum of squares between groups of 2.368, an F-value of 0.812, and a significance of 0.564. This indicates that the intervention did not have a considerable impact on student participation in the classroom.

Lastly, feedback, with a sum of squares between groups of 78.608, a mean square of 13.101, an F-value of 9.173, and a significance of 0.000, reveals significant differences between groups. This indicates that students experienced notable variations in feedback. These differences, along with those observed in comprehension improvement and the sense of inclusion, demonstrate that the intervention had a considerable impact on students' perception and learning processes.

Table 3

ANOVA – Results

ANOVA						
		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Comprehension Improvement	Between Groups	113.230	6	18.872	19.378	.000
	Within Groups	61.355	63	0.974		
	Total	174.586	69			
Participation	Between Groups	2.368	6	0.395	0.812	.564
	Within Groups	30.617	63	0.486		
	Total	32.986	69			
Sense of Inclusion	Between Groups	26.144	6	4.357	2.781	.018
	Within Groups	98.727	63	1.567		
	Total	124.871	69			
Feedback	Between Groups	78.608	6	13.101	9.173	.000
	Within Groups	89.978	63	1.428		
	Total	168.586	69			

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Results

The results demonstrate that the intervention using AI-based tools has a positive influence on various dimensions of the educational process, showing notable improvements in the experimental group compared to the control group. Furthermore, the study highlights the importance of factors such as the sense of inclusion and the quality of feedback, which showed significant differences between groups. However, not all variables analyzed reflected significant changes—as in the case of classroom participation—suggesting that certain aspects of the educational environment may be less influenced by the intervention. Overall, the findings emphasize the potential of personalized learning to enhance students' educational experience while also highlighting the complexity of comprehensively measuring the effects of new methodologies in academic settings.

Discussion

The data indicate that the experimental group, which used AI-based tools, showed a considerable increase in academic performance after the intervention, reaching an average score of 9.00 compared to the control group, whose performance decreased to 6.60. This finding highlights the effectiveness of AI in optimizing learning, as also demonstrated in the study by Ifenthaler et al. (2024), showcasing its potential as a key tool for personalized teaching. This result aligns with previous studies by Lavidas et al. (2024) and Obregón et al. (2023), which point out that AI-based adaptive platforms—by adjusting content to students' progress—improve comprehension and information retention (Holmes et al., 2019; Romero & Ventura, 2020).

One of the most relevant aspects is the improvement in academic understanding, where the experimental group showed an average of 4.26 compared to 1.37 in the control group. This suggests that AI tools, such as intelligent tutoring systems, provide tangible learning benefits, which has also been documented in studies by Álvarez and Cepeda (2024) and Aparicio-Gómez (2023), emphasizing AI's ability to offer learning dynamics that help overcome specific academic difficulties (Xu et al., 2019; Pane et al., 2015). Moreover, this personalization aligns with Moreno Padilla's (2019) view of AI as a transformative technology in educational processes.

Feedback, as perceived by students, also showed significant differences between groups, with an average of 4.23 in the experimental group versus 1.40 in the control group. This supports the findings of Álvarez and Cepeda (2024), who highlight the use of AI in higher education settings. AI's ability to adjust content and teaching strategies in real time reinforces its importance in educational contexts, especially when addressing students' individual needs (Holmes et al., 2019).

Another highlighted result is the sense of inclusion, where the AI-based intervention led to significant differences, showing its potential to improve equity in educational access. AI's ability to adapt content and provide specialized support to students with specific needs—as discussed by Korzynski et al. (2023)—underscores the importance of developing educational policies that promote the use of these technologies in inclusive education contexts (Sanchez-Acedo et al., 2024).

For instance, the implementation of virtual assistants and accessible learning tools could become essential components of special education programs. It is also recommended that Ministries of Education and academic institutions develop strategies to evaluate the effectiveness of AI in reducing educational barriers and promoting more equitable learning experiences (Kabudi et al., 2021; Khan & Khusro, 2021). This impact reinforces the role of AI in fostering educational inclusion as a crucial element of technological transformation (Magallanes Ronquillo et al., 2023).

However, not all analyzed dimensions showed significant changes. In the case of participation, no relevant differences were found between the groups, suggesting that this aspect may depend more on contextual and pedagogical factors not directly influenced by AI (Dwivedi et al., 2021). This finding aligns with Selwyn's (2019) argument for integrating technological tools with traditional pedagogical methodologies to comprehensively address learning challenges.

Addressing challenges related to data privacy is essential, as algorithmic bias and technological dependence highlight the need to ensure that AI serves as a complementary tool that enhances pedagogical capabilities and fosters equitable, sustainable learning (Chassignol et al., 2018; Gallent-Torres et al., 2023). These findings open new opportunities for future research—particularly in the integration of AI with inclusive, sustainable, and ethically responsible educational practices (Nedungadi et al., 2024).

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