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Virtual Learning System with Artificial Intelligence for the Academic Management Process

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Abstract: The impact of the COVID-19 pandemic on global education, with the massive closure of schools and universities. It highlights the challenge of adapting to distance learning modalities and the loss of students' knowledge. In this context, the use of Artificial Intelligence (AI) has become a promising alternative to improve distance education; it is presented as a solution to automate administrative tasks and personalize learning. The research work conducted focuses on how an AI-based e-learning system has improved academic management and learning at the institution. The study involved the participation of 20 experts, who evaluated the prototype in terms of efficiency, usability, technology, functionality, and design. As a result of the evaluation of the criteria, 93% in design and 92% in functionality were obtained. Likewise, 68.9% of experts determined that the system has a "Good" efficiency, with the highest percentage followed by 64.4% of "very good" efficiency. In conclusion, efficiency has a high degree of satisfaction due to being fast and efficient.

Keywords: Artificial Intelligence, Academic Management, Personalized Learning, Virtual Platforms, Technological Innovation

Introduction

The education system was affected worldwide in the COVID-19 pandemic, having a major impact on aspects of society (Pir *et al*., 2022). The sudden appearance of the virus and the social distancing measures necessary to control its spread led to the closure of schools and universities around the world, leaving millions of students without access to education in the traditional format (Nations, 2020) in the field of education, this emergency has led to the mass closure of face-to-face activities of educational institutions in more than 190 countries in order to prevent the spread of the virus and mitigate its impact.

Likewise, most of the measures adopted by the countries of the region in response to the crisis are related to the suspension of face-to-face classes at all levels, which has given rise to three main fields of action: The deployment of distance learning modalities (Cabanillas-García *et al*., 2022), through the use of a variety of formats and platforms (with or without the use of technology); support and mobilization of educational staff and communities; healthcare (Cabanillas-Carbonell *et al*., 2023) and the integral well-being of students (Rajmil *et al*., 2021).

The pandemic has represented an abrupt change in educational systems for which there was no warning (Abdelfattah *et al*., 2023; Khalil *et al*., 2021). It was unexpected, so not being prepared for it does not mean a failure but rather a rupture since the educational institutions were acting in their usual processes, planned under the assumption of normality: Admission, development, and culmination of teaching processes (Gutierrez-Moreno, 2020).

According to the Organization for Economic Cooperation and Development (OECD) (OCDE, 2020). The COVID-19 crisis has forced schools to temporarily close in 188 countries, resulting in an abrupt interruption of the learning process for more than 1.7 billion children, youth, and their families. During this time, distance learning solutions were implemented to ensure continuity of education; the current debate focuses on how much students have learned during the school closures (Garay *et al*., 2021).

The need to ensure continuity of educational service during the Covid-19 pandemic (Scavarda *et al*., 2021) has generated several ways of innovating in education (Hernández *et al*., 2014; Karma *et al*., 2021, changing the pedagogical practices of teachers. In this sense, the objective of the research was to implement virtual

pedagogical strategies that allow elementary and middle school students in Colombia to continue their learning from home, focused on the achievement of educational objectives and their integrated development (Gutierrez-Moreno, 2020).

Artificial Intelligence (AI) (Ocaña-Fernández *et al*., 2019) is a new technology that is revolutionizing many fields, including education (Harry and Sayudin, 2023), and has demonstrated its role in educational management by automating and personalizing learning. This technology has been used in education management (Ge and Hu, 2020) to automate repetitive tasks and improve efficiency. It can be used for document classification and organization, automated tracking of attendance and grades, and scheduling of assignments, which reduces the workload of administrators and teachers, allowing them to focus on more important tasks, such as teaching and student development (Isusqui *et al*., 2023).

The formats based on artificial intelligence promise a very substantial improvement in education at all levels, with an unprecedented qualitative improvement: To provide the student with an accurate personalization of learning tailored to their requirements, integrating the various forms of human interaction and information and communication technologies (Morales López *et al*., 2020).

The objective of this research was to determine how the virtual learning system with artificial intelligence influences the academic management process with respect to how it improves the learning of the students of the Educational Institution (IE).

Materials

In this phase of the research process, the essential technological resources, encompassing both hardware and software, required for the successful execution of the research project have been thoroughly identified and assured. This rigorous process of defining and securing resources ensures a solid and technologically supported foundation for carrying out our study effectively and efficiently.

Hardware:

a) Connection devices: Devices that allow remote communication, such as computers, servers, routers, and mobile devices, are needed. These devices must be configured to access the network and resources remotely
b) Networking and connectivity: A robust network infrastructure is essential. This may include broadband connections, routers, switches, and secure VPN connections to ensure reliable connectivity between local and remote devices
c) Security and authentication: To ensure security, hardware that supports security protocols such as firewalls, encryption, and user authentication is required. It is also essential to have security servers and monitoring systems

Software: As for the programming language to develop a system with artificial intelligence, languages such as Python, R, Java, and C++ are used. Python is widely preferred due to its robust machine-learning library and ease of use. SQL Server:

a) Scalability: SQL server is known for its scalability, which means it can handle large volumes of data and grow as business needs dictate. This is essential for systems that anticipate significant growth
b) Security: SQL server offers strong security features, including authentication, authorization, and data encryption. It complies with numerous security standards and allows granular control over data access

Integration with Microsoft platform: If the organization uses a wide range of Microsoft products and technologies, the SQL server integrates seamlessly with these tools, facilitating data management in a broader Microsoft environment.

Methods

Concerning the development of this research work, a search of existing agile methodologies was carried out, and they were compared with various segments such as knowledge, information management, flexibility, and adaptation (Caso, 2004). Table (1) shows a rating from 1-5 among the possible methodologies to be used.

Therefore, in determining the points of each segment that were found in the research, the choice of a good agile methodology (Munoz *et al*., 2016), in the result of Table (1) and as shown in Fig. (1), the best methodology is SCRUM.

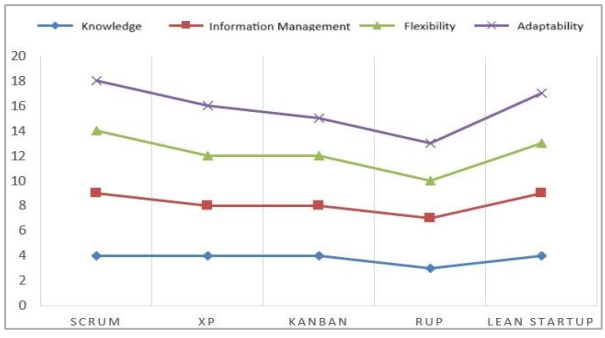

Fig. 1: Methodology chart

Table 1: Choice of methodology

Methodologies	Knowledge	Information Management	Flexibility	Adaptation	Points
SCRUM	4	5	5	4	18
XP	4	4	4	4	16
KANBAN	4	4	4	3	15
RUP	3	4	3	3	13
Lean Startup	4	5	4	4	17

Project Definition

Before starting SCRUM, it is crucial to clearly define the objective of the e-learning system. This includes identifying the specific academic management needs you want to address, such as automating enrollment processes, tracking student performance, and personalizing learning.

Caso (2004) tells us that SCRUM is a methodology for managing, improving, and maintaining a new or existing system. SCRUM focuses on how team members should function to produce a flexible system in a constantly changing environment.

Exploration

The phases of the interests of each group will be shown:

a) Stakeholder: Educational institutions
b) Application users: Teachers and students of the IE
c) Developers: Researchers of the present project

Roles in Scrum

SCRUM establishes specific roles that are critical to project management (Shastri *et al.*, 2021).

Product owner: This role is assumed by an academic or administrative representative who defines the characteristics and requirements of the system. He/she is responsible for prioritizing the backlog and ensuring that the team understands the needs of the end user.

Scrum master: Acts as a facilitator of the SCRUM process, helping the team to follow agile practices and removing obstacles that may arise during development.

Development team: This team consists of developers, designers, and AI experts. It is responsible for building the system. It must be self-organized and multidisciplinary.

Production

In this image, Fig. (2), the solid data architecture stands out, where the protagonists are both the Administrator and the teacher, together with the student. In addition, the languages used in the development of the system and the choice of the database are revealed with impact.

Both the Administrator and the teacher share a uniform design in the visual structure of the system, which guarantees a coherent and efficient experience for both roles. The student portal is highlighted by a unique and specific design that nevertheless maintains a close relationship with the main system. This visual distinction provides a personalized user experience for students while ensuring seamless integration with the core system.

The work is organized in short cycles called sprints (Ameta *et al.*, 2021), which generally last between one and four weeks. Each sprint includes several stages:

– Sprint planning: At the beginning of each sprint, the team selects backlog items that they commit to complete during that cycle
– Incremental development: During the sprint, the team works on the selected tasks, developing system functionalities. This approach allows for partial deliveries and continuous feedback
– Sprint review: At the end of each sprint, a meeting is held to review what has been developed. The product is presented to the stakeholders, and possible improvements are discussed

Sprints

– Sprint retrospective: The team reflects on the process, identifying what worked well and what can be improved for future sprints

Creation

At this stage, the application prototyping process begins. In Fig. (3), the user is given the option to choose between two types of login: Administrator or teacher.

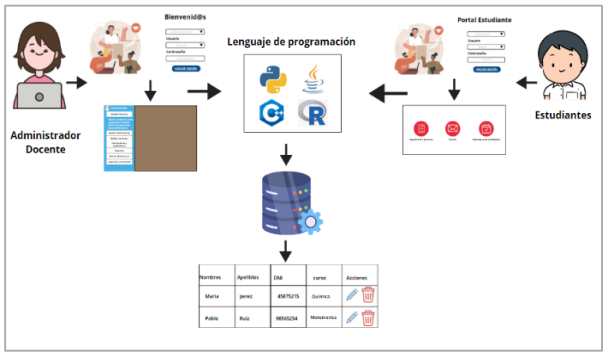

Fig. 2: Project Architecture

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Fig. 3: Logging interface

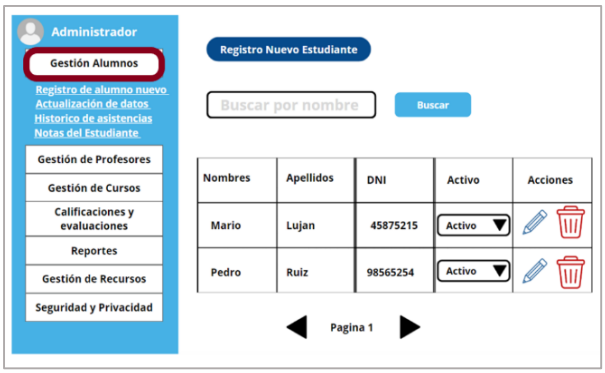

Fig. 4: New student registration interface

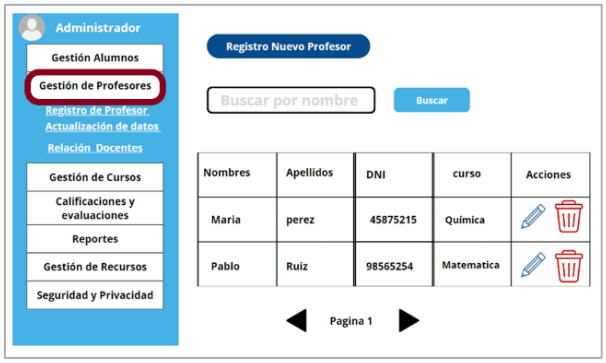

Fig. 5: Teacher module interface

Iteration and Continuous Improvement

SCRUM promotes an iterative and evolutionary approach, allowing constant adjustments based on the feedback obtained (Riesener *et al*., 2021). This is especially useful in an academic environment where needs can change rapidly. The ability to adapt to these changes is one of the main benefits of using SCRUM in academic management.

Once the user has selected his role, in the case of the Administrator, he accesses the main menu that provides a wide range of functionalities and tools. In the main menu, the Student Management button, you can access the different options, such as New student registration, which shows the following interface Fig. (4), the option Update data of previously registered students.

In Fig. (5), the Teachers module is presented along with a grid of results with a search option by name and registration of new teachers. The same Design shows the interface for updating the data of previously registered teachers.

Figure (6) presents the course management module together with a grid of results with a search option by name. In Fig. (7), the study plan interface is shown; the latter interface is worked with Artificial Intelligence (AI), and its operation is based on the analysis of the student's data. For example, data, including the GPA of all the student's courses, are collected. Through rigorous analysis, the system generates a highly personalized study plan that is tailored to the student's specific needs to improve their academic grades effectively and efficiently.

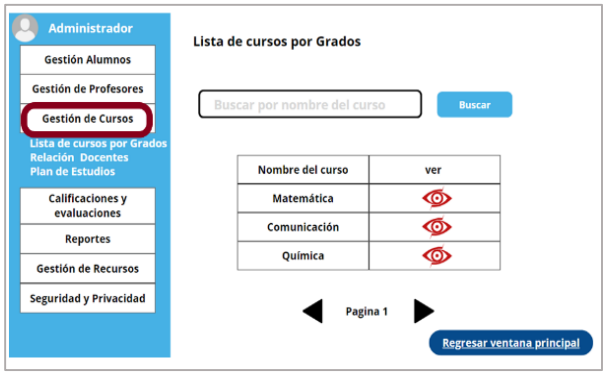

Fig. 6: Course management interface

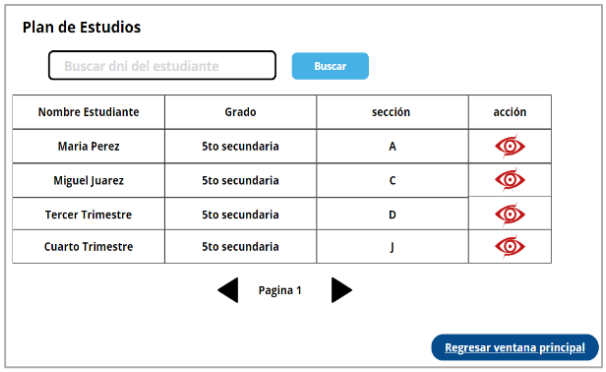

Fig. 7: Interface study plan

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In Fig. (8), the Grades and Evaluations module is presented along with a results grid that includes two fields to filter by semester and grade. In Fig. (9), we have the Reports module, which will allow filtering of the students' academic reports by grade and section, as well as the submodule attendance report and student observations.

In Fig. (10), the Student Portal platform is visualized, which offers the possibility of login, and in Fig. (11), the interface of the main module, which consists of only three sections: Grade tracking, mail, and activity calendar.

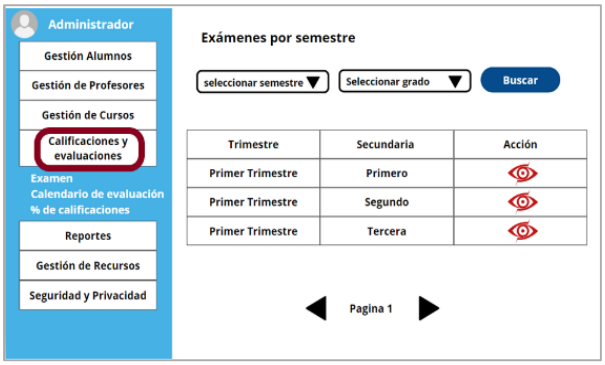

Fig. 8: Grades and evaluations interface

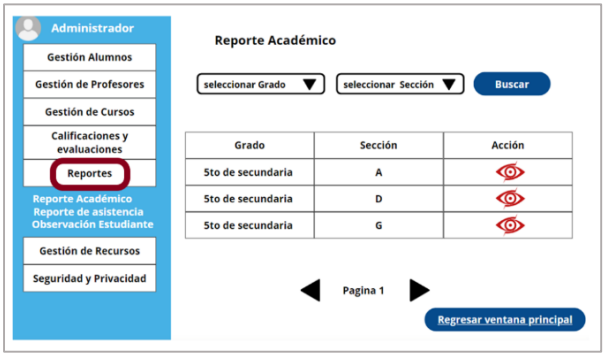

Fig. 9: Reporting module interface

Fig. 10: Student portal interface

In Fig. (12), the Grade Tracking module is presented, where students can visualize their grades by subject in real-time. In Fig. (13), the Mail module is displayed, where students will receive newsletters and can send e-mails to their teachers or classmates. Finally, the activity calendar module Fig. (14), where students can check in real-time if a teacher has created an event for a specific date. Similarly, students can schedule activities in their calendar, which will only be visible to themselves.

Fig. 11: Student portal interface (main menu)

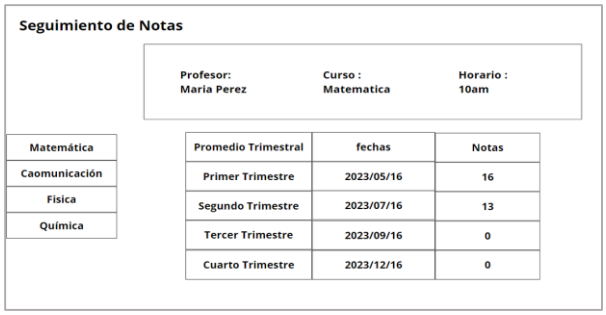

Fig. 12: Student portal (grade tracking)

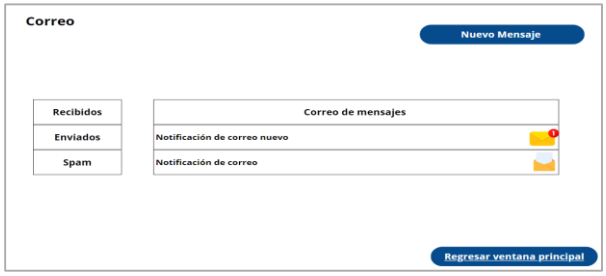

Fig. 13: Student portal (mail)

Fig. 14: Student portal (activities calendar)

Results

Validation of the Design Model with an Expert

For the results, a sample of validation results of the level of design quality was carried out by calculating the mean and Standard Deviation (SD) based on 20 experts, which used several criteria (Efficiency, usability, technology, functionality, and design). Each expert was asked questions based on the likert scale, where they had to select options, which were 5, from very bad 1, bad 2, neutral 3, good 4, and very good, which was 5. The purpose of this validation was to measure the experts' degree of acceptance. Table (2) shows the criteria used in this validation, as well as the different questions used in each criterion.

As can be seen in Fig. (15), there is a summary of the criteria. The highest percentage of efficiency is 87%, which is Design, followed by usability at 80%, Functionality at 73%, and Efficiency at 69%. Consequently, Design is the criterion with more virtues.

In Fig. (16), it can be seen in a very significant way that the Design has a 93% in the evaluation by the expert, highlighting the others above the other criteria reaching the scale of "Very good," so the prototype is standing out for it.

Regarding the quality of the prototype, the following criteria were evaluated: Efficiency, usability, technology, functionality, and design. Figure (17) allows verifying that designthe has the highest mean score with 4.65 and the others 4.49, 4.6, 4.56, and 4.45. Also when performing the general analysis, the overall average is 4.55.

Table 2: Expert validation

Criteria	Questions	Media	Standard deviation (D.E.)	Quality
Efficiency	Is the system fast and efficient in its performance?	4.55	0.45	Very good
	Does the system make efficient and flexible use of available resources?	4.45	0.55	Good
	Does the system accomplish specific tasks without requiring excessive resources?	4.45	0.55	Good
Usability	Is the system interface intuitive and user-friendly?	4.70	0.3	Very good
	Does the system offer easy access and navigation?	4.45	0.55	Good
	Is the relationship between the user and the system perceived as reliable?	4.65	0.35	Very good
Technology	Is the quality of the innovation satisfactory?	4.50	0.50	Good
	Is it perceived as reliable and accurate?	4.60	0.40	Very good
	Is technology at the forefront of the field of artificial intelligence?	4.60	0.40	Very good
Functionality	Are the planned tasks effective?	4.40	0.60	Good
	Do the requirements shown interact with each other effectively?	4.50	0.50	Good
	Is the readability of the system adequate?	4.45	0.55	Good
Design	Does the system have visual appeal?	4.45	0.55	Good
	Does each segment of the system communicate information clearly?	4.60	0.40	Very good
	Are interfaces and connections intuitive for users?	4.25	0.75	Good
Total measurement and final quality level		4.51= 5		Very good

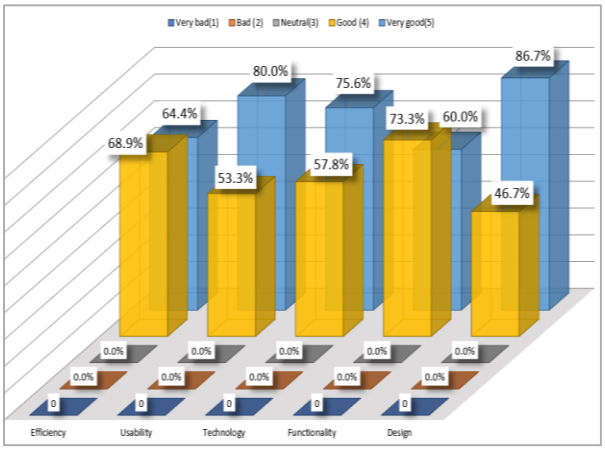

Fig. 15: Summary of criteria

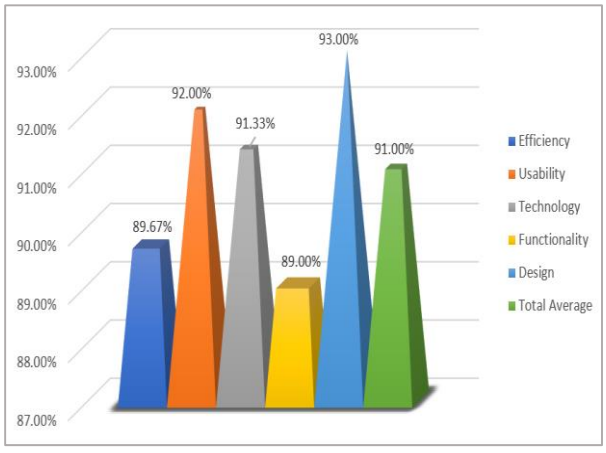

Fig. 16: Likert scale analysis

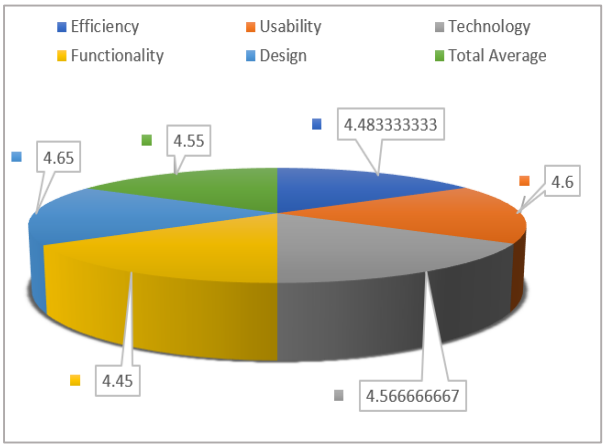

Fig. 17: Criteria evaluation

Discussion

El desarrollo de un Sistema de Aprendizaje Virtual potenciado con Inteligencia Artificial (IA) y gestionado mediante la metodología ágil SCRUM, destaca no solo por su potencial en la mejora de la eficiencia y personalización en la educación, sino también por su capacidad de adaptación en cada fase del desarrollo. Este enfoque permite un proceso iterativo y flexible, facilitando mejoras continuas en el desarrollo mediante ciclos de retroalimentación rápida. Por ejemplo, en (Torres-Barreto *et al*., 2020) la creación de herramientas de aprendizaje gamificadas como "Didactic City", SCRUM proporcionó ciclos de "sprints" que permitieron refinar elementos de gamificación de acuerdo con las necesidades de los usuarios. En comparación, metodologías más tradicionales, como el Modelo en Cascada, no permiten la misma adaptabilidad, lo que puede resultar en productos menos ajustados a las expectativas del usuario final. En otros estudios, se ha demostrado que SCRUM facilita la integración de IA en los sistemas, dado que se pueden probar y ajustar modelos de aprendizaje automático en cada iteración, lo cual es esencial para desarrollar funciones adaptativas en entornos virtuales (Rodríguez Chávez, 2021).

Desde el punto de vista de los resultados del aplicativo, el desarrollo de un Sistema de Aprendizaje Virtual potenciado con Inteligencia Artificial (IA) representa un avance significativo en la gestión académica. En esta investigación, se evaluaron múltiples aspectos, incluyendo la eficiencia, personalización y accesibilidad del sistema, en comparación con los modelos tradicionales de gestión académica. Los hallazgos indican que el uso de IA en sistemas de aprendizaje virtual mejora considerablemente la eficiencia del proceso de gestión, optimizando tareas como el seguimiento de progreso estudiantil, la personalización de contenido y la automatización de evaluaciones. En términos de efectividad, los sistemas basados en IA han mostrado ser beneficiosos para mejorar el proceso de aprendizaje y la retención de conocimiento en plataformas de gestión académica. Un ejemplo es el uso de sistemas de tutoría inteligente (ITS), que permiten personalizar el aprendizaje adaptándose a las fortalezas y debilidades del estudiante, mejorando significativamente la comprensión de temas complejos (Rodríguez Chávez, 2021). Estudios recientes muestran que la implementación de ITS y técnicas de IA puede mejorar el rendimiento académico hasta en un 30% en comparación con sistemas no personalizados, debido a la capacidad de estos sistemas para ofrecer una orientación continua y específica (Torres-Barreto *et al*., 2020).

Uno de los aspectos más destacables de este estudio es la capacidad de la IA para personalizar el proceso de aprendizaje, permitiendo mejorar y personalizar el diseño y usabilidad del aplicativo. A diferencia de los sistemas tradicionales, que presentan una estructura de contenidos fija, la IA permite adaptar el contenido en tiempo real según el rendimiento y las necesidades del estudiante. Según los datos recolectados, esta personalización incrementa significativamente la tasa de retención de conocimientos y la motivación de los estudiantes, dado que se enfrentan a materiales ajustados a su nivel de comprensión y ritmo de aprendizaje. La usabilidad y el diseño centrado en el usuario son aspectos cruciales en los sistemas de aprendizaje virtual con IA, tal como lo mencionan los autores en (Torres-Barreto *et al*., 2020), la herramienta "Didactic City" se diseñó para priorizar perfiles de usuario específicos, como el "estudiante fantasma" y el "estudiante trabajador", logrando así una interfaz intuitiva que permite una interacción amigable y relevante para diversos tipos de estudiantes. Por su parte en (Wong-Fajardo *et al*., 2023), las evaluaciones de usabilidad han mostrado que diseños centrados en el usuario mejoran la retención y el compromiso, logrando una satisfacción del usuario cercana al 90% en algunos estudios. Comparativamente, los sistemas que carecen de un diseño enfocado en la experiencia del usuario tienden a presentar problemas de accesibilidad y aceptación, especialmente en grupos de estudiantes menos familiarizados con la tecnología.

Conclusion

The implementation of the virtual learning system with Artificial Intelligence (AI) i.e,. has a positive impact on academic management. In particular, AI contributes to the improvement of efficiency, personalization, and quality of learning. In addition, AI has demonstrated its role in educational management by

automating and personalizing learning, which contributes to the improvement of efficiency in academic monitoring. It proves to be an effective solution in terms of efficiency, adaptability, and personalization in the teaching process. The implementation of artificial intelligence allows the adaptation of learning to the individual needs of students, increasing retention and comprehension of academic content. Agile methodologies have facilitated more flexible and collaborative development, allowing for constant feedback and iterative adjustments that improve user experience and learning effectiveness. In turn, attention to usability and user-centered Design has proven to be critical to maximizing learner engagement, especially in gamified applications, where the interface must be intuitive and tailored to different user profiles.

Finally, AI can help route and redirect the type and mode of teaching according to the evaluation results, which contributes to improving the learning-teaching process. In addition, useful recommendations for future research projects or work will be shared. In this way, the knowledge and experience gained in this study can be used as a basis for further research or work.

In future work, we suggest exploring advanced artificial intelligence and deep learning models to improve personalization in learning; evaluate effectiveness in different educational contexts and academic levels to ensure adaptability, integrate virtual and augmented reality technologies to create immersive learning environments, and deepen the analysis of ethics and privacy in the management of student data, ensuring transparency and security in the use of information.

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Author's Contributions

Luis Lopez-Zevallos: Conceptualization, methodology, investigation, written original draft preparation.

Evellyn Navarro-Prado: Methodology, resources, investigation, visualization, written review and edited.

Michael Cabanillas-Carbonell: Validation, formal analysis, data curation, project administration.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and no ethical issues involved.

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