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SUMARIO

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Editorial

En pleno siglo XXI, la educación superior enfrenta una transformación profunda que responde a un mundo en constante cambio. Este proceso no es solo tecnológico o metodológico, sino también estructural y filosófico, ya que cuestiona los modelos tradicionales sobre los cuales las universidades han operado. La globalización, la revolución digital, la Inteligencia Artificial (IA) y los desafíos sociales demandan instituciones más dinámicas y comprometidas con el desarrollo sostenible y equitativo. Por lo tanto, la capacidad de las universidades para adaptarse y liderar este cambio determinará su relevancia en un entorno global y profundamente interconectado.

En este sentido, un factor esencial en este proceso transformacional es el cambio en el paradigma educativo. El modelo tradicional, centrado en la transmisión unidireccional del conocimiento, ha dado paso a enfoques centrados en el estudiante, los cuales priorizan el aprendizaje activo, colaborativo y basado en competencias. Por ejemplo, metodologías como el aprendizaje adaptativo, la educación híbrida y la inteligencia artificial permiten una personalización del aprendizaje sin precedentes, gracias a que sistemas avanzados identifican las necesidades individuales de cada estudiante. Sin embargo, su implementación enfrenta resistencias institucionales y barreras económicas que limitan su alcance. Por esta razón, reflexionar sobre estas tensiones es crucial para evitar confundir avances tecnológicos con una verdadera innovación educativa.

Por otro lado, la digitalización y la IA han reconfigurado profundamente los procesos de enseñanza y aprendizaje. Estas herramientas no solo automatizan procesos administrativos, sino que también permiten analizar grandes volúmenes de datos para mejorar la toma de decisiones pedagógicas y curriculares. De hecho, algoritmos de IA facilitan la creación de modelos predictivos, optimizando los recursos y personalizando la experiencia educativa. No obstante, aunque la educación híbrida y las plataformas digitales han ampliado el acceso a la formación, también han evidenciado la desigualdad tecnológica entre estudiantes y docentes. La persistente "brecha digital" es más que un desafío técnico; en realidad, es un problema social que amenaza con profundizar las desigualdades existentes. Por consiguiente, es responsabilidad de las universidades diseñar políticas inclusivas que garanticen el acceso equitativo a una educación de calidad.

En cuanto al vínculo entre la universidad y el mercado laboral, este es otro eje central de la transformación. La cuarta revolución industrial exige profesionales con competencias transversales como pensamiento crítico, resolución de problemas y creatividad. En este marco, la IA se ha integrado en este ámbito, analizando tendencias laborales y ayudando a diseñar programas académicos alineados con las demandas del mercado. A pesar de ello, las universidades no deben limitarse a ser centros de formación profesional; por el contrario, deben mantener su rol como espacios de pensamiento crítico, generación de conocimiento y reflexión ética. En definitiva, la educación superior tiene la responsabilidad de formar individuos capaces de liderar cambios sociales y contribuir al desarrollo sostenible, trascendiendo las exigencias inmediatas del mercado.

Por otro lado, el aseguramiento de la calidad en la educación superior ha adquirido una importancia creciente. Los procesos de evaluación y acreditación buscan garantizar estándares mínimos, aunque a menudo se convierten en formalidades burocráticas que desvían la atención de los objetivos sustantivos. Aquí, la inteligencia artificial puede contribuir a estos procesos mediante el análisis automatizado de indicadores de desempeño, reduciendo la carga administrativa y enfocando los esfuerzos en la mejora continua. Por ello, es necesario que estos mecanismos estén orientados hacia la pertinencia social y la innovación. La clave, en este caso, radica en lograr un equilibrio entre calidad, autonomía y flexibilidad, permitiendo a las universidades adaptarse sin perder de vista su misión fundamental.

Desde una perspectiva ética, la transformación tecnológica en la educación superior plantea desafíos significativos. La creciente automatización y el uso de algoritmos generan preocupaciones sobre la privacidad de los datos, la transparencia y la posible deshumanización del aprendizaje. Si bien la IA, al recopilar y analizar datos, puede potenciar resultados, también debe someterse a principios éticos rigurosos, pues la educación es, en esencia, un proceso humano. Por lo tanto, la tecnología debe ser una herramienta para potenciar el aprendizaje, no un fin en sí misma. Las universidades deben liderar un debate ético que asegure que la implementación tecnológica esté alineada con principios de justicia, equidad y humanidad.

Como vemos, el cambio transformacional en la educación superior es inevitable y necesario, aunque también complejo. Las universidades deben redefinir su rol en la sociedad, equilibrando tradición e innovación, tecnología y humanidad, globalización y equidad. Por esta razón, la integración de la inteligencia artificial debe ser crítica, reflexiva y ética, asegurando que potencie las capacidades humanas en lugar de reemplazarlas. Esta transformación requiere un enfoque inclusivo que permita a las Instituciones de Educación Superior (IES) liderar el cambio hacia un futuro más justo, sostenible e inclusivo.

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ARTÍCULO ORIGINAL

Uso de las herramientas de Inteligencia Artificial por estudiantes universitarios dentro del proceso de enseñanza aprendizaje

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Resumen

En la educación el uso de la Inteligencia Artificial puede considerarse viable, ya que la ayuda automatizada permite una posibilidad nueva y atractiva con respecto al aprendizaje. El objetivo de esta investigación es determinar el uso de herramientas de Inteligencia Artificial dentro del proceso de enseñanza aprendizaje, en estudiantes universitarios de cuatro áreas del conocimiento, ingeniería y tecnología, humanidades, económico administrativo y ciencias de la salud. Se obtuvo una muestra de 275 estudiantes del Instituto Tecnológico de Sonora (ITSON). Se realizó un análisis utilizando estadística descriptiva, resultando que el 61.8% de los encuestados se considera con poca experiencia y el 38.2% con suficiente experiencia en el uso de la inteligencia artificial. Se concluye que el uso de herramientas con Inteligencia Artificial aún no es generalizado por todos los estudiantes, es considerada un área de conocimiento reciente, que el profesorado puede usar a favor del proceso de aprendizaje.

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Use of Artificial Intelligence Tools by University Students in the Teaching-Learning Process

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Abstract

The use of Artificial Intelligence in education can be considered viable, as automated assistance provides a new and attractive possibility for learning. The objective of this research is to determine the use of Artificial Intelligence tools within the teaching-learning process among university students in four areas of knowledge: engineering and technology, humanities, economic-administrative sciences, and health sciences. A sample of 275 students from the Instituto Tecnológico de Sonora (ITSON) was obtained. The analysis was conducted using descriptive statistics, revealing that 61.8% of respondents reported having little experience, while 38.2% indicated sufficient experience in the use of artificial intelligence. The study concludes that the use of AI tools is not yet widespread among all students, as it is considered a recent area of knowledge, which faculty can leverage to enhance the learning process.

Introducción

El suceso de pandemia por COVID-19, llevó al sistema educativo mexicano y de todo el mundo, a la utilización de herramientas tecnológicas para el apoyo de los procesos de enseñanza en modalidad remota y virtual, y que en la era post pandemia se han mantenido como apoyo en cursos presenciales o virtuales, además, se han incorporado nuevas herramientas tecnológicas que aportan significativamente en la formación de los estudiantes en su nuevo contexto. Por lo anterior, es fundamental la combinación de métodos y estrategias de enseñanza desde el profesorado, conscientes que, a finales del año 2022, se pusieron al alcance de cualquiera con un equipo de cómputo, herramientas tecnológicas de Inteligencia Artificial (IA), como el ChatGPT. En otras palabras, las Tecnologías de la Información y Comunicación (TIC), específicamente las relacionadas con IA, abren un nuevo escenario para la educación en el modo de enseñanza que, durante años, el sistema educativo se había mantenido similar a la forma de enseñanza del pasado (Carbonell et al, 2023).

Inteligencia Artificial

La inteligencia artificial (IA) es la simulación de procesos intelectuales humanos mediante algoritmos integrados en un entorno dinámico y basado en datos (ISO/IEC, 2019), que debe su origen al trabajo desarrollado por los investigadores estadounidenses John McCarthy, Marvin Minsky, Nathaniel Rochester y Claude Shannon, quienes acuñaron el término y son considerados los padres de la Inteligencia Artificial (Peña *et al.,* 2020).

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En la actualidad, la IA ha favorecido la diversificación tecnológica, y el desarrollo de nuevos campos de aplicación, entre estos el Machine Learning (ML), también conocido como aprendizaje automático o aprendizaje de máquina, que ha tenido un incremento sustancial en los últimos años. La IA y el ML comparten el objetivo de instaurar sistemas que puedan ejecutar tareas propias de los seres humanos, ambos campos utilizan técnicas matemáticas y estadísticas para analizar y procesar datos (Forero-Corba, y Negre, 2024).

Inteligencia Artificial en la educación

Durante la Conferencia Internacional sobre IA en la Educación, realizada en el Consenso de Beijing, del 16 al 18 de mayo de 2019, se señalaron cinco recomendaciones en ámbitos estratégicos sobre IA en la educación, los cuales señalan que la IA sirve a la gestión e implementación de la educación; empodera a los docentes y su enseñanza; sirve para el aprendizaje y la evaluación del desempeño; para desarrollar valores y habilidades necesarios para la vida y el trabajo en la era de la IA; finalmente señala que la IA brinda oportunidades de aprendizaje permanente para todos (UNESCO, 2019).

Es decir, la integración de la IA en la enseñanza superior ofrece, por tanto, un amplio margen de posibilidades para mejorar la enseñanza y el aprendizaje, así como para mejorar la gestión de las instituciones. Wang y Cheng (2021), citados por García (et al, 2024), identifican tres líneas principales de investigación sobre la IA en Educación, (AIEd, por sus siglas en inglés Artificial Intelligence in Education), aprender con la IA, aprender sobre la IA y utilizar la IA para aprender a aprender.

La habilidad para adaptar los materiales educativos, las actividades y las evaluaciones a las necesidades y a las preferencias individuales de cada alumno ha mejorado enormemente la eficacia del proceso de aprendizaje (Pimienta y Mosquera, 2022 citado por Aparicio, 2023).Además, la IA puede resultar de gran utilidad en la adquisición de competencias claves mediante aplicaciones pedagógicas basadas en big data, aprendizaje automático y aprendizaje profundo (Tomalá *et al*., 2023).

Dentro de la creación de plataformas online para el autoaprendizaje, Martínez (2023) señala la importancia de reconocer posibilidades didácticas sobre el uso de la IA para el apoyo del aprendizaje, enfatiza en el uso responsable de ellas por parte del docente, bajo un proceso de reflexión y estándares éticos. Al respecto, Flores y García (2023), concluyen que la IA, se encuentra cada vez más integrada en el área de la educación, considerándola, así como una aliada de los estudiantes y maestros, brindando contenidos pedagógicos y tutorías personalizadas en distintos momentos.

Bajo el contexto pedagógico las herramientas o aplicaciones de la IA pueden ser utilizadas con intenciones de enseñanza o aprendizaje, sin embargo, es importante reconocer que ciertas herramientas están especialmente diseñadas para ser utilizadas bajo este contexto (Prendes y Cerdán, 2021). La IA Generativa (IAG) pretende comprender la distribución de las distintas características de los datos, con el propósito de crear datos semejantes de forma artificial (Chong et al, citado por Chávez *et al*., 2023). Sánchez plantea que los estudiantes hacen uso de diferentes herramientas tales como generar imágenes, textos, música, para gestionar la información, buscar y contrastar información, practicar actividades

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conversacionales tales como entrevistas y debates, para aprender a programar, trabajar con idiomas, y para desarrollar sistemas aprendizajes personalizados (Sánchez, 2023).

En concreto, la IA sirve a la gestión e implementación de la educación; empodera a los docentes y su enseñanza; sirve para el aprendizaje y la evaluación del desempeño; desarrollar valores y habilidades necesarios para la vida y el trabajo en la era de la IA; y brinda oportunidades de aprendizaje permanente para todos (UNESCO, 2019).

En cuanto al proceso de educación personalizada, la aplicación de la IA puede considerarse, como una medida viable, ya que la ayuda automatizada en relación con la atención a los estudiantes (independientemente del nivel) permite una posibilidad nueva y atractiva con respecto al movimiento del aprendizaje, puesto que la interacción virtual, facilita el aprendizaje, pues los dispositivos de apoyo estarán disponibles cuando se necesiten, sin que importe el tiempo ni el espacio del usuario (Zavala *et al*., 2023).

Planteamiento del problema y objetivo

Si bien los estudios previos han coincidido sobre las ventajas y beneficios que puede significar el uso de la IA en la educación, y que la misma sociedad demanda cambios en los sistemas educativos con el fin de preparar a los jóvenes para los futuros escenarios académicos y laborales que se avecinan como resultado de la transformación digital ligada a la cuarta revolución industrial o revolución tecnológica (Fredy y Calderón, 2020); aún es necesario conocer sobre la experiencia de los estudiantes del nivel universitario con respecto a las herramientas de IA que tiene a su disposición dentro del ambiente educativo en el que se desenvuelven, por lo tanto, se establece la siguiente pregunta de investigación, ¿Cuáles son las principales herramientas de IA que los estudiantes del nivel superior utilizan en el proceso de enseñanza aprendizaje?, y para atender dicha pregunta, en esta investigación se ha establecido el objetivo de determinar el uso de herramientas de Inteligencia Artificial dentro del proceso de enseñanza aprendizaje, en estudiantes universitarios, para proponer estrategias.

Metodología

La presente investigación se desarrolló bajo un enfoque metodológico cuantitativo, no experimental, de corte transversal, y de alcance descriptivo (Hernández y Mendoza, 2018). En la unidad académica bajo estudio, el Instituto Tecnológico de Sonora (ITSON) campus Empalme, se ofrecen cuatro programas educativos, de cuatro especialidades, uno del área de conocimiento de ingeniería y tecnología, uno de humanidades, uno de económico administrativo y otro de ciencias de la salud. Los participantes son estudiantes inscritos en esta unidad académica en el ciclo lectivo agosto- diciembre del 2023, de la población de 474 estudiantes participaron de manera voluntaria una muestra de 275 estudiantes, de los cuales 153 son del género femenino, 119 masculino y 3 se consideran de otro género. La media promedio de edades es de 20 años, la mínima 17 y máxima de 42. En la tabla 1, se presenta la distribución de la muestra.

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Tabla 1: *Distribución de la muestra*

	Programa Educativo				
Genero	LA	LCE	IIS	LENF	Total:
Femenino	29	35	57	32	153
Masculino	17	15	80	7	119
Otro	1	0	2	0	3
Total:	47	50	139	39	275

Nota: LA=Licenciatura en Administración, LCE=Licenciatura en Educación, IIS=Ingeniería Industrial y de Sistemas, LENF= Licenciatura en Enfermería.

La encuesta fue el instrumento utilizado para la recolección de datos, lo que permitió conocer la opinión de los estudiantes inscritos en las distintas carreras que se ofrecen en ITSON campus Empalme, el cual contempla dos secciones, la primera se integra por preguntas para la identificación y clasificación del participante: Dirección de correo electrónico, género, edad, carrera, semestre, y los dispositivos inteligentes que posee, la segunda sección se integra por tres preguntas, sobre si ha usado o no las herramientas de IA para asignaciones académicas, en otra se le da opción de señalar entre 18 opciones cuales son las herramientas que ha utilizado, y finalmente, una para estimar la experiencia que considera sobre el uso de las aplicaciones de IA, para este ítem se utilizó una escala de intensidad de 1 al 10.

El procedimiento para esta investigación fue el siguiente; diseño de cuestionario para estudiantes, preparación de instrumento (formularios de Google), fiabilidad y validez por experto del instrumento, aplicación de instrumento, recolección de datos, análisis de datos, integración y discusión. Se realizó un análisis utilizando una estadística descriptiva, se agrupan las respuestas para cada herramienta y el uso que le da cada estudiante. Se descargó el archivo de Excel de Google Forms, se obtuvo la frecuencia de los datos nominales del estudiante y en la pregunta respecto a las herramientas usadas de la IA se calcularon las frecuencias de cada una de las herramientas seleccionadas por los estudiantes, se calculó el porcentaje que representa la sumatoria de cada herramienta y se diseñaron gráficas para mostrar los datos obtenidos y finalmente se realizó una comparación entre las herramientas y el programa educativo al que pertenece el estudiante.

Resultados

En la siguiente Figura 1, se presentan los estadísticos descriptivos del total de las frecuencias sobre el uso de las herramientas de IA y de los porcentajes que corresponden a las frecuencias de uso de los estudiantes.

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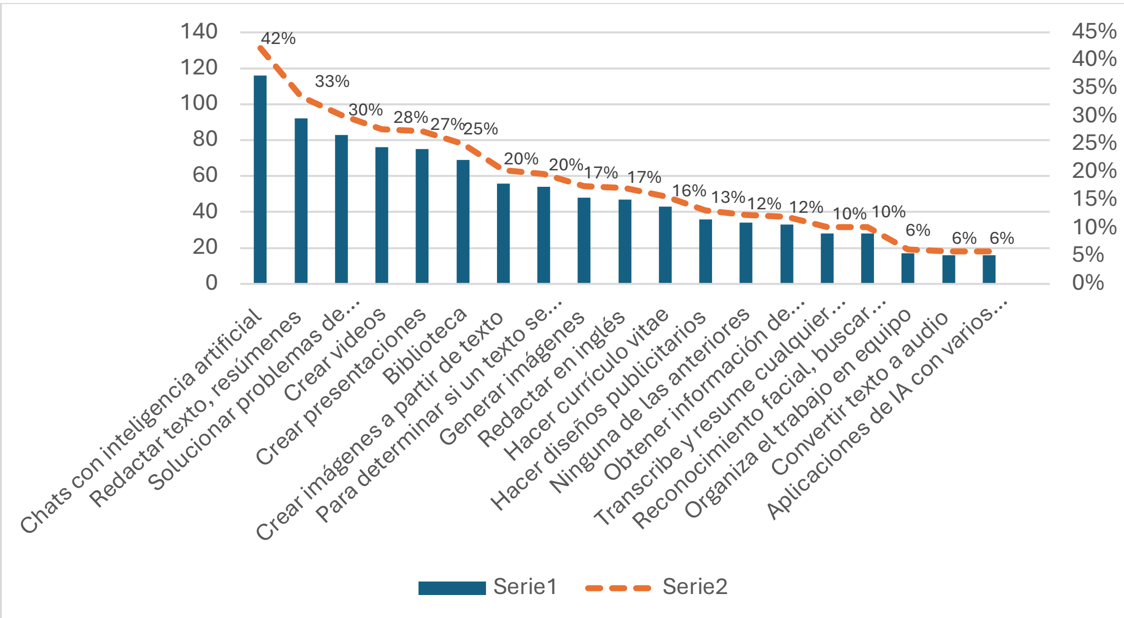
Figura 1: *Frecuencias del uso de las herramientas de la IA del total de estudiantes*



Nota: Elaboración propia.

Se observa que la herramienta más utilizada por los estudiantes es el chat con IA (42%), las segundas herramientas son para la redacción de textos y resúmenes (33%), y la tercera, es para solucionar problemas de ciencias exactas (30%); las herramientas con menos uso por los estudiantes son tres con un 6% las cuales corresponden a organizar el trabajo en equipo, convertir texto a audio y aplicaciones de la IA con varios usos.

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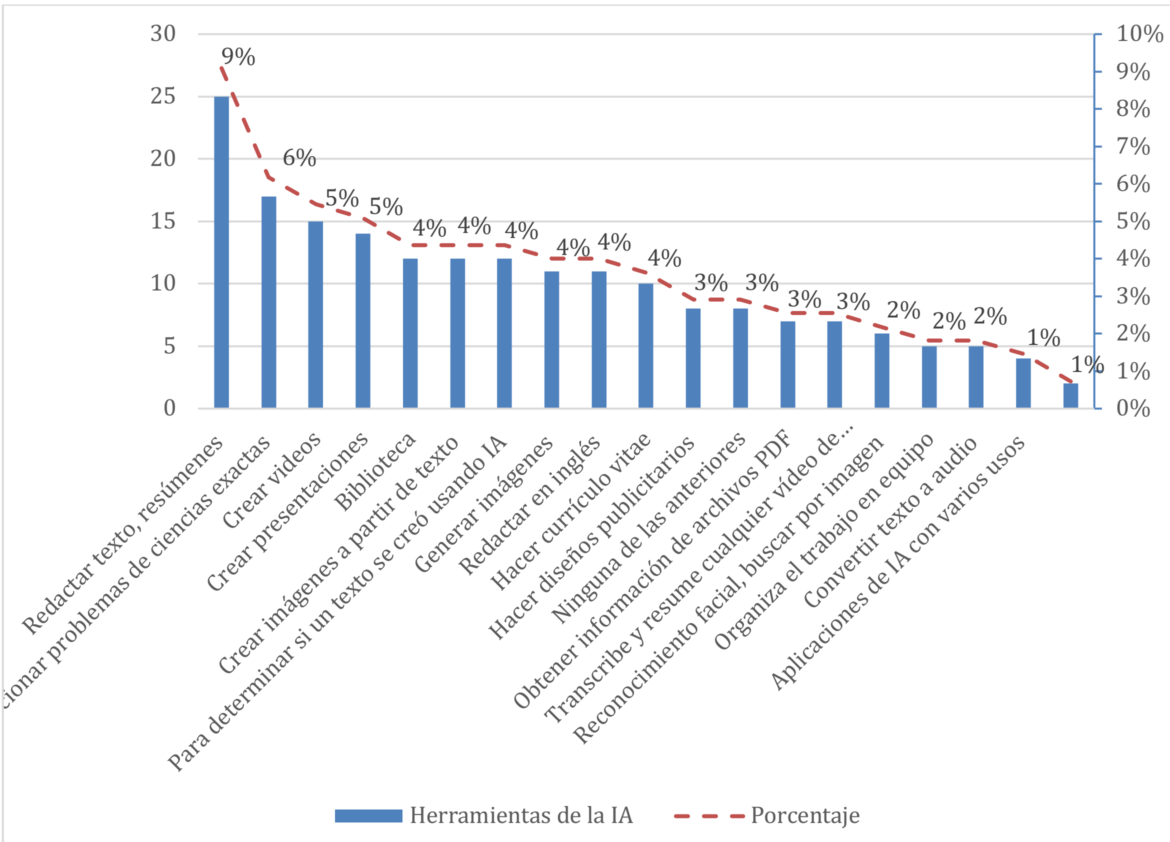
En la Figura 2, se muestran las frecuencias y porcentajes del uso de las herramientas de la IA por estudiantes de la Licenciatura en Ciencias de la Educación (especialidad de humanidades).

Figura 2: *Frecuencias y porcentajes del uso de las herramientas de la IA, Licenciatura en Ciencias de la Educación*



Nota: Elaboración propia.

Se identifica como las herramientas con mayor uso por estudiantes de especialidad de humanidades, las que ayudan a redactar textos y resúmenes con un 9%, y para solucionar problemas de las ciencias exactas con un 6%.

Con respecto a la frecuencia y porcentaje del uso de las herramientas por estudiantes de la carrera de Licenciados en Administración (especialidad económico administrativo) se muestran en la Figura 3.

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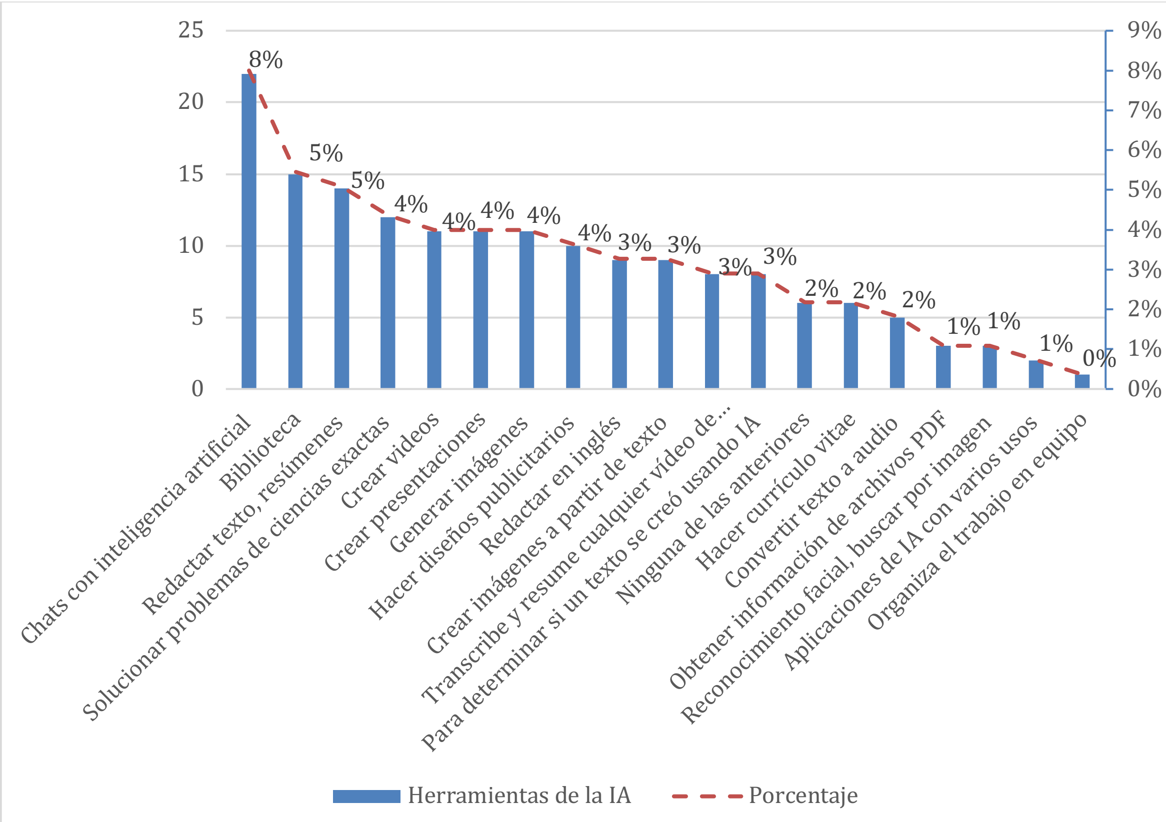
Figura 3: *Frecuencias y porcentajes del uso de las herramientas de la IA, Licenciatura en Administración*

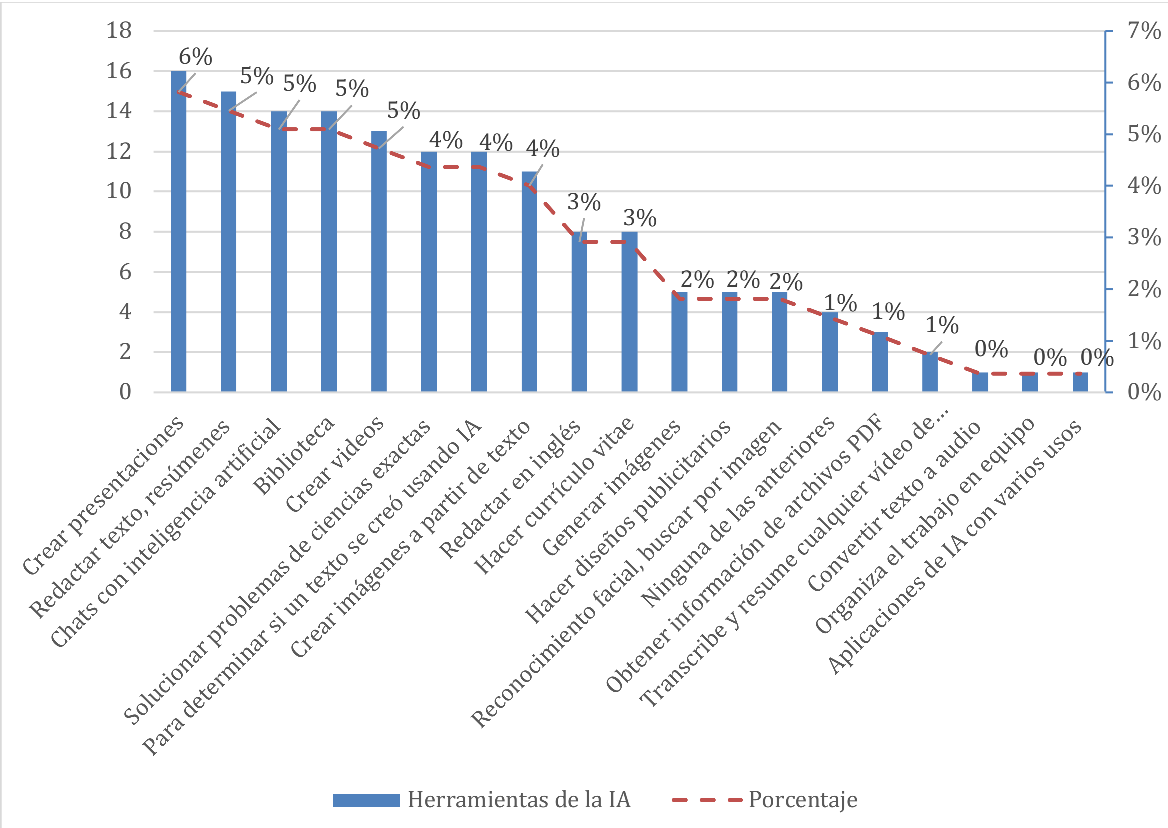


Nota: Elaboración propia.

Se observa que las herramientas de IA más usadas por los estudiantes de Administración son los Chats con IA con 8%, las herramientas de biblioteca y redacción de textos y resúmenes con 5%, además la herramienta que no ha sido utilizada es para organizar el trabajo en equipo con 0%.

Por otro lado, con respecto a los estudiantes de la carrera de Licenciatura en Enfermería (especialidad en ciencias de la salud), y su frecuencia de uso de las herramientas se presentan en la Figura 4.

Figura 4: *Frecuencias y porcentajes del uso de las herramientas de la IA, Licenciatura en Enfermería*



Nota: Elaboración propia.

La herramienta que mencionan los estudiantes de enfermería utilizar son para crear presentaciones con un porcentaje del 6% y las herramientas con un menor uso son las que se muestran con el 0%, como son; las aplicaciones de la IA con varios usos, para organizar el trabajo en equipo y las herramientas que permiten convertir textos a audio.

Finalmente, se muestra la Figura 5, sobre el uso de las herramientas de la IA por estudiantes de la carrera de Ingeniería Industrial y de Sistemas (especialidad del área de conocimiento de ingeniería y tecnología).

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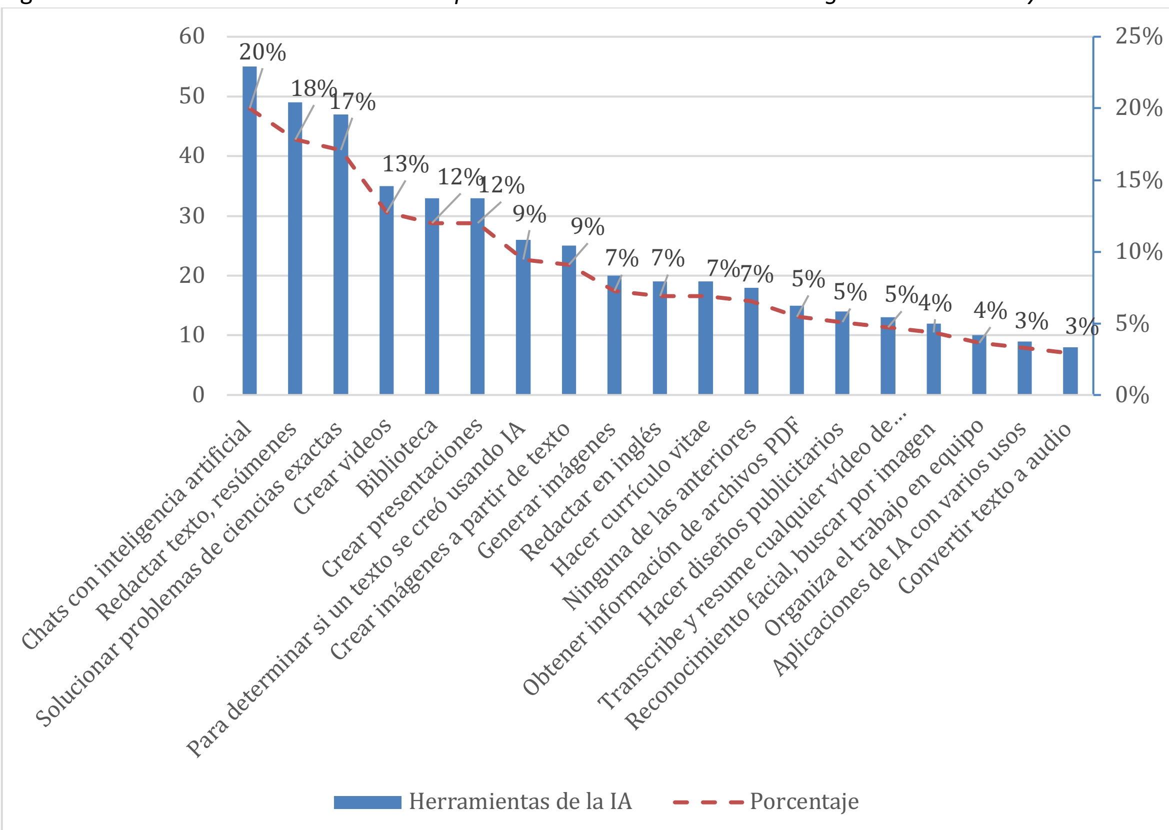
Figura 5: *Uso de las herramientas de la IA por estudiantes de la carrera de Ingeniería Industrial y de Sistemas*



Nota: Elaboración propia.

En esta figura 5, se logra identificar que las herramientas que más utilizan los estudiantes de Ingeniería son los chats con IA con un 20% y el menor porcentaje de uso corresponde al 3%, que son para convertir textos a audios y las aplicaciones de la IA con varios usos.

Se destaca que los estudiantes de la carrera de Ingeniería Industrial y de sistemas tienen un mayor uso de las herramientas IA, las herramientas que presentan mayor diferencia en el uso con respecto a las otras tres carreras son seis; los chats con IA con el (20%), para redactar texto, resúmenes (18%), herramientas para solucionar problemas de ciencias exactas (17%), para la creación de videos (13%) y herramientas para crear presentaciones y para biblioteca (12%).

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Conclusiones

En este estudio se logró el objetivo de determinar el uso de herramientas de IA dentro del proceso de enseñanza aprendizaje, en estudiantes universitarios, para proponer estrategias, en este sentido, la herramienta con más utilización es el Chat bot con el 42%, dato similar al porcentaje de estudiantes que dice tener experiencia en el uso de las herramientas de IA con el 38.182%, es decir, esa experiencia está sustentada principalmente en el uso de esa herramienta.

Se cuestionó a los participantes por el uso de 18 herramientas de IA, se presentaron diferencias entre las que tienen principal uso en función del programa educativo, sin embargo, las principales fueron los chats con IA, para crear presentaciones, y redactar textos y resúmenes. Por otro lado, el 61.818% expresa poca o nula experiencia en el uso de las herramientas de IA, lo que abre una oportunidad para el establecimiento de estrategias de enseñanza por parte de los docentes que permitan una mayor vinculación con estas herramientas.

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ORIGINAL ARTICLE

Perception of Construction Engineering Students concerning Professional Competencies at a Chilean Private University

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Abstract:
This study examines the development of professional competencies in 21 construction engineering students enrolled at a private university in Chile. Recognizing the growing demand for highly skilled professionals in the construction industry, the research aims to evaluate the students' self-perceived competencies using a 21-item Likert-scale questionnaire. The study focuses on identifying key strengths and areas for improvement in their preparation for the labor market. Results indicate a favorable perception of their abilities, particularly in technical problem-solving, teamwork, and effective communication—competencies considered critical for professional success in the field. The findings underscore the effectiveness of the current curriculum in fostering these competencies while highlighting the need for ongoing enhancement in practical training and leadership development. The main conclusion is that the students demonstrate a solid foundation of professional skills, positioning them well for career challenges, but there is room to strengthen specific areas to align fully with industry demands.

Introduction

The 21st century has brought unprecedented challenges and opportunities for engineering education, driven by rapid technological advancements, globalization, and evolving societal needs. In this context, universities play a pivotal role in shaping professionals capable of addressing complex problems and contributing to sustainable development. The construction engineering field, in particular, requires a blend of technical expertise, innovative thinking, and collaborative skills to tackle issues such as urbanization, climate change, and resource management. To meet these demands, academic programs must integrate cutting-edge knowledge with practical, hands-on training, fostering not only technical, but also transversal competencies such as teamwork, communication, and leadership (de Campos et al., 2020; Caten et al., 2019; Vera, 2023a). These competencies are crucial for bridging the gap between academic preparation and industry expectations, ensuring graduates are ready to thrive in dynamic, multidisciplinary environments.

Despite significant progress in modernizing curricula, questions remain about how effectively engineering education equips students with the professional competencies required for the labor market. Higher Education Institutions (HEIs) must continuously assess and refine their educational strategies to align with industry needs and global standards. This is particularly relevant in Chile, where private universities are gaining prominence in producing skilled construction engineers. By evaluating students' self-perceptions of their competencies, researchers can identify strengths and areas for improvement in current programs, guiding future reforms. This study focuses on understanding these dynamics, using empirical data from construction engineering students to offer insights into educational outcomes and propose actionable recommendations.

Research Questions

1. How do construction engineering students perceive their professional competencies?
2. What specific competencies are most developed among students in this field?
3. Are there significant gaps between perceived competencies and industry demands?
4. How can academic programs be improved to better prepare students for professional challenges?

Engineering education

Fostering problem-solving capabilities and driving innovation (Bakthavatchaalam, 2024) have traditionally formed the cornerstone of engineering education, equipping graduates with the technical skills needed to address complex challenges and develop practical solutions. However, in the evolving context of the 21st century, the scope of engineering education has broadened significantly. Beyond achieving technical proficiency, there is a growing need for engineers to develop a diverse set of competencies. These include critical thinking, effective communication, collaboration within multidisciplinary teams, and the adaptability required to navigate dynamic global industries.

Additionally, engineers must now integrate ethical decision-making and sustainability considerations into their solutions, aligning technological advancements with societal and environmental needs. This shift reflects the growing recognition that innovation must not occur in isolation but address global challenges such as climate change, resource scarcity, and social equity. By embedding ethics and sustainability into engineering education, future professionals are better prepared to develop solutions that are not only effective but also responsible and inclusive. Modern engineering graduates must be equipped with the ability to evaluate the broader impacts of their work, balancing economic, environmental, and societal priorities. This holistic approach ensures they are not only innovators but also well-rounded professionals capable of leading progress in an ever-changing world while fostering a sustainable future for all.

The field of engineering education is constantly evolving as new technologies and methodologies emerge (Veza et al., 2023). This evolution reflects the growing complexity of global challenges and underscores the importance of preparing engineers who can lead interdisciplinary initiatives, contribute to sustainable development, and thrive in dynamic professional environments. Engineers today are expected to address issues that transcend traditional technical boundaries, such as climate change, resource scarcity, and ethical implications of emerging technologies. To meet these demands, engineering education must emphasize not only technical expertise but also critical thinking, creativity, and effective communication skills. Furthermore, engineers must be equipped to collaborate across disciplines, working alongside professionals from diverse fields to develop innovative and sustainable solutions. By fostering adaptability and leadership, academic programs can prepare engineers to navigate the complexities of an interconnected world and play a key role in solving pressing global issues while advancing technological and societal progress.

The significance of engineering education and its curriculum in equipping learners with the skills needed to navigate the complexities of the 21st century and contribute to a sustainable future cannot be overstated (Lamere et al., 2021; Vera, 2023b). A well-structured curriculum extends beyond imparting technical knowledge; it fosters critical thinking, ethical responsibility, and creativity, enabling students to design and manufacture products and processes that emphasize energy efficiency, resource conservation, and social responsibility. Integrating sustainability principles into educational frameworks ensures that students are not only technically competent but also capable of addressing pressing environmental challenges. This holistic approach prepares graduates to innovate solutions that align with global sustainability goals, contributing meaningfully to society and industry. Engineering programs, therefore, serve as catalysts for fostering a new generation of professionals dedicated to driving sustainable development and technological progress worldwide.

More importantly, such a curriculum shapes students into agents of transformative change, equipping them with the ability to critically assess and mitigate the long-term social, economic, and environmental impacts of their professional practices (Kolmos, 2021). This holistic approach develops engineers who excel not only in technical expertise but also in ethical responsibility, sustainability awareness, and global citizenship.

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By fostering interdisciplinary collaboration, problem-solving skills, and critical thinking, engineering education empowers graduates to address real-world challenges effectively. These future professionals are prepared to lead initiatives that drive sustainable development, balancing technological progress with environmental stewardship and societal well-being. Aligning curriculum design with sustainability imperatives ensures the development of resilient, forward-thinking leaders capable of contributing meaningfully to societal progress without compromising the needs of future generations.

Professional Competencies in Engineering

The success of contemporary engineering graduates in their professional roles increasingly hinges on a comprehensive skill set that extends beyond technical expertise (Lowe et al., 2024; Vera, 2023). Professional competencies encompass transferable skills essential for holistic performance at the point of attaining professional registration. These competencies include abilities such as effective communication, teamwork, ethical reasoning, and project management, which are crucial in addressing real-world challenges (Berdanier, 2021; Colman & Willmott, 2016; Vera, 2023a). While there is some variation in how professional competencies are interpreted, they consistently emphasize skills that enable engineers to navigate complex, multidisciplinary environments and adapt to rapidly evolving industry needs. Thus, fostering these skills within engineering education is not just beneficial but essential for preparing graduates to thrive in a competitive global landscape.

Accredited engineering programs globally have incorporated professional competencies into their learning outcomes, reflecting the guidelines set by bodies such as the Washington Accord in 1989. These competencies are now integral to accreditation processes, ensuring that graduates meet minimum international standards for employability and professional practice. However, embedding these skills into curricula requires innovative pedagogical approaches, including problem-based learning, collaborative projects, and experiential education. While progress has been made, gaps remain in aligning academic training with industry demands, especially in fostering leadership and entrepreneurial thinking among engineering students.

Despite the increased emphasis on professional skills within engineering curricula, many employers report that graduates often fall short of expectations in key areas. Research by Byrne et al. (2020) highlights persistent dissatisfaction with graduates' readiness to effectively apply professional skills in the workplace. This gap underscores the need for stronger collaboration between academia and industry to co-design educational experiences that reflect real-world requirements. Practical initiatives such as internships, mentorship programs, and industry-driven projects can act as effective bridges to enhance skill development and workplace readiness. By fostering these partnerships, students gain exposure to real challenges and opportunities to apply their technical and professional competencies. Addressing these gaps is critical for developing a workforce that not only excels in technical proficiency but also demonstrates adaptability, creativity, and leadership—key attributes for success in today's dynamic and competitive engineering profession.

Critical Thinking: A Cornerstone for Technical Competencies in Engineering Education

Critical thinking is an essential competence in engineering education because it empowers students to analyze, evaluate, and systematically solve complex problems. In a field where precision, innovation, and practicality are crucial, critical thinking equips students and professionals with the tools to approach challenges using a structured and evidence-based mindset. This skill enables them to identify root causes of problems, assess available data, explore multiple viable solutions, and make informed decisions that optimize outcomes.

Additionally, critical thinking fosters creativity and adaptability, empowering engineers to navigate the uncertainty and demands of rapidly evolving technologies. This skill enables them to question assumptions, analyze problems from multiple perspectives, and recognize the limitations of existing methods or solutions (Vera & Tejada, 2020). By balancing technical, economic, and ethical considerations, critical thinking ensures engineers make informed and responsible decisions in complex situations. It also encourages a mindset of continuous learning and improvement, essential for addressing challenges in a dynamic, technology-driven world. Engineers equipped with strong critical thinking skills are better prepared to develop innovative, effective, and sustainable solutions that address pressing real-world problems. Moreover, these skills help them anticipate future trends, collaborate effectively in interdisciplinary teams, and lead technological advancements that align with societal needs, ultimately shaping a better, more resilient future for all.

As Adair and Jaeger (2016) highlight, the quality of students' and engineers' thinking, as well as their methods of problem-solving, directly impacts the quality of what they produce. Strong critical thinking skills allow individuals to systematically analyze problems, evaluate alternatives, and implement effective solutions with precision. Beyond improving technical performance, critical thinking fosters creativity by encouraging innovative approaches and novel ideas. Additionally, it promotes adaptability, enabling engineers to navigate challenges in rapidly changing technological and societal landscapes. Ethical decision-making is another critical outcome, ensuring that solutions are not only effective but also responsible and sustainable. These traits—creativity, adaptability, and ethical awareness—are essential for success and leadership in the dynamic, complex, and ever-evolving field of engineering.

According to Waks et al. (2011), the majority of graduates from engineering schools engage in engineering design, which is a central and essential activity in their professional practice. In fact, engineering design involves the creation of new products, processes, or systems to address specific needs or solve complex problems. This process requires the application of engineering-focused thinking, which combines technical knowledge, creativity, and critical analysis to develop innovative and practical solutions. Graduates must integrate multidisciplinary skills, including mathematics, science, and technology, to ensure their designs are functional, efficient, and sustainable. Furthermore, engineering design emphasizes collaboration, as it often involves teamwork and communication with clients, stakeholders, and other professionals. By engaging in design activities, engineers contribute significantly to technological advancements and the development of solutions that meet societal and industrial needs.

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In this context, engineering challenges often involve ambiguity, incomplete data, and multiple possible solutions, requiring students to assess information critically and make informed decisions. By developing critical thinking skills, engineers can approach problems logically, break them into manageable components, and identify patterns or relationships that lead to effective solutions. This competence is particularly valuable in today's fast-paced technological landscape, where engineers must adapt to emerging tools, evolving processes, and interdisciplinary demands. Beyond technical expertise, critical thinking fosters an innovative mindset, enabling graduates to approach problems with creativity and resilience (Adair & Jaeger, 2016; Vera, 2023a). Without this skill, students risk relying on rote learning or predefined methods, limiting their capacity to adapt to real-world complexities. Encouraging critical thinking equips future engineers to question assumptions, explore diverse solutions, and address global challenges with a focus on sustainability and ethical considerations.

Moreover, critical thinking fosters ethical and responsible decision-making—key qualities for modern engineers (Álvarez-Salazar, et., 2024; Lysak, 2022). Engineers often face decisions with significant societal, environmental, and economic implications. Integrating critical thinking into engineering education ensures that students develop a holistic perspective, considering the broader impact of their solutions while balancing risks, benefits, and sustainability. This approach enables future engineers to design systems, technologies, and processes that are not only efficient but also socially responsible and environmentally conscious. As industries demand professionals who can think critically, solve problems creatively, and lead effectively, embedding this competence in engineering curricula equips graduates with the adaptability and leadership needed to drive innovation, meet evolving professional standards, and tackle the complex challenges of the 21st century with confidence and responsibility.

Overview of the Washington Accord

The Washington Accord, established in 1989, is an international agreement that fosters mutual recognition of engineering education programs among its signatory nations. Under the umbrella of the International Engineering Alliance (IEA), the Accord ensures that accredited programs meet a set of internationally benchmarked graduate attributes and educational standards. Its primary aim is to facilitate global mobility for engineering graduates by enabling the recognition of qualifications across borders, thereby supporting international professional practice (International Engineering Alliance, 2014). Initially signed by six countries—Australia, Canada, Ireland, New Zealand, the United Kingdom, and the United States—the Accord has since grown to include 15 signatories, representing over 7,000 accredited programs globally. The agreement emphasizes outcome-based education, where the quality of graduates is measured by their demonstrated competencies rather than merely course content or instructional methods. This shift to outcome-based accreditation has significantly influenced the evolution of engineering education worldwide (Box 1).

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Box 1: *Summary of the Six Most Relevant Characteristics of The Washington Accord*

- *Mutual Recognition:* Facilitates the recognition of accredited undergraduate engineering degree programs among signatory countries, ensuring global credibility.
- *Unified Global Standard:* Establishes consistent quality standards for engineering education across participating nations.
- *Outcomes-Based Education (OBE):* Emphasizes the development of graduates' knowledge, skills, and professional competencies to meet modern engineering demands.
- *Quality Assurance:* Implements rigorous processes to maintain compliance with academic and professional standards.
- *International Mobility:* Enhances opportunities for engineering graduates to practice professionally across signatory regions.
- *Graduate Preparedness:* Ensures graduates possess key competencies such as problem-solving, ethical responsibility, teamwork, and innovative design capabilities to excel in professional practice.

Source: Own elaboration.

As a result, it is regarded as the gold standard for engineering education, promoting consistency in graduate preparation for complex, multidisciplinary challenges. By aligning educational practices with shared graduate attributes, the Accord strengthens the foundation for mutual trust and recognition between countries. Accredited programs under the Accord prepare graduates to address societal and environmental needs, uphold ethical standards, and embrace lifelong learning in response to technological advancements. Furthermore, the Accord has inspired other educational agreements, such as the Sydney and Dublin Accords, which cater to engineering technologists and technicians. Its influence extends beyond signatory nations, offering guidance to aspiring members and fostering collaboration in engineering education. By emphasizing quality and international benchmarking, the Washington Accord ensures the development of engineers equipped to contribute effectively to global innovation and sustainable development.

The Washington Accord is an international agreement that recognizes the substantial equivalence of engineering degree programs accredited by its signatory countries. Each signatory is represented by its respective accrediting body, which ensures that the accredited programs meet rigorous academic and professional standards for engineering education. This mutual recognition facilitates mobility for engineering graduates, enabling them to pursue professional opportunities across member countries.

The table below lists the signatory countries alongside their corresponding accrediting institutions. These institutions play a critical role in maintaining the quality of engineering education and fostering a globally competent workforce. By aligning accreditation standards internationally, the Washington Accord supports collaboration, innovation, and the exchange of engineering talent across borders. This agreement is particularly valuable in an increasingly interconnected world where engineering solutions address global challenges.

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Table 1: Signatory Countries and Their Accrediting Institutions Under the Washington Accord

Country	Accrediting Institution
Australia	Engineers Australia (EA)
Bangladesh	The Institution of Engineers Bangladesh (IEB)
Canada	Engineers Canada (EC)
China	China Association for Science and Technology (CAST)
Chinese Taipei	Institute of Engineering Education Taiwan (IEET)
Costa Rica	Colegio Federado de Ingenieros y de Arquitectos de Costa Rica (CFIA)
Hong Kong China	The Hong Kong Institution of Engineers (HKIE)
India	National Board of Accreditation (NBA)
Indonesia	Indonesian Accreditation Board for Engineering Education (IABEE)
Ireland	Engineers Ireland (EI)
Japan	Japan Accreditation Board for Engineering Education (JABEE)
Korea	Accreditation Board for Engineering Education of Korea (ABEEK)
Malaysia	Board of Engineers Malaysia (BEM)
Mexico	Consejo de Acreditación de la Enseñanza de la Ingeniería (CACEI)
New Zealand	Engineering New Zealand (EngNZ)
Pakistan	Pakistan Engineering Council (PEC)
Peru	Instituto de Calidad y Acreditación de Programas de Computación, Ingeniería y Tecnología (ICACIT)
Philippines	Philippine Technological Council (PTC)
Russia	Association for Engineering Education of Russia (AEER)
Singapore	Institution of Engineers Singapore (IES)
South Africa	Engineering Council South Africa (ECSA)
Sri Lanka	Institution of Engineers Sri Lanka (IESL)
Turkey	Association for Evaluation and Accreditation of Engineering Programs (MÜDEK)
United Kingdom	Engineering Council United Kingdom (ECUK)
United States	Accreditation Board for Engineering and Technology (ABET)

Note: Based on the latest available data from the International Engineering Alliance (2024).

It is important to highlight that the Washington Accord emphasizes the necessity for engineering graduates to develop the ability to navigate complexity and uncertainty in professional practice. Real-world engineering projects are inherently unique, requiring graduates to tackle challenges with a combination of creativity and analytical thinking. A key component of their professional skill set is the ability to solve complex engineering problems, seamlessly integrating technical expertise with innovative approaches. This ensures they can adapt to dynamic environments, address unprecedented challenges, and contribute effectively to advancing modern engineering solutions.

Chile's Status within the Washington Accord

Chile, represented by the Agencia Acreditadora Colegio de Ingenieros de Chile S.A. (ACREDITA CI), currently holds Provisional Signatory status within the Washington Accord. This status, approved in 2018, signifies that Chile has established appropriate systems and processes for accrediting engineering degree programs but has not yet achieved full recognition. As a Provisional Signatory, Chile's accreditation framework and quality assurance mechanisms are recognized as being on the right path toward alignment with the Washington Accord's rigorous standards. However, this status implies that Chile is still in the process of demonstrating substantial equivalence with the educational standards upheld by full signatories.

To progress to full signatory status, Chile must continue refining its accreditation processes, ensuring they consistently meet the Accord's requirements. This involves rigorous evaluation, peer reviews, and periodic assessments to verify that engineering programs produce graduates equipped with outcomes-based education, aligning with global engineering education standards. Achieving full status would enhance the international recognition of Chilean engineering graduates, facilitating professional mobility and fostering trust in the quality of engineering education in the country.

Engineering Education in Chile: A Critical Perspective

Engineering education in Chile has undergone significant reforms over the past decades to align with global trends and address the growing demand for skilled professionals. One of the central features of these reforms has been the incorporation of generic competencies, such as teamwork, communication, critical thinking, and ethical reasoning, into undergraduate curricula. However, these competencies are often introduced as standalone courses or workshops, disconnected from the technical and disciplinary-specific learning outcomes of engineering programs. This siloed approach results in fragmented learning experiences where students struggle to see the relevance of generic skills in their professional practice (Vera, 2023b; Vera, 2024). Consequently, while graduates may formally meet academic requirements, their ability to integrate and apply these competencies within complex, real-world engineering scenarios often falls short of industry expectations.

Traditionally, curriculum development in HEIs has often been characterized by a siloed approach, where individual departments or faculties operate independently with minimal collaboration (Kirwan et al., 2022; Vera & García-Martínez, 2022). This fragmented structure can lead to a range of inefficiencies, particularly when it comes to the design and implementation of learning resources. A lack of coordination across departments frequently results in the unnecessary duplication of course content and curricula, causing significant waste of time, effort, and institutional resources. Moreover, this disconnected approach contributes to inconsistencies in learning and teaching methods, learning outcomes, and the overall student experience, as each silo may interpret standards and objectives differently.

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Inefficiencies in higher education curricula often arise due to poorly designed or outdated learning resources, which fail to meet the evolving needs of students and industries. For instance, textbooks and materials that lack alignment with current technological advancements or professional practices leave students underprepared for real-world challenges. Similarly, learning platforms or digital tools may be introduced without proper training for faculty, leading to inconsistent or ineffective implementation. In some cases, generic resources are reused across courses without tailoring them to specific learning outcomes, diminishing their relevance and impact. Additionally, there are instances where traditional lectures dominate the curriculum while active, engaging learning resources—such as simulations, case studies, or interactive tools—are overlooked. These gaps limit students' ability to develop critical thinking, problem-solving, and hands-on skills, which are essential for success in today's rapidly changing professional environments.

To address these challenges, a more integrated and collaborative approach to curriculum development is essential. By fostering cross-departmental communication and cooperation, institutions can streamline resource development, eliminate redundancy, and establish standardized teaching practices. This not only ensures greater alignment across programs but also enhances the quality of education, promotes innovation, and supports more efficient use of institutional resources. Ultimately, breaking down silos can lead to a more cohesive, student-centered learning environment that prepares graduates to meet the demands of an increasingly interconnected and interdisciplinary professional world.

The siloed approach in Chilean engineering education limits its effectiveness by isolating technical knowledge from broader, interdisciplinary contexts. This fragmentation prevents students from developing a holistic understanding of real-world problems and essential skills like critical thinking, creativity, and teamwork—key demands of modern industries. The disconnection between theory and practice further exacerbates the issue, as students lack exposure to hands-on projects or problem-solving scenarios that integrate multiple disciplines. To address this, curricula must shift toward interdisciplinary learning, teamwork, and practical applications. Breaking down these silos will enable Chile's engineering education to better prepare students to tackle global challenges, drive innovation, and meet industry expectations for well-rounded, adaptable professionals.

By treating generic competencies—such as teamwork, communication, and critical thinking—as separate from technical knowledge, IES inadvertently perpetuate a fragmented learning process, as illustrated in Figure 1. This compartmentalization reinforces a mindset that limits the integration of these essential skills into real-world engineering challenges. As a result, students often struggle to apply their knowledge in practical, interdisciplinary settings, which are increasingly critical in today's professional landscape. This disconnect weakens the alignment between academic preparation and industry demands, leaving graduates underprepared to meet the multifaceted requirements of the engineering profession. A more integrated approach would better support the holistic development of engineers by blending technical expertise with core competencies, ensuring graduates are adaptable, innovative, and equipped to address complex global challenges.

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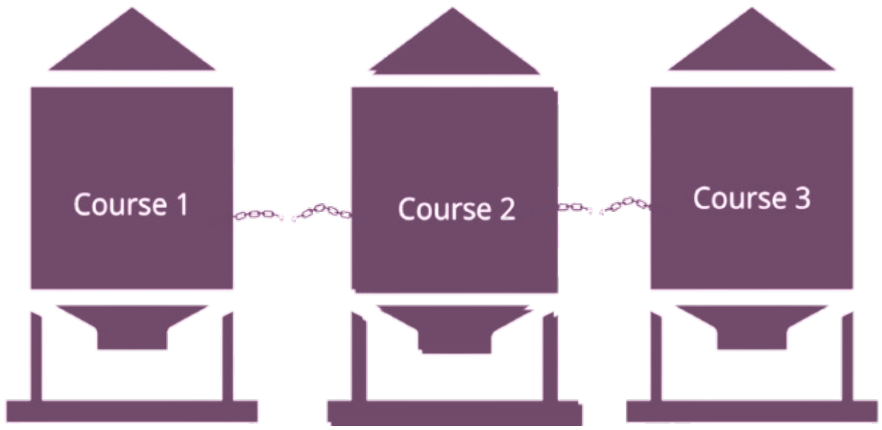
Figure 1: *Academic silos*



Source: Own elaboration.

Building on this perspective, Vera (2022) argues for a paradigm shift toward an integrated curriculum, where generic and specific competencies are developed concurrently through project-based learning, interdisciplinary collaboration, and problem-solving activities. Such an approach not only enhances technical expertise but also cultivates critical skills such as communication, teamwork, and adaptability. By merging academic rigor with real-world applications, this model bridges the gap between academic training and industry needs. It prepares engineers who are not only technically proficient but also capable of addressing complex societal challenges. Furthermore, Vera (2022) emphasizes that this educational shift aligns with the evolving demands of the global workforce, where engineers must navigate diverse, multidisciplinary contexts. The integration of soft skills, such as communication, teamwork, and problem-solving, with technical expertise ensures that graduates become well-rounded professionals. This combination allows them to drive innovation and implement sustainable solutions in an increasingly interconnected and complex world.

According to Plaza Gálvez et al. (2023) and Vera (2022), engineers are no longer confined to technical roles; they are now expected to actively engage in decision-making processes, adapt to rapidly emerging technologies, and address complex global challenges, including environmental sustainability and social equity. This shift highlights the need for engineers to balance technical expertise with essential professional competencies such as leadership, critical thinking, adaptability, and effective communication. As industries and societies evolve, engineering education must respond by preparing graduates to be not only problem solvers, but also ethical innovators and leaders capable of driving change. By integrating interdisciplinary learning, real-world applications, and collaboration with industry, academic programs can equip engineers with the skills necessary to thrive in a dynamic global landscape. This approach ensures engineers contribute meaningfully to sustainable development while creating lasting, positive impacts in an increasingly interconnected world.

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As you can see, the siloed approach limits the ability of engineering education to produce graduates who can seamlessly integrate theoretical knowledge with practical application. By addressing only isolated competencies, students are deprived of opportunities to develop critical skills like interdisciplinary thinking and adaptability, which are essential in solving real-world engineering challenges. As Vera (2022) emphasizes, bridging this gap requires a concerted effort to transform curricula into cohesive learning pathways. IES in Chile must prioritize curricular reforms that embrace integrative learning experiences, combining technical and generic competencies within authentic, industry-relevant contexts. For example, implementing capstone projects, internships, and collaborative problem-solving workshops could facilitate the development of a well-rounded skill set. Such changes would not only improve the quality of engineering education but also enhance graduates' readiness to meet the dynamic demands of the labor market, ensuring that they contribute meaningfully to societal and professional advancement.

Materials and Methods

This study is grounded in a positivist paradigm and adopts a strictly quantitative methodology (Johnson et al., 2007). A non-experimental, cross-sectional design was selected for this research (Green et al., 2006), providing a descriptive focus aimed at detailing the phenomena under investigation without manipulating any variables. By employing a field design, the study collects data directly from participants within their natural environments, ensuring real-world applicability and relevance. This approach allows researchers to observe and measure variables as they naturally occur, enhancing the validity of the findings. The non-experimental nature of the study eliminates potential bias arising from controlled conditions while enabling an accurate snapshot of the current state of the phenomenon. Such a methodological framework ensures that the study's results are reliable, offering valuable insights grounded in objective and measurable data.

The research was conducted at a private university in Chile, recognized for its national presence and its bachelor's program in Construction Engineering. This higher education institution (HEI) was selected due to its accessibility and its capacity to provide valuable insights into the educational experiences of engineering students. The institution's reputation for fostering a strong academic environment further supported its inclusion in the study. Data collection occurred during the academic semester - a period chosen to ensure optimal participant engagement while minimizing disruptions to their routine activities.

Participants

The study involved a total of 21 students enrolled in the construction engineering program at a private Chilean university. Of these participants, 15 were men, representing 71% of the sample, while 6 were women, accounting for the remaining 29%. The students had an average age of 23 years, reflecting a relatively young cohort typical of undergraduate programs in the region. The composition of the group highlights the gender disparity often observed in engineering disciplines, offering an opportunity to analyze potential differences in experiences or perspectives between male and female students within this academic context.

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Instrument

Data were collected using a self-administered online questionnaire consisting of two sections. The first section included 21 Likert-scale items focused on professional competencies (Table 1), rated on a scale of 1 to 5 (1 = Not developed at all, 5 = Fully developed). The second section contained six closed-ended items addressing sociodemographic information to provide participant context. This instrument is part of an international collaborative research project conducted across Latin America, coordinated by the International Network of Researchers in Education (REDIIE). The instrument was designed to assess participants' self-perceived professional competency development while providing insights to enhance educational practices. By combining quantitative measures with demographic data, the instrument delivers a comprehensive understanding of competencies and participant characteristics, supporting robust data analysis and facilitating international comparisons across educational contexts.

It is important to note that, to ensure the validity and reliability of the instrument, it was submitted to a panel of experts for evaluation. This step is essential in the development of research tools, as expert review helps assess the clarity, relevance, and adequacy of the items included. The panel consisted of professionals with expertise in areas such as artificial intelligence (AI), nursing education, instrument design, and quantitative research methods. Each expert was tasked with reviewing the instrument to determine whether the items accurately measured the intended dimensions: Impact on Learning, Institutional Benefits, and Social Concerns.

The panel evaluated the instrument on several criteria, including **content validity**, item clarity, and relevance to the research objectives. Feedback provided by the experts was carefully analyzed and incorporated into the final version of the questionnaire. Recommendations typically involved rephrasing items for better clarity, ensuring that the wording was unambiguous and accessible to the target audience—nursing students. Additionally, the panel assessed the alignment between the questions and the study's conceptual framework to ensure the instrument comprehensively captured students' perceptions of AI in education.

The table below presents a comprehensive list of questionnaire items designed to evaluate professional competencies among engineering students and professionals. These 21 items focus on essential skills and attributes required for success in modern engineering practice. They address both technical and non-technical competencies, including knowledge of the profession, problem-solving, teamwork, and communication. Additionally, the items emphasize critical aspects such as ethical awareness, sustainable development, adaptability to challenges, and diversity and inclusion. By examining these competencies, the questionnaire seeks to assess how well engineering education prepares individuals to meet current and future demands. This evaluation not only highlights key areas of strength but also identifies opportunities for improvement in fostering well-rounded, innovative, and socially responsible engineers equipped for a dynamic global workforce.

Table 1: *Questionnaire Items addressing Professional Competencies in Engineering*

Questionnaire items
1. Knowledge of the profession
2. Research skills
3. Management and organizational skills
4. Oral and written communication skills
5. Decision-making skills
6. Communication in English
7. Use of advanced technological tools
8. Interpersonal skills
9. Teamwork skills
10. Participation in social projects
11. Problem-solving skills
12. Lifelong learning
13. Commitment to diversity and inclusion
14. Ethical awareness and social responsibility
15. Ability to work in multidisciplinary teams
16. Commitment to sustainable development
17. Commitment to quality
18. Critical thinking
19. Adaptability to new challenges and environments
20. Creativity and innovation
21. Uncertainty management skills

Source: Own elaboration.

Data analysis was conducted using JASP—formally known as Jeffrey's Amazing Statistics Program—a free and open-source statistical software package that offers a wide range of standard and advanced statistical techniques (JASP Team, 2023). Descriptive statistical methods were employed to summarize and interpret the data, providing a clear overview of key trends and patterns observed among the participants. Measures such as frequencies, percentages, means, and standard deviations were used to illustrate the distribution of responses and highlight significant findings. To ensure confidentiality and ethical compliance, results were presented in aggregated form, safeguarding participant anonymity. This methodological approach offers a reliable foundation for examining critical aspects of engineering education within the context of a private Chilean university. By leveraging detailed descriptive analysis, the study delivers valuable insights that contribute to understanding and improving educational practices.

The table below presents the descriptive statistics for the 21 Likert-scale items focused on professional competencies assessed in the study. The table includes measures such as valid responses, mode, mean, standard deviation, minimum, and maximum values for each competency. These statistical indicators provide a clear overview of participants' self-perceived development across various professional skills.

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Table 2: *Descriptive Statistics*

	Valid	Mode	Mean	Std. Deviation	Minimum	Maximum
1. Knowledge of the profession	21	4.000 [a]	3.762	0.625	3.000	5.000
2. Research skills	21	4.000 [a]	4.000	0.837	2.000	5.000
3. Management and organizational skills	21	4.000 [a]	4.000	0.707	2.000	5.000
4. Oral and written communication skills	21	4.000 [a]	3.810	0.928	2.000	5.000
5. Decision-making skills	21	4.000 [a]	4.095	0.700	3.000	5.000
6. Communication in English	21	2.000 [a]	2.810	1.209	1.000	5.000
7. Use of advanced technological tools	21	4.000 [a]	3.857	1.153	1.000	5.000
8. Interpersonal skills	21	4.000 [a]	4.048	0.973	2.000	5.000
9. Teamwork skills	21	4.000 [a]	4.190	0.928	2.000	5.000
10. Participation in social projects	21	5.000 [a]	3.571	1.399	1.000	5.000
11. Problem-solving skills	21	4.000 [a]	4.190	0.750	3.000	5.000
12. Lifelong learning	21	4.000 [a]	4.286	0.717	3.000	5.000
13. Commitment to diversity and inclusion	21	5.000 [a]	4.714	0.463	4.000	5.000
14. Ethical awareness and social responsibility	21	5.000 [a]	4.714	0.463	4.000	5.000
15. Ability to work in multidisciplinary teams	21	5.000 [a]	4.429	0.811	3.000	5.000
16. Commitment to sustainable development	21	5.000 [a]	4.429	0.746	3.000	5.000
17. Commitment to quality	21	5.000 [a]	4.619	0.590	3.000	5.000
18. Critical thinking	21	4.000 [a]	4.095	0.944	2.000	5.000
19. Adaptability to new challenges and environments	22	5.000 [a]	7.136	0.294	2.000	5.000
20. Creativity and innovation	21	4.000 [a]	3.905	0.700	3.000	5.000
21. Uncertainty management skills	21	4.000 [a]	3.571	0.926	2.000	5.000

[a] The mode is computed assuming that variables are discreet.

The mode identifies the most frequently reported score, while the mean reflects the average response for each item. The standard deviation highlights the variability of responses, indicating how consistently participants rated each competency. Together, these measures offer insights into the strengths and areas for improvement among the surveyed participants, contributing to a better understanding of their professional competency levels. The analysis supports the identification of key trends and patterns relevant to engineering education

Reliability of the Instrument

To evaluate the internal consistency of the instrument, Cronbach's Alpha coefficient was calculated. The analysis yielded a Cronbach’s Alpha value of 0.92 for the 21 items included in the instrument. This result indicates excellent reliability, as values above 0.9 are generally considered to demonstrate a very high level of consistency among the items (Table 3).

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Table 3: *Cronbach's Alpha*

Cronbach's Alpha	Number of Items
0.92	21

A Cronbach's Alpha of 0.92 suggests that the instrument effectively measures the intended construct with minimal measurement error. The high reliability ensures that the responses obtained are consistent and reliable, providing confidence in the quality of the data collected. As a result, the instrument can be considered robust for use in further analysis and research applications.

Key Observations

Highest-Performing Competencies

- *Commitment to diversity and inclusion* (Mean = 4.714, SD = 0.463).
- *Ethical awareness and social responsibility* (Mean = 4.714, SD = 0.463).
- *Commitment to quality* (Mean = 4.619, SD = 0.590).

These competencies show the highest average ratings, with relatively low standard deviations, suggesting strong consensus and high development among participants. These results highlight the students' strong ethical values and commitment to quality and inclusion—key components in modern professional and sustainable engineering practices.

Lowest-Performing Competency

- *Communication in English* (Mean = 2.810, SD = 1.209).

This competency received the lowest score and showed a large variability (SD = 1.209), indicating inconsistencies in participants' skills. It reflects a significant area for improvement, particularly given the importance of English proficiency in global engineering contexts.

High Variability

- *Participation in social projects* (Mean = 3.571, SD = 1.399).
- *Use of advanced technological tools* (Mean = 3.857, SD = 1.153).

These competencies show higher standard deviations, suggesting diverse levels of experience or skill development among participants. This variability might be due to differences in exposure to social initiatives or advanced technologies.

Anomaly in Adaptability

- *Adaptability to new challenges and environments* (Mean = 7.136, SD = 14.294).

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The reported mean and standard deviation for this item appear highly inflated and inconsistent with the scoring range of 1 to 5. This could indicate a data entry error or a calculation issue that needs further verification.

Strong Core Competencies

Competencies such as *Teamwork skills* (Mean = 4.190, SD = 0.928) and *Problem-solving skills* (Mean = 4.190, SD = 0.750) received consistently high scores with moderate standard deviations, reinforcing their importance as foundational skills in engineering education.

Based on these results, the following action lines are proposed to improve or reinforce key areas:

1. **Enhance Communication in English**
   - Implement mandatory English language training programs tailored to professional contexts, such as technical writing and presentations.
   - Integrate bilingual learning resources and encourage participation in international collaborations or exchange programs.
2. **Strengthen Research Skills**
   - Incorporate project-based learning and research-oriented courses into the curriculum to promote hands-on experience.
   - Offer workshops on research methodologies, academic writing, and the use of advanced research tools.
3. **Promote Creativity and Innovation**
   - Encourage interdisciplinary projects that challenge students to find innovative solutions to real-world problems.
   - Establish innovation hubs or laboratories where students can prototype ideas and collaborate with industry mentors.
4. **Reinforce Problem-Solving and Critical Thinking**
   - Use case studies, simulations, and active learning strategies to develop critical thinking and problem-solving skills.
   - Integrate scenarios requiring ethical decision-making and resource optimization to mimic professional challenges.
5. **Foster Sustainable Development and Social Responsibility**
   - Align course content with the UN Sustainable Development Goals (SDGs).
   - Promote service-learning projects and social initiatives that emphasize diversity, inclusion, and environmental awareness.
6. **Improve Adaptability and Technological Proficiency**
   - Update curricula to include training in advanced technological tools, artificial intelligence, and digital innovation.
   - Encourage adaptability by exposing students to emerging technologies and multidisciplinary team projects.

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These action lines aim to address areas requiring reinforcement while supporting the holistic development of students to meet global professional and societal demands.

Discussion

The findings of this study offer critical insights into the perceived professional competencies of construction engineering students at a Chilean private university. Overall, the results demonstrate that students exhibit strengths in key areas such as teamwork, problem-solving, ethical awareness, and commitment to diversity and inclusion. These findings align with existing literature emphasizing the importance of these competencies for professional success in engineering (Berdanier, 2021; Vera, 2023a). However, the study also reveals gaps in areas like communication in English, advanced technological tools, and participation in social projects, highlighting opportunities for targeted improvements.

The high ratings for teamwork skills and problem-solving abilities confirm the effectiveness of the current curriculum in fostering foundational engineering competencies. These skills are integral to professional practice, where engineers frequently collaborate on multidisciplinary teams to solve complex, real-world challenges (Lowe et al., 2024). Similarly, the strong ratings for ethical awareness and commitment to quality reflect the institution's success in instilling values essential for sustainable and responsible engineering practices.

In contrast, the low scores for communication in English underscore a significant challenge. Given the globalized nature of the construction industry, English proficiency is critical for professional communication, international collaboration, and access to cutting-edge research. This finding aligns with prior research suggesting that language barriers can limit the global competitiveness of engineering graduates (Veza et al., 2023). Institutions must address this gap by integrating technical English courses, encouraging participation in international exchange programs, and incorporating bilingual teaching materials.

Furthermore, the variability observed in technological tools and social project participation suggests unequal access or exposure to these learning opportunities. This disparity could stem from inconsistencies in the curriculum or resource allocation. To bridge this gap, academic programs should prioritize the use of advanced digital tools and promote community-based initiatives that connect students with real-world social challenges, fostering civic engagement and practical experience.

In light of these findings, a more integrated, student-centered approach to curriculum design is necessary. Active learning strategies, such as project-based learning, internships, and collaborative industry projects, can provide students with opportunities to apply their technical and professional skills in realistic settings. Moreover, aligning curriculum content with sustainability goals and emerging technologies will better prepare graduates to meet industry demands.

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Ultimately, this study underscores the importance of continuous assessment and improvement of engineering programs to ensure they equip students with the competencies needed for success in a dynamic global landscape. By addressing identified gaps and building on existing strengths, institutions can foster a new generation of engineers capable of driving innovation, ethical leadership, and sustainable development.

Conclusion

This study aimed to assess the perceived professional competencies of construction engineering students, identify the most developed competencies, analyze gaps between student perceptions and industry demands, and propose improvements to academic programs. The main findings of this study are presented below:

- **Perceptions of Professional Competencies:** The results demonstrate that students generally perceive their professional competencies as well-developed, particularly in areas related to teamwork, problem-solving, and ethical awareness. These competencies align with the foundational skills expected in the engineering profession and reflect strengths within the current academic framework.

- **Most Developed Competencies***:* Key strengths identified include *commitment to diversity and inclusion*, *ethical awareness and social responsibility*, and *commitment to quality*, all of which scored highly with minimal variability. These findings highlight the program's success in fostering values essential for ethical and sustainable engineering practices, which are increasingly critical in the global job market.

- **Gaps in Competencies:** Despite these strengths, significant gaps remain in *communication in English*, which received the lowest scores with notable variability. Given the globalized nature of the construction industry, English proficiency is vital for professional communication and collaboration. Additionally, variability in skills such as *advanced technological tools* and *participation in social projects* indicates unequal exposure and preparedness among students.

Enhancing Construction Engineering Programs

To improve the current construction engineering program, **English proficiency** should be prioritized as a key competency for global employability. Integrating specialized English courses within the curriculum will enhance students' technical writing, oral communication, and ability to comprehend industry-specific terminology. Practical applications, such as delivering project presentations, drafting reports, and collaborating on international case studies, will ensure students are better prepared to engage in a globalized construction industry where English is a dominant language.

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Additionally, programs must **promote advanced technological skills** by incorporating hands-on training in emerging tools like Artificial Intelligence (AI) and Building Information Modeling (BIM). Providing students with access to industry-standard software and encouraging the application of such technologies in real-world scenarios will bridge the gap between academia and professional practice. This approach ensures graduates are equipped to address modern construction

Final Reflection

The study highlights the strong professional and ethical competencies of construction engineering students, underscoring their preparedness in critical areas such as teamwork, problem-solving, and ethical responsibility. However, the identified gaps, particularly in English proficiency, technological skill application, and social engagement, must be addressed to achieve better alignment with industry demands. Academic programs should integrate targeted language training, hands-on technological experience, and opportunities for community-based projects to bridge these gaps. Enhancing students' exposure to emerging industry trends and tools, such as digital modeling and artificial intelligence, will further strengthen their professional readiness.

Additionally, fostering stronger collaboration between universities and industry stakeholders is essential to ensure that educational programs remain relevant, adaptable, and aligned with evolving professional challenges. This partnership allows for the integration of real-world experiences into the curriculum, such as internships, mentorship programs, and industry-driven projects. These initiatives help students develop practical skills, adaptability, and problem-solving abilities that are highly valued in today's globalized workforce. Furthermore, involving industry experts in program design ensures that graduates are equipped with up-to-date knowledge of emerging technologies, sustainable practices, and market demands. By prioritizing these improvements, higher education institutions can produce highly skilled, innovative, and adaptable graduates who are prepared to thrive in competitive professional environments. This approach not only enhances graduate employability but also ensures meaningful contributions to the engineering profession and broader societal progress.

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ARTÍCULO ORIGINAL

Análisis de la Coordinación Motriz y Agilidad del Alumnado de Educación Secundaria

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Resumen

El presente estudio analiza la coordinación y agilidad motriz de estudiantes de Educación Secundaria para identificar y atender las dificultades motrices en el ámbito educativo. Se evaluaron 80 estudiantes, con edades entre 12 y 16 años (40 de sexo masculino y 40 de sexo femenino, de 1.º y 4.º de ESO), utilizando el test Motor SportComp como herramienta de medición. Los resultados evidencian diferencias significativas en función del género, observándose que el sexo femenino obtiene puntuaciones inferiores en comparación con el masculino. No se encontraron diferencias significativas en los resultados entre los diferentes niveles educativos. Además, se identificó que los/las estudiantes que realizan actividad física de manera regular presentan un mejor desempeño en las pruebas de coordinación y agilidad motriz que aquellos que no practican actividad física, con diferencias estadísticamente significativas. Estos hallazgos subrayan la relevancia de promover la actividad física en el contexto escolar, particularmente para mejorar la coordinación motriz. El estudio aporta evidencias que pueden ser útiles para diseñar estrategias de intervención orientadas a reducir las dificultades motrices en estudiantes, especialmente entre las mujeres, y destaca la necesidad de abordar estas diferencias para contribuir al desarrollo integral de habilidades físicas en Educación Física.

Analysis of Motor Coordination and Agility in Secondary School Students

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Abstract

The present study analyzes the motor coordination and agility of Secondary Education students to identify and address motor difficulties in the educational field. Eighty students, aged between 12 and 16 years (40 males and 40 females, from 1st and 4th grade of ESO), were evaluated using the Motor SportComp test as a measurement tool. The results show significant gender differences, with females scoring lower compared to males. No significant differences were found in the results across different educational levels. Additionally, it was identified that students who engage in physical activity regularly perform better in motor coordination and agility tests than those who do not, with statistically significant differences. These findings underscore the importance of promoting physical activity in the school context, particularly to enhance motor coordination. The study provides evidence that may be useful for designing intervention strategies aimed at reducing motor difficulties in students, especially among females, and highlights the need to address these differences to contribute to the comprehensive development of physical skills in Physical Education.

Introducción

La actividad motora es esencial para la supervivencia humana (Schmidt *et al*., 2018), y dentro de ella destacan las habilidades, entendidas como interacciones eficientes entre el aparato locomotor, el sistema nervioso y los sentidos, que permiten ejecutar movimientos precisos y rápidos en respuesta al entorno (Kiphard, 1976). Estas habilidades se desarrollan de manera progresiva, comenzando por las más básicas y avanzando hacia las complejas (Ávalos-Ramos y Vega-Ramírez, 2020; Schmidt et al., 2018). Sin embargo, en las primeras etapas, surgen preocupaciones crecientes sobre el desarrollo motor en coordinación y agilidad.

La coordinación motriz ha sido descrita de diferentes maneras a lo largo del tiempo. Castañer y Camerino (1990) y Grosser *et al.* (1991), la definen como un “conjunto de capacidades que organizan y regulan los procesos de movimiento en función de un objetivo motor”. Para un análisis adecuado de la coordinación motriz, Hirtz *et al.* (1982) destacan la importancia de componentes como el equilibrio, la diferenciación kinestésica, la orientación espacial y el ritmo.

La agilidad, por su parte, es fundamental en el rendimiento motriz, definida como la habilidad de cambiar de dirección rápidamente según el desplazamiento (Sheppard et al., 2006), integrando otros elementos como la fuerza, la velocidad y la coordinación (Bidaurrazaga-Letona *et al.,* 2015). Estos aspectos son clave en el ámbito educativo, donde constituyen la base de la competencia motriz, que se refiere a la capacidad de ejecutar movimientos complejos de forma eficaz en distintos contextos (Ruiz-Pérez *et al*., 2015). La competencia motriz se desarrolla gradualmente desde edades tempranas y abarca dimensiones

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perceptivo-cognitivas, motrices, afectivas y sociales que interactúan con el entorno a lo largo de la etapa escolar (Ruiz-Pérez, 1994).

En el contexto escolar, se observan estudiantes con deficiencias motrices caracterizadas por una falta de coordinación y agilidad, lo que dificulta su ejecución en actividades físicas (Vidarte-Claros *et al*., 2018). Estos problemas, aunque no siempre se manifiestan con claridad, pueden persistir si no se abordan adecuadamente, lo que resalta la importancia de identificarlos y valorarlos (Ruiz-Pérez *et al*., 2007). No obstante, la identificación y atención a estas dificultades pueden verse afectadas por el prejuicio de que el desarrollo motor mejorará naturalmente con la madurez (Ruiz-Pérez, 2005). Diversos estudios sugieren que los problemas de coordinación no son transitorios, sino que pueden perdurar hasta la adolescencia y la adultez (Geuze y Börger, 1993; Knight *et al*., 1992).

La falta de competencia motriz no solo afecta el rendimiento físico, sino que también impacta en el bienestar emocional del estudiante. Aquellos con dificultades en la coordinación y agilidad pueden ser objeto de burlas o exclusión social, lo que contribuye a una baja percepción de competencia y altos niveles de ansiedad (Causgrove y Watkinson, 1994; Ruiz-Pérez, 1995). Esta baja percepción se asocia a una disminución de la práctica física y un incremento del sedentarismo, tendencias observadas en los adolescentes actuales (Escribano et al., 2017; Saakslahti *et al.,* 1999), lo cual, a su vez, afecta la condición física y aumenta los problemas de coordinación (Cairney, 2015).

Investigaciones en adolescentes evidencian la relación entre la falta de habilidades motrices y una baja autoeficacia percibida, lo que contribuye a la desmotivación y al abandono de la práctica física (Arruza *et al.,* 2011; García-Canto *et al*., 2013). El contexto escolar ofrece un espacio óptimo para abordar estas dificultades, pero los estudios dedicados a evaluar la competencia motriz en educación secundaria, específicamente en España, aún son limitados (Katic *et al*., 2013; Yanci y Los Arcos, 2015).

Por tanto, el presente estudio tiene como objetivo evaluar la coordinación y agilidad en estudiantes de educación secundaria de la provincia de Alicante, en España, analizando diferencias de género, curso y práctica deportiva extraescolar. Este enfoque permitirá identificar necesidades específicas para implementar estrategias efectivas que promuevan el desarrollo motriz y el bienestar integral de los estudiantes, contribuyendo así a una educación física inclusiva y de calidad.

Método

La metodología del estudio se estructura en un enfoque cuantitativo, exploratorio, descriptivo e inferencial, orientado al análisis de la coordinación y agilidad motriz en estudiantes de educación secundaria.

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Participantes

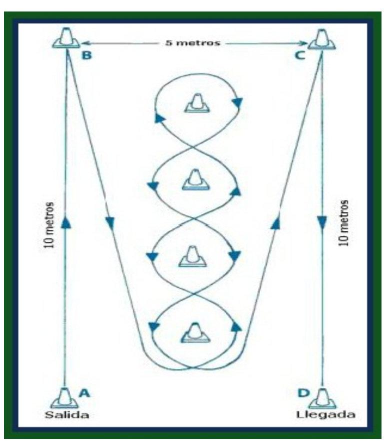
La muestra del estudio consistió en un total de 80 estudiantes, con una distribución equitativa de género (40 varones y 40 mujeres), pertenecientes a distintos niveles de la Educación Secundaria Obligatoria (ESO), y cuyas edades oscilaban entre los 12 y los 16 años. Las/los participantes se agruparon en cuatro conjuntos de trabajo, cada uno de ellos correspondiente a un curso específico de la ESO (1º, 2º, 3º y 4º), permitiendo así una representatividad equilibrada de todas las etapas de esta etapa educativa. Cada grupo recibió la misma batería de pruebas de evaluación de la coordinación motriz, garantizando la homogeneidad en el procedimiento de aplicación y en las condiciones de testaje.

Los sujetos de la muestra fueron seleccionados del Instituto de Educación Secundaria, un centro educativo ubicado en la provincia de Alicante en España. La elección de esta institución se realizó bajo criterios de conveniencia y accesibilidad, permitiendo evaluar a estudiantes en su entorno habitual y bajo las mismas condiciones de desarrollo escolar. Esta selección busca ofrecer un enfoque preciso sobre las habilidades de coordinación motriz en población adolescente, con datos que podrían contribuir a intervenciones específicas en el contexto educativo español.

Instrumentos

El instrumento seleccionado para la evaluación de la coordinación motriz y agilidad de los estudiantes fue el test Motor SportComp, desarrollado por Ruiz-Pérez *et al*. (2017), el cual se compone de cinco pruebas orientadas a medir distintos aspectos de la motricidad. En esta investigación, se seleccionaron únicamente aquellas pruebas que permitían una medición basada en la variable tiempo: carrera de 7 metros a pies juntos, carrera de 7 metros a la pata coja, carrera de 9 metros de ida y vuelta, y desplazamiento sobre soportes. Adicionalmente, se incluyó el “Test Illinois”, un instrumento reconocido que también permite la evaluación de la coordinación motriz y agilidad a través del tiempo requerido para completarlo, aportando una medida complementaria y robusta a la batería de pruebas (Figura 1).

Figura 1: *Test Illinois*



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Procedimiento

Tras organizar adecuadamente la muestra y preparar los instrumentos de medición, se procedió a contactar con el departamento de Educación Física y el director del centro para explicar el objetivo de esta investigación y obtener el consentimiento necesario para llevarla a cabo. Una vez aprobado el proyecto, se acudió al centro en las fechas previamente acordadas, donde se configuraron los recorridos de cada prueba con el material requerido. Antes de iniciar las evaluaciones, se registraron el género y curso de los/las participantes, además de indagar sobre su participación en actividades físicas extracurriculares.

Las/los estudiantes se distribuyeron en grupos de diez para la realización de cada una de las cinco pruebas de coordinación y agilidad, asegurando un descanso de cinco minutos entre cada prueba para evitar efectos de fatiga en los resultados. Las pruebas incluían:

1. **Carrera de 7 metros a pies juntos**: desplazamiento mediante saltos con ambos pies juntos en el menor tiempo posible.
2. **Carrera de 7 metros a la pata coja**: salto con una sola pierna, cubriendo una distancia de 7 metros.
3. **Carrera de 9 metros de ida-vuelta**: con dos relevos, el participante debe trasladarlos de una línea de salida a una línea opuesta situada a 9 metros.
4. **Desplazamiento sobre soportes**: desplazamiento de 3 metros sobre dos soportes en el menor tiempo.
5. **Test Illinois**: circuito con sprint, cambios de dirección y recorrido en zig-zag.

Cada participante disponía de un solo intento, registrándose el tiempo en segundos y décimas mediante cronómetro. Para el análisis de datos se utilizó el software estadístico IBM SPSS, aplicando pruebas T-Student y ANOVA para la comparación de medias entre cursos, con un nivel de significancia establecido en $p < 0,005$.

Resultados

Tras la obtención de los resultados de las diversas pruebas, se procedió a un análisis exhaustivo, clasificando y evaluando los datos en función de tres variables principales: género, nivel de curso académico y participación en actividades deportivas extracurriculares. Esta categorización permitió una interpretación detallada y comparativa de los patrones de desempeño.

Resultados por Género

En la Tabla 1 se presentan los resultados de las pruebas de coordinación motriz de pies juntos (PJ) y pata coja (PC), observándose patrones de rendimiento similares en ambas. En términos generales, los valores obtenidos oscilan entre niveles bajos y medios. Los hombres alcanzaron tiempos más rápidos, con un rango de 2,5 a 3,9 segundos en PJ y de 2,1 a 3,5 segundos en PC. En contraste, las mujeres mostraron tiempos intermedios y altos, con un rango de 3,0 a 5,4 segundos en PJ y de 2,6 a 5,0 segundos en PC.

Las pruebas estadísticas indican diferencias significativas entre géneros en ambas pruebas, tanto en PJ (t = -4,454, *p* = 0,001) como en PC (t = -3,484, *p* = 0,001), sugiriendo una ventaja relativa en el rendimiento masculino para estas habilidades específicas.

Tabla 1: *Resultados por género pruebas pies juntos y pata coja*

Prueba	Tiempo	Género		Total
		Hombres	Mujeres	
Pies juntos	2,5-2,9	11 (27,5%)	0 (0,0%)	11 (13,75%)
	3,0-3,4	12 (30,0%)	10 (25,0%)	22 (27,5%)
	3,5-3,9	14 (35,0%)	14 (35,0%)	28 (35,0%)
	4,0-4,4	3 (7,5%)	10 (25,0%)	13 (16,25%)
	4,5-4,9	0 (0,0%)	3 (7,5%)	3 (3,75%)
	5,0-5,4	0 (0,0%)	3 (7,5%)	3 (3,75%)
Pata coja	2,1-2,5	4 (10,0%)	1 (2,5%)	5 (6,25%)
	2,6-3,0	20 (50,0%)	10 (25,0%)	30 (37,5%)
	3,1-3,5	11 (27,5%)	14 (35,0%)	25 (31,25%)
	3,6-4,0	4 (10,0%)	8 (20,0%)	12 (15,0%)
	4,1-4,5	0 (0,0%)	5 (12,5%)	5 (6,25%)
	4,6-5,0	1 (2,5%)	2 (5,0%)	3 (3,75%)

En la prueba de ida y vuelta (Tabla 2), se observa una diferencia significativa entre ambos sexos (t = -6,138, *p* = 0,001), con tiempos más bajos para los participantes masculinos, cuyas marcas oscilan entre 10,1 y 12 segundos, mientras que los tiempos femeninos se concentran en el rango superior, entre 11,6 y 14 segundos. Este patrón de distribución revela una clara ventaja masculina en esta prueba, aunque los tiempos están ampliamente distribuidos, sin una concentración específica.

Por otro lado, en la prueba de desplazamiento sobre soportes, no se registran diferencias significativas entre géneros (t = -1,523, *p* = 0,132). La mayoría de los/las participantes, tanto hombres como mujeres, muestran tiempos en el rango de 1,7 a 2,2 segundos, con una ligera ventaja no significativa para el grupo masculino. Estos resultados sugieren que, a diferencia de la prueba de ida y vuelta, la prueba de soportes no presenta una variabilidad significativa en función del género.

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Tabla 2: *Resultados por género pruebas ida y vuelta y soportes*

Prueba	Tiempo	Género		Total
		Hombres	Mujeres	
Ida y vuelta	10,1-10,5	1 (2,5%)	0 (0,0%)	1 (1,25%)
	10,6-11,0	14 (35,0%)	2 (5,0%)	16 (20,0%)
	11,1-11,5	5 (12,5%)	0 (0,0%)	5 (6,25%)
	11,6-12,0	11 (27,5%)	7 (17,5%)	18 (22,5%)
	12,1-12,5	5 (12,5%)	6 (15,0%)	11 (13,75%)
	12,6-13,0	1 (2,5%)	9 (22,5%)	10 (12,5%)
	13,1-13,5	0 (0,0%)	8 (20,0%)	8 (10,0%)
	13,6-14,0	3 (7,5%)	8 (20,0%)	11 (13,75%)
Soportes	1,7-1,9	22 (55,0%)	18 (45,0%)	40 (50,0%)
	2,0-2,2	18 (45,0%)	20 (50,0%)	38 (47,5%)
	2,3-2,5	0 (0,0%)	2 (5,0%)	2 (2,5%)

En el análisis del Test de Illinois (ver Tabla 3), se observa una clara diferenciación en los resultados según el género. En términos generales, la mayoría de los tiempos registrados se sitúan en la categoría de tiempos medios. Los resultados obtenidos para el grupo masculino oscilan predominantemente entre 14,6 y 17 segundos, lo que indica un rendimiento notablemente bajo en comparación con el grupo femenino, cuyos tiempos se distribuyen entre 17 y 20 segundos. Además, se han identificado diferencias estadísticamente significativas entre ambos sexos, con un valor t = -5,105 y un valor $p < 0,001$.

Tabla 3: *Resultados por género prueba Illinois*

Prueba	Tiempo	Genero		Total
		Hombres	Mujeres	
Illinois	14,6-15,0	3 (7,5%)	0 (0,0%)	3 (3,75%)
	15,1-15,5	3 (7,5%)	0 (0,0%)	3 (3,75%)
	15,6-16,0	6 (15,0%)	1 (2,5%)	7 (8,75%)
	16,1-16,5	9 (22,5%)	2 (5,0%)	11 (13,75%)
	16,6-17,0	9 (22,5%)	8 (20,0%)	17 (21,25%)
	17,1-17,5	1 (2,5%)	7 (17,5%)	8 (10,0%)
	17,6-18,0	5 (12,5%)	7 (17,5%)	12 (15,0%)
	18,1-18,5	1 (2,5%)	2 (5,0%)	3 (3,75%)
	18,6-19,0	1 (2,5%)	2 (5,0%)	3 (3,75%)
	19,1-19,5	0 (0,0%)	4 (10,0%)	4 (5,0%)
	19,6-20,0	2 (5,0%)	7 (17,5%)	9 (11,25%)

Resultados por Curso

En el análisis de las pruebas de equilibrio en posición de PJ y en PC (ver Tabla 4), no se observan diferencias significativas entre los distintos grupos de estudiantes. Sin embargo, se destaca que las/los participantes de los tres primeros cursos presentan un menor número de marcas en la categoría de tiempos bajos y algunos tiempos más prolongados en la categoría alta en comparación con el grupo de 4º de ESO. En términos generales, todos los grupos se sitúan aproximadamente entre 3 y 4,4 segundos en la prueba de PJ y entre 2,6 y 4 segundos en la prueba de PC. En la prueba de pata coja, las diferencias observadas no alcanzan significación estadística (p = 0,447). No obstante, se identifican diferencias significativas entre los grupos de 1º de ESO y 4º de ESO en la prueba de pies juntos, con un valor F = 3,345 y un valor p = 0,023.

Tabla 4: *Resultados por curso pruebas pies juntos y pata coja*

Prueba	Tiempo	Curso				Total
		1º ESO	2º ESO	3º ESO	4º ESO	
Pies juntos	2,5-2,9	2 (10,0%)	1 (5,0%)	3 (15,0%)	5 (25,0%)	11 (13,75%)
	3,0-3,4	6 (30,0%)	1 (5,0%)	7 (35,0%)	8 (40,0%)	22 (27,5%)
	3,5-3,9	6 (30,0%)	13 (65,0%)	3 (15,0%)	6 (30,0%)	28 (35,0%)
	4,0-4,4	3 (15,0%)	4 (20,0%)	5 (25,0%)	1 (5,0%)	13 (16,25%)
	4,5-4,9	1 (5,0%)	1 (5,0%)	1 (5,0%)	0 (0,0%)	3 (3,75%)
	5,0-5,4	2 (10,0%)	0 (0,0%)	1 (5,0%)	0 (0,0%)	3 (3,75%)
Pata coja	2,1-2,5	1 (5,0%)	0 (0,0%)	1 (5,0%)	3 (15,0%)	5 (6,25%)
	2,6-3,0	7 (35,0%)	4 (20,0%)	9 (45,0%)	10 (50,0%)	30 (37,5%)
	3,1-3,5	8 (40,0%)	8 (40,0%)	6 (30,0%)	3 (15,0%)	25 (31,25%)
	3,6-4,0	1 (5,0%)	7 (35,0%)	3 (15,0%)	1 (5,0%)	12 (15,0%)
	4,1-4,5	2 (10,0%)	1 (5,0%)	1 (5,0%)	1 (5,0%)	5 (6,25%)
	4,6-5,0	1 (5,0%)	0 (0,0%)	0 (0,0%)	2 (10,0%)	3 (3,75%)

En relación con los resultados obtenidos en el test de ida y vuelta y en la prueba de soportes (ver Tabla 5), se observan diferencias significativas entre los distintos grupos, destacándose el grupo de 3º de ESO en la prueba de soportes (F = 7,639, p = 0,001). Este grupo presenta un rendimiento ligeramente inferior en comparación con los demás cursos. En cuanto al test de ida y vuelta, los tiempos registrados son relativamente homogéneos. Sin embargo, se nota que los tres primeros cursos tienden a concentrarse en las categorías de tiempos más altos, mientras que el grupo de 4º de ESO muestra marcas ligeramente inferiores que los otros grupos, aunque no se identifican diferencias significativas entre ninguno de los cursos (p = 0,559). En general, los tiempos de todos los participantes se distribuyen de manera bastante uniforme entre 10 y 14 segundos.

Tabla 5: *Resultados por curso pruebas ida y vuelta y soportes*

Prueba	Tiempo	Curso				Total
		1º ESO	2º ESO	3º ESO	4º ESO	
Ida y vuelta	10,1-10,5	0 (0,0%)	0 (0,0%)	0 (0,0%)	1 (5,0%)	1 (1,25%)
	10,6-11,0	2 (10,0%)	4 (20,0%)	4 (20,0%)	6 (30,0%)	16 (20,0%)
	11,1-11,5	3 (15,0%)	1 (5,0%)	1 (5,0%)	0 (0,0%)	5 (6,25%)
	11,6-12,0	7 (35,0%)	2 (10,0%)	5 (25,0%)	4 (20,0%)	18 (22,5%)
	12,1-12,5	2 (10,0%)	6 (30,0%)	2 (10,0%)	1 (5,0%)	11 (13,75%)
	12,6-13,0	1 (5,0%)	2 (10,0%)	2 (10,0%)	5 (25,0%)	10 (12,5%)
	13,1-13,5	1 (5,0%)	1 (5,0%)	3 (15,0%)	3 (15,0%)	8 (10,0%)
	13,6-14,0	4 (20,0%)	4 (20,0%)	3 (15,0%)	0 (0,0%)	11 (13,75%)
Soportes	1,7-1,9	14 (70,0%)	11 (55,0%)	4 (20,0%)	11 (55,0%)	40 (50,0%)
	2,0-2,2	6 (30,0%)	9 (45,0%)	14 (70,0%)	9 (45,0%)	38 (47,5%)
	2,3-2,5	0 (0,0%)	0 (0,0%)	2 (10,0%)	0 (0,0%)	2 (2,5%)

En el análisis de los resultados del Test de Illinois (ver Tabla 6), se observan resultados bastante homogéneos entre los grupos evaluados, sin diferencias significativas entre ellos (p = 0,630). Estudiantes de 1º, 2º y 3º de ESO presentan un rendimiento similar, con la mayoría de las marcas situándose entre 15,6 y 18 segundos, aunque algunos/algunas alcanzan hasta 20 segundos. Por otro lado, en el grupo de 4º de ESO, los tiempos son ligeramente inferiores, registrando tiempos de hasta 14,6 segundos. En términos generales, la media de los tiempos para todos los grupos se encuentra entre 16 y 18 segundos.

Tabla 6: *Resultados por curso prueba Illinois*

Prueba	Tiempo	Curso				Total
		1º ESO	2º ESO	3º ESO	4º ESO	
Illinois	14,6-15,0	0 (0,0%)	0 (0,0%)	0 (0,0%)	3 (15,0%)	3 (3,75%)
	15,1-15,5	0 (0,0%)	0 (0,0%)	2 (10,0%)	1 (5,0%)	3 (3,75%)
	15,6-16,0	2 (10,0%)	2 (10,0%)	0 (0,0%)	3 (15,0%)	7 (8,75%)
	16,1-16,5	6 (30,0%)	2 (10,0%)	2 (10,0%)	1 (5,0%)	11 (13,75%)
	16,6-17,0	3 (15,0%)	5 (25,0%)	6 (30,0%)	3 (15,0%)	18 (22,5%)
	17,1-17,5	2 (10,0%)	2 (10,0%)	3 (15,0%)	1 (5,0%)	8 (10,0%)
	17,6-18,0	3 (15,0%)	4 (20,0%)	1 (5,0%)	4 (20,0%)	12 (15,0%)
	18,1-18,5	0 (0,0%)	1 (5,0%)	1 (5,0%)	1 (5,0%)	3 (3,75%)
	18,6-19,0	1 (5,0%)	1 (5,0%)	0 (0,0%)	1 (5,0%)	3 (3,75%)
	19,1-19,5	0 (0,0%)	0 (0,0%)	3 (15,0%)	1 (5,0%)	4 (5,0%)
	19,6-20,0	3 (15,0%)	3 (15,0%)	2 (10,0%)	1 (5,0%)	9 (11,25%)

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Resultados por Deporte

Al analizar los resultados obtenidos en el test de PJ y en el test de PC (ver Tabla 7), se evidencia que las/los estudiantes sedentarios/sedentarias presentan marcas significativamente inferiores en comparación con aquellos/aquellas que realizan actividad física, con diferencias significativas observadas en ambas pruebas (t = 5,393, p = 0,001; t = 5,188, p = 0,001). Los/las estudiantes sedentarios/sedentarias registran tiempos que oscilan entre 3 y 5,4 segundos en la prueba de PJ y entre 3,1 y 5 segundos en la prueba de PC. En contraste, estudiantes que participan en actividad física muestran tiempos que varían entre 2,5 y 4,4 segundos en la prueba de PJ y entre 2,6 y 3,5 segundos en la prueba de PC. En lo que respecta al tipo de actividad física practicada, se observan pocas diferencias entre aquellos/aquellas que participan en deportes individuales y los/las que practican deportes colectivos. En general, los valores medios de todos los/las participantes se sitúan entre 2,5 y 4,4 segundos en la prueba de PJ y entre 2,6 y 4 segundos en la prueba de PC.

Tabla 7: *Resultados por actividad física pruebas pies juntos y pata coja*

Prueba	Tiempo	Deporte			Total
		No	Individual	Colectivo	
Pies juntos	2,5-2,9	1 (2,85%)	3 (15,0%)	7 (28,0%)	11 (13,75%)
	3,0-3,4	5 (14,3%)	8 (40,0%)	9 (36,0%)	22 (27,5%)
	3,5-3,9	13 (37,15%)	8 (40,0%)	7 (28,0%)	28 (35,0%)
	4,0-4,4	10 (28,6%)	1 (5,0%)	2 (8,0%)	13 (16,3%)
	4,5-4,9	3 (8,7%)	0 (0,0%)	0 (0,0%)	3 (2,9%)
	5,0-5,4	3 (8,7%)	0 (0,0%)	0 (0,0%)	3 (2,9%)
Pata coja	2,1-2,5	1 (2,85%)	2 (10,0%)	2 (8,0%)	5 (6,95%)
	2,6-3,0	6 (17,1%)	12 (60,0%)	12 (48,0%)	30 (41,6%)
	3,1-3,5	13 (37,15%)	3 (15,0%)	9 (36,0%)	25 (29,4%)
	3,6-4,0	7 (20,0%)	3 (15,0%)	2 (8,0%)	12 (14,3%)
	4,1-4,5	5 (14,3%)	0 (0,0%)	0 (0,0%)	5 (4,8%)
	4,6-5,0	3 (8,7%)	0 (0,0%)	0 (0,0%)	3 (2,9%)

En relación con la prueba de ida y vuelta y el test de soportes (ver Tabla 8), se observan diferencias más marcadas entre los grupos de estudiantes sedentarios y activos, corroborando los hallazgos de las pruebas anteriores. Se identifican diferencias significativas en ambas pruebas (t = 8,281, p = 0,001; t = 4,493, p = 0,001). En la prueba de ida y vuelta, los tiempos de los/las estudiantes sedentarios/sedentarias son notablemente elevados, con la mayoría de los resultados situándose entre 11,6 y 14 segundos. En contraste, los/las estudiantes que participan en actividades deportivas extracurriculares presentan tiempos considerablemente más bajos, que oscilan entre 10,6 y 12,5 segundos.

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El test de soportes revela una tendencia similar, donde las/los participantes sedentarias/sedentarios registran tiempos entre 2 y 2,2 segundos, mientras que aquellas/aquellos que realizan actividad física obtienen marcas que varían entre 1,7 y 1,9 segundos. Además, en ambas pruebas se aprecia una diferencia mínima en los tiempos entre las/los estudiantes que practican deportes de forma individual y aquellos/aquellas que lo hacen de forma colectiva, siendo los tiempos de estos últimos ligeramente superiores a los de los primeros.

Tabla 8: *Resultados por actividad física prueba ida y vuelta y soportes*

Prueba	**Tiempo**	**No**	**Deporte Individual**	**Colectivo**	**Total**
Ida y vuelta	10,1-10,5	0 (0,0%)	0 (0,0%)	1 (4,0%)	1 (1,3%)
	10,6-11,0	1 (2,85%)	7 (35,0%)	8 (32,0%)	16 (23,3%)
	11,1-11,5	1 (2,85%)	1 (5,0%)	3 (12,0%)	5 (6,6%)
	11,6-12,0	4 (11,4%)	6 (30,0%)	8 (32,0%)	18 (24,4%)
	12,1-12,5	4 (11,4%)	3 (15,0%)	4 (16,0%)	11 (14,1%)
	12,6-13,0	7 (20,0%)	2 (10,0%)	1 (4,0%)	10 (11,3%)
	13,1-13,5	7 (20,0%)	1 (5,0%)	0 (0,0%)	8 (8,3%)
	13,6-14,0	11 (31,4%)	0 (0,0%)	0 (0,0%)	11 (10,4%)
Soportes	1,7-1,9	10 (28,6%)	11 (55,0%)	19 (76,0%)	40 (53,2%)
	2,0-2,2	23 (65,7%)	9 (45,0%)	6 (24,0%)	38 (44,9%)
	2,3-2,5	2 (5,7%)	0 (0,0%)	0 (0,0%)	2 (1,9%)

En el análisis del Test de Illinois (ver Tabla 9), se observa una diferencia notable entre los/las estudiantes sedentarios/sedentarias y aquellos que participan en actividades físicas, con diferencias significativas confirmadas (t = 8,123, p = 0,001), al igual que en las pruebas previas. Los individuos que no realizan actividad deportiva presentan tiempos que oscilan entre 16,6 y 20 segundos, mientras que aquellos/aquellas que participan en actividades físicas registran tiempos aproximados entre 15,6 y 18 segundos, resultando en una media de valores intermedios. Aunque la diferencia entre las/los participantes que practican deportes individuales y colectivos es menos pronunciada, se evidencia la existencia de esta variación.

Tabla 9: *Resultados por actividad física prueba Illinois*

Prueba	Tiempo	No	Deporte Individual	Colectivo	Total
	14,6-15,0	0 (0,0%)	1 (5,0%)	2 (8,0%)	3 (4,3%)
	15,1-15,5	0 (0,0%)	2 (10,0%)	1 (4,0%)	3 (4,6%)
	15,6-16,0	1 (2,85%)	3 (15,0%)	3 (12,0%)	7 (9,95%)
	16,1-16,5	1 (2,85%)	2 (10,0%)	8 (32,0%)	11 (14,95%)
	16,6-17,0	4 (11,4%)	5 (25,0%)	8 (32,0%)	17 (22,8%)
Illinois	17,1-17,5	4 (11,4%)	3 (15,0%)	1 (4,0%)	8 (10,1%)
	17,6-18,0	7 (20,0%)	4 (20,0%)	1 (4,0%)	12 (14,6%)
	18,1-18,5	2 (5,7%)	0 (0,0%)	1 (4,0%)	3 (3,2%)
	18,6-19,0	3 (8,7%)	0 (0,0%)	0 (0,0%)	3 (2,9%)
	19,1-19,5	4 (11,4%)	0 (0,0%)	0 (0,0%)	4 (3,8%)
	19,6-20,0	9 (25,7%)	0 (0,0%)	0 (0,0%)	9 (8,6%)

Discusión

El presente estudio tuvo como objetivo evaluar y analizar la coordinación motriz y la agilidad en estudiantes de educación secundaria, así como examinar las posibles diferencias en función del género, el curso académico y la práctica de actividad deportiva extraescolar.

La coordinación motriz y la agilidad son habilidades fundamentales para alcanzar una competencia motriz adecuada. Los análisis de los resultados por género indican que los varones presentan niveles superiores de coordinación motriz y agilidad en comparación con las mujeres. Estos hallazgos son consistentes con investigaciones previas (Lorenzo, 2009; Pérez-Muñoz *et al*., 2021; Torralba *et al*., 2015), que también reportan resultados superiores en los varones en todas las variables, a pesar de utilizar diferentes pruebas de coordinación y agilidad. Esta tendencia puede explicarse a través de estudios que sugieren que los varones, en esta etapa de desarrollo, experimentan una mayor interacción motriz y una mayor actividad física en comparación con las mujeres (Gallegos-Sánchez *et al.,* 2019; Lamoneda y Huertas, 2017), quienes tienden a practicar menos actividad física durante la preadolescencia y adolescencia (Luengo, 2007; Montil *et al*., 2005; Sallis et al., 2000) y son más propensas al abandono de la actividad deportiva y al sedentarismo en esta etapa (Ruiz-Pérez *et al*., 2015). Estas diferencias tienen implicaciones en el desarrollo motor y en la salud (Ruiz-Pérez *et al*., 2007). Además, Gómez-García (2004) señala que los varones también muestran una mayor competitividad, un factor que podría influir en los resultados finales, lo que se apoya en la hipótesis de que la motivación intrínseca es crucial para el compromiso en la actividad física, tal como apuntan Moreno y Cervelló (2010).

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En el presente estudio, se observaron diferencias significativas en todas las pruebas, excepto en el test de soportes. Esta excepción podría deberse a la naturaleza diferente de la prueba, ya que Cermak y Larkin (2002) afirman que los varones sobresalen en tareas que requieren habilidades de motricidad gruesa, mientras que Jastrzębska (2020) destaca que las mujeres presentan un mejor control postural y equilibrio. Estos hallazgos pueden corroborar las diferencias de género en habilidades motrices básicas (Ávalos-Ramos y Vega-Ramírez, 2020). Comparando nuestros resultados con la investigación que validó el test utilizado (Ruiz-Pérez *et al.,* 2017), se observa que la media de las/los estudiantes de la localidad objeto de estudio, se encuentra significativamente por debajo de la media nacional, con las mujeres distanciándose más que los varones.

En cuanto a los resultados por curso académico, se observó que los/las estudiantes de 4º de ESO presentan un nivel ligeramente superior de coordinación motriz y agilidad en comparación con los cursos inferiores, lo que puede explicarse por las diferencias físicas asociadas a la edad (Pérez-Muñoz *et al*., 2021). Sin embargo, otros estudios (Arcos *et al.,* 2020; Fernández-Álvarez *et al*., 2020) indican que existen escasas diferencias en el desarrollo de la coordinación y agilidad entre los distintos niveles de educación secundaria. Este fenómeno podría atribuirse a la tendencia de los/las docentes a suponer que los procesos de maduración física resolverán de manera natural los problemas de coordinación y agilidad, lo que podría llevar a una falta de atención a esta problemática (Ruiz-Pérez, 2004).

Esta realidad, cada vez más evidente en las clases de Educación Física, subraya la necesidad de que los responsables educativos reflexionen sobre la implementación de medidas para abordar estas deficiencias desde etapas más tempranas, como la educación infantil (Ruiz-Pérez, 2005). La intervención temprana puede mitigar la gravedad de los problemas motrices en diversos aspectos (Cantell *et al*., 1994; Schöemaker *et al*., 2003). A pesar de lo anterior, se encontraron diferencias significativas entre los/las estudiantes de 1º y 4º de ESO en la prueba de pies juntos, lo que puede explicarse por el carácter continuo del desarrollo motor (Cano de la Cuerda *et al.,* 2017), dado que el alumnado de 4º de ESO suele estar más desarrollado físicamente que el de 1º de ESO. También se identificaron diferencias significativas en el test de soportes entre 3º de ESO y los demás cursos, lo cual puede atribuirse a la mayor frecuencia de abandono de la actividad física en esta etapa, ya que, en edades de 14 a 15 años, los/las estudiantes comienzan a exhibir conductas asociadas a niveles reducidos de actividad física y participación deportiva (Van Mechelen *et al*., 2000). Un estudio realizado por Gil et al. (2012) analizó las percepciones de adolescentes de esta edad sobre la actividad física y corroboró el bajo interés y el abandono.

En lo que respecta a la variable de actividad extraescolar, los resultados evidencian una clara superioridad en los niveles de coordinación y agilidad entre los/las estudiantes activos/activas en comparación con los/las sedentarios/sedentarias, con diferencias significativas observadas en todas las pruebas realizadas. Estos hallazgos son consistentes con investigaciones previas (Arboix-Alió *et al.*, 2019; Beltrán *et al*., 2008), que establecen una relación entre la inactividad física y bajos niveles de condición física.

Una de las razones que contribuyen a esta situación es el déficit de actividad física en una parte significativa de la población escolar (Henderson *et al*., 2011). Según Ruiz-Pérez *et al*. (2015), el porcentaje de estudiantes que no participan en actividades físicas o deportivas extracurriculares es alarmantemente elevado, y las dos horas semanales de Educación Física en ESO son insuficientes para abordar la situación de este alumnado.

Además, estas/estos estudiantes tienden a presentar una baja percepción de competencia motriz y autoestima, lo que las/los lleva a sentir incapacidad para realizar ciertas actividades que el alumnado activo ejecuta con facilidad, resultando en una disminución de su motivación hacia la práctica de actividades físicas y deportivas (Ruiz-Pérez *et al*., 2007). Ignorar esta problemática puede llevar a estas/estos escolares a adoptar estilos de vida sedentarios, lo que perpetúa estas dificultades en la adultez (Cousins y Smyth, 2003). Por ello, Pérez-Muñoz *et al.* (2021) sugieren la inclusión de actividades y tareas en Educación Física que promuevan el desarrollo de capacidades coordinativas y agilidad, especialmente para aquel alumnado que solo tiene acceso a la actividad física en el entorno escolar, con el fin de mejorar su salud y fomentar hábitos saludables. Asimismo, estos autores proponen un incremento en las horas dedicadas a esta área de estudio como una medida necesaria y beneficiosa para la calidad de vida de las/los estudiantes.

Conclusiones

Se han identificado diferencias significativas de género en los niveles de competencia motriz, evidenciando que los varones presentan una mayor coordinación motriz y agilidad en comparación con las mujeres, excepto en aquellas pruebas o tareas que requieren habilidades motrices básicas menos relacionadas con la motricidad gruesa.

Las diferencias observadas entre los distintos cursos académicos no resultan significativas. A pesar de que existen excepciones atribuibles al desarrollo evolutivo motor, es un error común suponer que el paso del tiempo resolverá los problemas de coordinación motriz. Por lo tanto, es fundamental que el personal docente sea consciente de esta situación y aborde la enseñanza de estas habilidades desde etapas más tempranas, dado que la adolescencia representa un período crítico para el abandono de la actividad física.

Además, se ha evidenciado diferencias marcadas en las habilidades coordinativas entre el alumnado que realiza actividad física y aquel que lleva un estilo de vida sedentario. Es importante destacar que el alumnado sedentario tiende a adoptar este estilo de vida en parte debido a su falta de competencia motriz. Por consiguiente, el trabajo en la mejora de la coordinación motriz en la asignatura de Educación Física se convierte en una estrategia clave para fomentar la participación activa de este tipo de estudiantes.

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ORIGINAL ARTICLE

Students' Perceptions of the Integration of Artificial Intelligence Nursing Education: A Study at a Private Chilean University

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Abstract:
The use of artificial intelligence (AI) in higher education has gained significant attention, particularly in health-related fields. This study explores the perceptions of AI use among nursing students at a private Chilean university. The research aimed to assess students' attitudes and experiences with AI in their learning process. A sample of 36 nursing students participated, and data were collected using a Likert-scale questionnaire measuring various dimensions of AI integration. Results indicated moderate perceptions of AI use, with an average score of M = 3.15. While students recognized the potential of AI to enhance learning efficiency and access to information, concerns were raised regarding the limited practical implementation and insufficient training opportunities. The findings suggest that to fully leverage AI in nursing education, improvements such as targeted training programs and expanded technological resources are essential. Future efforts should focus on fostering AI literacy to better prepare nursing students for technologically advanced healthcare environments.

Introduction

Artificial Intelligence (AI) has emerged as a transformative force across multiple sectors, particularly in education and healthcare (Bahroun et al., 2023; Mhlanga, 2021; Vera, 2023). In higher education, AI-driven technologies are reshaping traditional learning and teaching methods, particularly in health-related disciplines such as nursing. Specifically, AI has the capability to revolutionize how nurses deliver personalized, evidence-based care that is tailored to meet patients' specific needs and priorities (Glauberman et al., 2023). For instance, tools like adaptive learning systems, intelligent tutoring programs, and virtual simulations provide individualized learning experiences, enhancing both knowledge acquisition and practical skills (Cheung et al., 2021). These advancements promote self-paced learning and foster critical thinking, which are essential for navigating real-world clinical challenges (Vera, 2024).

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Furthermore, AI creates immersive training environments that simulate complex healthcare scenarios, offering students opportunities to practice decision-making and clinical interventions in a risk-free setting (Glauberman et al., 2023; Kollerup et al., 2024). This advanced simulation technology bridges the gap between theoretical knowledge and real-world practice, enhancing critical thinking and clinical reasoning. However, the successful integration of AI in nursing education depends on addressing significant challenges such as technological accessibility, faculty preparedness, and student adaptability. Institutions must invest in infrastructure, provide faculty with professional development programs, and ensure students are equipped with the digital literacy required to engage effectively with AI tools. By overcoming these barriers, AI can empower nursing students with the competencies needed to excel in modern, dynamic healthcare environments, fostering a highly skilled and future-ready workforce.

In addition, AI technologies play a vital role in modern education by improving instructional effectiveness and delivering personalized support tailored to individual student needs (Chen et al., 2020). Within healthcare education, AI applications—including diagnostic tools and predictive analytics—contribute significantly to patient care management and clinical decision-making, strengthening practical skills among future healthcare professionals (Alowais et al., 2023). Specifically, AI-driven learning platforms and simulation tools offer nursing students adaptive, hands-on experiences that closely replicate real-world clinical situations. As a result, these tools not only improve students' technical competencies but also enhance their critical thinking and decision-making abilities, essential for effective healthcare delivery. However, the successful implementation of AI requires resolving key challenges, such as equitable access to technology, comprehensive faculty training, and students' readiness to embrace these innovations. Addressing these issues will unlock AI's full potential to transform nursing education and meet the demands of an increasingly complex healthcare environment.

Moreover, nursing education plays a critical role in preparing future professionals to navigate intricate clinical settings where AI technologies are becoming increasingly prevalent. Applications such as diagnostic tools, virtual simulations, and decision-support systems complement traditional teaching methods, offering innovative ways to improve both theoretical knowledge and practical skills. However, nursing students' perceptions and attitudes toward AI are key determinants for the successful adoption of these tools. Understanding their experiences and addressing potential gaps in knowledge, acceptance, and confidence are vital steps to ensure the effective integration of AI. Thus, fostering AI literacy and building awareness will not only bridge these gaps but also encourage a culture of innovation and adaptability in nursing education.

Building on this premise, the present study explores nursing students' perceptions of AI use in their educational experiences at a private Chilean university. By evaluating their attitudes and experiences through a structured questionnaire, this research aims to identify key strengths, challenges, and opportunities associated with AI integration. Additionally, the findings will contribute to the development of strategies that enhance AI implementation, improve learning outcomes, and prepare a technology-ready healthcare workforce.

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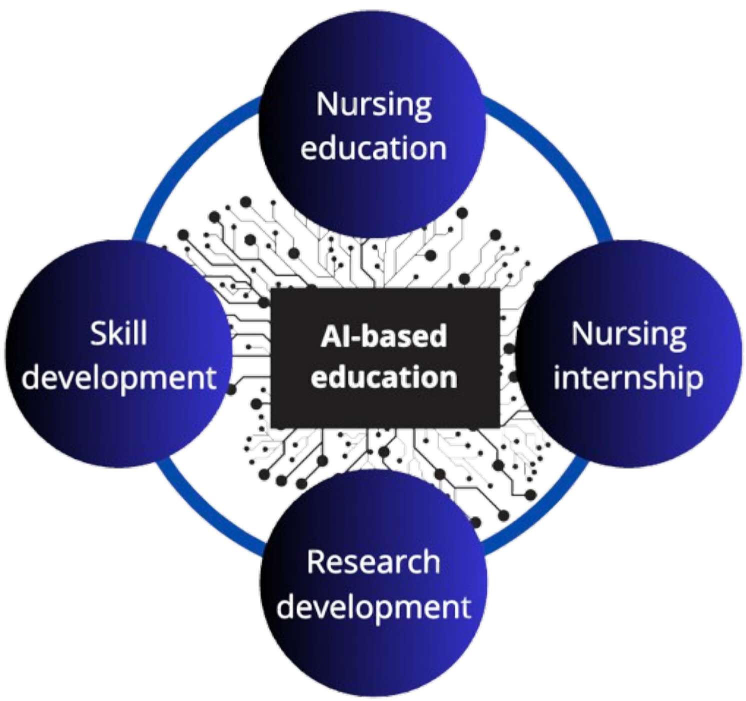
Research Questions:

1. What are nursing students' perceptions of the integration of AI in their education?
2. How do students evaluate the effectiveness and relevance of AI tools in their learning processes?
3. What challenges and opportunities do students identify in the use of AI within nursing education?

Integration of AI in Nursing Education

This approach offers transformative opportunities to enhance learning experiences, clinical decision-making, and personalized instruction. Indeed, AI has the potential to revolutionize healthcare delivery, improve patient outcomes, and redefine the role of nurses (Clancy, 2020). Specifically, AI-powered tools, such as virtual simulations and adaptive learning platforms, enable students to engage in realistic and interactive scenarios that closely replicate clinical environments. These technologies provide immediate feedback, allowing learners to systematically practice and refine their critical thinking and procedural skills in a safe, risk-free setting. Additionally, AI-driven systems can track student performance, identify areas of improvement, and deliver targeted support to address learning gaps. By integrating these tools into nursing education, students gain a deeper understanding of clinical processes while building confidence. Ultimately, this innovative approach ensures that future nurses are better equipped to navigate complex healthcare systems and deliver high-quality, patient-centered care (Figure 1).

Figure 1: *AI-based nursing education*



Source: Own elaboration.

Embracing artificial intelligence (AI) has the potential to transform nursing practice across multiple essential areas. Firstly, AI-driven clinical decision support systems provide nurses with valuable insights and evidence-based recommendations, enabling them to make more informed, accurate, and timely decisions regarding patient care (Van Bulck et al., 2023). By analyzing extensive datasets and identifying patterns, AI systems can improve the precision and effectiveness of patient diagnoses and treatments, reducing human error and enhancing outcomes (Buchanan et al., 2020). Additionally, AI enables nurses to identify emerging health trends or risks by uncovering subtle correlations that may otherwise go unnoticed. This technology empowers nurses to personalize care plans to meet individual patient needs, streamline workflows, and manage complex cases with greater confidence. Ultimately, integrating AI into nursing practice enhances clinical decision-making, optimizes care delivery, and supports improved patient outcomes in a more efficient and data-driven manner.

Secondly, AI significantly enhances patient monitoring and supports predictive analytics, revolutionizing how healthcare providers anticipate and address clinical needs. Through AI-powered technologies, nurses can continuously track patients' vital signs, such as heart rate, oxygen levels, and blood pressure, providing an uninterrupted flow of critical data. These systems have the ability to analyze trends and identify subtle changes that may indicate early signs of clinical deterioration, prompting timely alerts (Alazzam et al., 2022). By providing real-time notifications, AI enables nurses to intervene quickly, preventing adverse events such as cardiac arrest or respiratory failure. Predictive analytics further strengthens care delivery by anticipating potential risks and suggesting preemptive measures. This capability not only reduces patient mortality rates but also minimizes the length of hospital stays and associated costs. Ultimately, AI-driven monitoring tools empower nurses to deliver more proactive, precise, and effective care, improving both efficiency and patient outcomes (McGrow, 2019).

Lastly, AI has the potential to optimize care coordination and significantly alleviate nurses' workload, allowing them to focus more on direct patient care. AI algorithms can automate routine administrative tasks such as scheduling, documentation, and managing patient records, reducing the time nurses spend on paperwork. These systems can also prioritize patient care needs by analyzing real-time data, identifying the most urgent cases, and allocating resources efficiently (Stokes & Palmer, 2020). Additionally, AI facilitates seamless communication within healthcare teams by centralizing information and enabling faster, more accurate exchanges of data across departments. This improved coordination helps prevent delays in treatment, minimizes errors, and enhances overall workflow efficiency. By streamlining operations and reducing unnecessary burdens, AI empowers nurses to dedicate their expertise to more critical tasks, improving both the quality of care and job satisfaction while ensuring better patient outcomes.

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Furthermore, AI systems can analyze individual student performance data to identify specific learning gaps, facilitating the delivery of personalized educational resources that create efficient and targeted pathways to skill mastery. Through adaptive learning technologies, AI ensures that nursing students receive the support they need at their own pace, strengthening their understanding of critical concepts. By incorporating AI into curriculum design, nursing educators can develop dynamic and data-driven learning environments that respond to students' evolving needs. This integration enhances students' preparedness for increasingly complex healthcare systems, equipping them with the skills to address modern clinical challenges effectively. Additionally, AI-driven tools promote competency-based education by focusing on practical outcomes, ensuring graduates meet industry standards and excel in clinical practice. Ultimately, AI empowers educators to provide tailored instruction while fostering a new generation of nurses who are adaptable, proficient, and prepared for future healthcare demands.

In fact, AI has the ability to transform healthcare delivery, enhance patient outcomes, and redefine the role of nurses (Clancy, 2020). In this context, AI-powered tools, such as virtual simulations and adaptive learning platforms, enable students to engage in realistic, interactive scenarios that mimic clinical environments. These technologies provide immediate feedback, allowing learners to practice and refine their critical thinking and procedural skills without risk to patients. Moreover, AI can analyze individual student performance data to identify learning gaps and deliver targeted educational resources, ensuring a customized pathway for skill mastery. By incorporating AI into curriculum design, nursing educators can better prepare students for complex healthcare systems, improving their readiness to address real-world challenges while promoting competency-based education.

Here are some practical examples related to the topic:

- **AI in Data Analytics for Evidence-Based Practice**: Nursing students using *IBM Watson Health* or *Tableau* can analyze patient data to identify patterns, such as trends in infection rates, enabling evidence-based decisions. For example, students might identify a link between delayed post-op care and higher complication rates.

- **AI-Driven Assessments**: AI tools like *Gradescope* automate grading for nursing case studies and quizzes. These systems evaluate answers quickly and offer detailed feedback, reducing faculty workload while ensuring consistency in assessment.

- **AI Chatbots and Virtual Tutors**: Platforms like *ChatGPT* or *Ada Health* assist students in learning theoretical concepts. For example, a nursing student can ask an AI chatbot to explain the physiological basis of hypertension or clarify nursing interventions for diabetic care in real-time, supporting independent learning.

Therefore, incorporating AI tools like Body Interact, SIMSTAT, and other AI-driven technologies into nursing education enhances learning outcomes, fosters clinical competence, and prepares students for the challenges of modern healthcare. These tools enable evidence-based decision-making, streamline assessments, and provide accessible learning support, ensuring that future nursing professionals are equipped with the skills needed to deliver high-quality patient care. Moreover, AI fosters a culture of continuous learning and adaptability, encouraging both students and educators to embrace technological advancements. By simulating real-world clinical experiences and automating routine educational processes, AI creates a dynamic, interactive, and highly efficient learning environment that bridges the gap between classroom instruction and clinical practice. As healthcare continues to evolve, the integration of AI ensures that nursing education remains forward-looking, innovative, and aligned with the demands of modern patient care.

The integration of AI tools into nursing education significantly improves the acquisition of critical skills, ensuring students are well-prepared to handle the complexities of real-world healthcare settings. Advanced technologies, such as virtual patient simulations and AI-driven adaptive learning systems, foster immersive, interactive, and personalized learning experiences. For instance, platforms like Body Interact and SIMSTAT offer virtual environments where students can diagnose, treat, and manage simulated patients with various conditions, including chronic illnesses like diabetes or critical cases such as acute respiratory distress. These tools enable students to practice clinical reasoning, enhance decision-making skills, and gain confidence—all within a safe, controlled environment. By removing the risks associated with real patients, AI-based platforms ensure that nursing students acquire practical competencies and experience that are essential for delivering high-quality, patient-centered care in modern healthcare systems (Table 1).

Table 1: *Summary of IA tools applied in nursing*

AI tool	Description	Location
Body Interact	This Ai tool is an advanced AI-driven virtual patient simulation tool widely used in nursing education and practice. It creates realistic, interactive clinical scenarios where nurses and nursing students can diagnose, treat, and manage virtual patients in a safe, controlled environment.	https://bodyinteract.com/virtual-patient-simulator/
SIMSTAT	This AI tool enables nurses to refine their skills in critical care, acute patient management, and team coordination, leading to better patient outcomes and more efficient workflows.	https://provalisresearch.com/products/simstat/

Source: Own elaboration.

AI also supports nursing education by enhancing research capabilities and fostering innovative teaching methodologies. For instance, AI-driven data analytics allows nursing students to interpret large datasets for evidence-based practice, a key skill in modern healthcare. Additionally, AI facilitates automated assessments and virtual mentors, streamlining administrative processes and enabling educators to focus more on interactive, human-centered teaching. Chatbots and AI tutors provide instant clarification for theoretical concepts, supporting self-paced learning and improving retention rates. However, successful implementation requires balancing technology with human oversight to maintain empathy and ethical care principles. Integrating AI into nursing education not only enhances academic outcomes, but it also equips future nurses with technological fluency to navigate digital healthcare ecosystems effectively.

As demonstrated, the integration of AI in nursing education not only enhances academic outcomes, but it also equips future nurses to confidently navigate digital healthcare systems. By combining AI-driven innovation with a human-centered approach, educators can ensure that nursing students develop into technologically proficient, empathetic, and highly skilled professionals. This balanced approach prepares them to address the evolving challenges of modern healthcare while maintaining the essential human touch required in patient care. Additionally, the integration of AI technologies fosters collaboration between educators, students, and healthcare systems, creating a seamless connection between learning environments and clinical practice. Ultimately, AI empowers nursing professionals to thrive in a healthcare landscape that demands both advanced technical expertise and compassionate, patient-centered care.

Integration of AI into the nursing curriculum

As healthcare systems become increasingly digitized, the role of AI in clinical practice and patient care continues to grow (Alowais et al. 2023; Bajwa et al., 2021; Maleki Varnosfaderani et al., 2024). To ensure nursing graduates are prepared to meet the demands of modern healthcare, nursing education must evolve to incorporate AI-driven knowledge, skills, and practical applications. These action lines provide a structured approach to embedding AI content into nursing programs, equipping students with the necessary technological literacy, critical thinking, and ethical awareness to navigate AI-enhanced healthcare environments.

By focusing on curriculum redesign, faculty training, practical applications, ethical considerations, and collaboration with healthcare and technology sectors, this plan aims to create a balanced, forward-thinking educational framework. The goal is to prepare nurses who are not only technologically proficient but also empathetic and patient-centered professionals ready to leverage AI for improved healthcare outcomes. This holistic approach ensures nursing graduates can adapt to rapid technological advancements, promote ethical AI use in clinical settings, and address the complexities of patient care with confidence. Through continuous innovation and collaboration, educators can shape a new generation of nurses equipped to navigate digital transformation while upholding the core values of nursing: compassion, empathy, and patient advocacy.

The following is a set of action lines to drive the integration of AI into the nursing curriculum:

- **Curriculum Redesign and AI Integration:** Integrating AI into the nursing curriculum requires a strategic redesign of courses to incorporate AI topics such as clinical decision-making, diagnostics, patient monitoring, and personalized care. Students should engage with tools like machine learning, wearable devices, and predictive analytics to understand their practical healthcare applications. Embedding AI progressively into foundational courses ensures students grasp its role in improving care delivery, optimizing resources, and supporting clinical workflows. By aligning AI content with learning stages, nursing students develop essential competencies to utilize AI effectively in modern healthcare environments.

- **Faculty Training and Development:** Faculty training is a fundamental step to successfully integrate AI into the nursing curriculum. Institutions should organize professional development programs, including workshops, certifications, and webinars, to provide educators with the knowledge and confidence to teach AI-related topics. Collaborations with AI and healthcare technology experts can offer faculty members the necessary tools to understand and convey the principles of AI, its applications, and its limitations. This preparation ensures that educators can engage students with relevant, up-to-date content that bridges the gap between nursing practice and emerging technologies.

- **Development of Practical AI Applications in Clinical Training:** Practical exposure to AI tools is essential for nursing students to gain real-world experience with emerging technologies. Integrating AI-powered simulations into clinical training allows students to interact with virtual patient scenarios, learn predictive analytics, and understand AI’s role in clinical decision-making. For instance, AI-driven software can provide real-time data on patient conditions, helping students analyze and respond to clinical information effectively. These tools also allow for repeated practice in low-risk environments, fostering confidence and competency in using AI for patient care.

- **Ethical and Humanistic Considerations:** Incorporating ethical considerations into AI education is crucial to maintain the humanistic aspect of nursing practice. While AI offers immense benefits, its use raises concerns about data privacy, bias, and the nurse-patient relationship. Courses must address ethical frameworks that govern AI use, ensuring students are aware of patient rights, confidentiality, and equity in care delivery. By encouraging critical discussions on issues like algorithmic bias and ethical decision-making, students will develop the skills to evaluate AI systems’ fairness and reliability while prioritizing patient safety and dignity.

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- **Collaboration with Healthcare and Technology Sectors:** Collaboration with healthcare institutions and technology companies is essential to integrate AI effectively into nursing education. Universities should establish partnerships with hospitals, AI developers, and healthcare technology providers to offer students exposure to real-world applications. Internships, research opportunities, and collaborative projects can allow students to engage directly with AI tools, such as machine learning systems for diagnostics, robotic surgical aids, and virtual care platforms. These experiences will provide students with practical skills and insights into the evolving healthcare landscape.

Therefore, incorporating AI into the nursing curriculum is not just a step toward innovation but a necessity for preparing future nurses to thrive in an increasingly digitized healthcare landscape. By blending technical knowledge, practical experience, and ethical understanding, nursing education can empower students to become confident, competent, and compassionate professionals. Future nurses must develop technological literacy to effectively utilize AI tools, including decision-support systems, predictive analytics, and patient monitoring technologies. However, it is equally essential to emphasize humanistic values, such as empathy, emotional intelligence, and patient-centered care, to maintain the human connection that defines nursing practice. This comprehensive approach ensures that nurses can integrate AI tools seamlessly into their workflows, improve clinical outcomes, and address the challenges of modern healthcare, while preserving the dignity and well-being of their patients. AI enhances their ability to provide timely, efficient, and personalized care.

Through strategic curriculum redesign, faculty development, real-world applications, and industry collaborations, nursing programs can bridge the gap between technology and practice. By doing so, they will produce graduates who are not only proficient in leveraging AI to improve clinical outcomes but also capable of maintaining the empathy, critical thinking, and ethical awareness essential for delivering high-quality, patient-centered care in the 21st century.

Materials and Methods

This study is framed within the positivist paradigm, adopting a purely quantitative approach, which involves gathering and analyzing numerical data to address specific research questions (Rana et al., 2021). This method is characterized by its objectivity and reliance on measurable evidence, enabling researchers to summarize and average data, identify patterns, make predictions, and examine causal relationships. The quantitative approach is particularly valuable for identifying trends across populations and generalizing findings to broader contexts, ensuring scientific rigor and replicability. By focusing on numerical evidence, researchers can test hypotheses, measure variables systematically, and generate reliable conclusions. This approach aligns with the study's goal of uncovering precise insights into nursing students' perceptions of AI integration, providing a solid foundation for evidence-based recommendations that can inform curriculum design and policy development in higher education.

Moreover, a non-experimental, cross-sectional design was employed (Green et al., 2006), allowing for the collection of data at a single point in time to describe and analyze the phenomenon under investigation. The research has a descriptive scope and utilizes a field design, enabling the assessment of participants' perceptions in their natural educational environment. The study was conducted at a private Chilean university with national coverage, offering a bachelor's degree in nursing. The institution's nursing program provides an ideal context for evaluating the integration and perceptions of artificial intelligence (AI) in higher education. This methodological approach ensures robust, context-specific data collection while adhering to established quantitative research principles.

Participants

The study involved 76 second-year nursing students enrolled in a research methodology course at a private Chilean university. Participants were divided into two groups: Group 1 included 36 students, while Group 2 comprised 40 students, with a notable predominance of female participants. Specifically, 55 students were women and 21 were men, reflecting a gender imbalance typical in nursing education programs. The average age of participants was approximately 25 years, indicating a relatively young cohort commonly observed in undergraduate nursing studies.

The diverse gender and group distribution provided a comprehensive representation of the student population, contributing valuable insights into their perceptions and experiences regarding the integration of technology and AI in education. This demographic information establishes the context for the study's findings and ensures a robust foundation for analyzing the educational challenges and opportunities in this specific setting.

Instrument

The instrument used in this study was the Questionnaire on Artificial Intelligence in Higher Education (Q-AIHE), a 20-item questionnaire specifically designed to evaluate undergraduate students' perceptions of AI integration in educational settings. It utilizes a five-point Likert scale, ranging from "Strongly Disagree" to "Strongly Agree," enabling a nuanced understanding of student opinions. The questionnaire items are systematically grouped into three dimensions to capture different aspects of AI's impact on education. Each dimension is tailored to explore students' attitudes toward AI's potential to transform learning processes, improve access to educational resources, and address concerns such as data privacy and fairness, providing comprehensive insights into their perceptions. The items are systematically grouped into three dimensions:

- Impact on Learning (*il*) – Includes 7 items assessing AI's role in enhancing learning processes, personalization, and resource access.
- Institutional Benefits (*ib*) – Comprises 9 items that focus on the advantages of AI for administrative efficiency, communication, and institutional support.
- Social Concerns (*sc*) – Contains 4 items addressing ethical issues, equity concerns, and data privacy related to AI use.

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It is important to highlight that this instrument underwent a rigorous review process conducted by a panel of expert judges. These professionals, possessing extensive experience in both nursing education and AI implementation, evaluated the content for clarity, relevance, and alignment with educational objectives. Their feedback ensured the instrument’s validity and reliability, making it a robust tool for integrating AI technologies into nursing education. This expert validation process not only enhances the instrument’s credibility, but it also confirms its potential to deliver meaningful insights and improvements within academic and clinical settings.

Additionally, the questionnaire features four demographic questions to collect participants' background information, such as, gender, age and semester. This well-structured instrument ensures a thorough and balanced assessment of AI's educational impact, institutional benefits, and related ethical concerns.

Results

The descriptive statistics reveal a generally positive perception of AI in higher education, with most statements receiving means between 3.5 and 4.1, indicating agreement or strong agreement. The highest-rated statements include *"AI facilitates access to higher education in more contexts and regions" (4.079)*, *"AI has facilitated my adaptation to online classes" (4.079)*, and *"Chatbots offer academic and administrative support" (4.118)*. These results suggest that participants value AI’s capacity to expand accessibility, streamline online learning, and provide institutional support. Similarly, personalization of learning experiences (3.868) and adaptability to student progress (4.118) were also highly rated, reinforcing AI’s role in enhancing tailored education. However, ethical challenges surrounding AI algorithms (4.145) remain a notable concern, reflecting participants' awareness of potential ethical dilemmas and the need for responsible AI implementation.

Interestingly, the statement *"I believe that AI can positively transform learning and teaching"* received a comparatively lower mean of 2.461, suggesting notable skepticism about AI's transformative impact on pedagogy. This contrasts sharply with the higher agreement regarding AI’s practical benefits, such as improving autonomous learning (3.934) and access to educational resources (3.947). Participants also expressed concerns about inequalities in access to education (3.868) and data privacy issues (3.500), which highlight ongoing anxieties that may hinder full acceptance of AI tools. These concerns reflect broader debates on the ethical implications of AI adoption in education. Moreover, the relatively high standard deviations, particularly in statements addressing data privacy (1.013) and communication improvement (1.045), indicate significant variability in participants' experiences and perspectives. Overall, while participants acknowledge AI’s functional advantages, ethical and implementation-related concerns create clear tensions regarding its adoption.

Table 2: *Descriptive Statistics of the Q-AIHE*

	Valid	Mean	Std. Deviation
1. I am concerned about the privacy of my personal data when using AI systems.	76	3.500	1.013
2. AI enables the personalization of students' learning experiences.	76	3.711	0.921
3. I believe that AI could increase inequalities in access to education.	76	3.868	0.838
4. I am aware of the implementation of AI tools in my educational institution.	76	3.750	0.954
5. AI personalizes educational content according to my needs and preferences.	76	3.868	0.900
6. I believe that AI can positively transform learning and teaching.	76	2.461	0.958
7. AI has improved my access to learning resources efficiently.	76	3.947	1.018
8. AI has improved my ability to learn autonomously.	76	3.934	0.869
9. AI facilitates access to higher education in more contexts and regions.	76	4.079	0.891
10. AI has improved my communication with peers and instructors.	76	3.618	1.045
11. AI will play an even more significant role in the future of higher education.	76	3.855	0.812
12. I have accessed educational resources that use AI to adapt to my progress.	76	4.118	0.848
13.The current implementation of AI in my institution has been positive.	76	4.118	0.832
14.I perceive ethical challenges in the use of AI algorithms in education.	76	4.145	0.860
15. AI has facilitated my adaptation to online classes.	76	4.079	0.860
16. AI can offer concrete benefits in university education.	76	4.066	0.772
17. Chatbots offer academic and administrative support.	76	4.118	0.799
18. AI will improve the quality of learning in the coming years.	76	3.789	0.838
19. AI has improved academic and administrative management in my institution.	76	3.934	0.838
20. I believe AI will significantly benefit specific areas of higher education.	76	3.974	0.848

Source: Own elaboration.

Reliability of the Instrument

To evaluate the internal consistency of the instrument, Cronbach's Alpha coefficient was calculated. The analysis yielded a Cronbach’s Alpha value of 0.96 for the 20 items included in the instrument. This result indicates excellent reliability, as values above 0.9 are generally considered to demonstrate a very high level of consistency among the items (Table 2).

Table 2: *Cronbach’s Alpha*

Cronbach’s Alpha	Number of Items
0.96	22

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Key Findings

The following section presents some key findings derived from this study:

1. **Perception of AI's Role in Education:**
   - Participants expressed strong agreement with statements highlighting AI's positive contributions to education, particularly:
     - AI facilitates access to education in diverse contexts and regions (mean = 4.079, SD = 0.891).
     - AI supports adaptation to online learning (mean = 4.079, SD = 0.860).
     - AI offers academic and administrative support via chatbots (mean = 4.118, SD = 0.799).
     - AI personalizes learning resources according to progress (mean = 4.118, SD = 0.848).
     -
2. **Concerns and Ethical Challenges:**
   - There are notable concerns regarding the ethics and inequalities in AI use:
     - Participants agreed with statements about ethical challenges (mean = 4.145, SD = 0.860).
     - AI's potential to increase inequalities in access to education (mean = 3.868, SD = 0.838).

3. **Positive Impact of AI Tools:**
   - Respondents believe that AI has enhanced:
     - Access to learning resources efficiently (mean = 3.947, SD = 1.018).
     - Autonomous learning (mean = 3.934, SD = 0.869).
     - Quality of learning and teaching in higher education (mean = 4.066, SD = 0.772).

4. **Mixed Awareness and Future Expectations:**
   - Participants reported moderate awareness of AI implementation in their institutions (mean = 3.750, SD = 0.954).
   - The belief that AI will significantly shape the future of higher education remains strong (mean = 3.855, SD = 0.812).

5. **Less Consensus on AI's Transformative Power:**
   - Interestingly, AI's potential to transform learning and teaching received lower agreement (mean = 2.461, SD = 0.958), suggesting mixed opinions or a lack of observed impact.

Discussion

The findings of this study reveal a generally positive perception of AI integration in nursing education, with most students acknowledging its role in enhancing accessibility, resource efficiency, and personalized learning. For instance, tools such as AI-driven simulations and adaptive platforms were valued for their ability to provide tailored educational support and immediate feedback, aligning with previous research (Glauberman et al., 2023). However, the comparatively lower perception of AI's transformative potential in learning and teaching ($M = 2.46$) indicates skepticism regarding AI's pedagogical impact. This result may stem from insufficient practical exposure or inadequate AI literacy, highlighting the need for curriculum adjustments to incorporate AI effectively.

The concerns surrounding ethical issues, particularly data privacy and algorithmic bias, are consistent with broader discussions on AI in healthcare education (Clancy, 2020). Although students appreciated AI's capacity to streamline learning processes, the findings suggest a lingering unease regarding the ethical implications and potential inequities in AI deployment. Addressing these concerns through ethical training and transparent AI frameworks is essential for fostering trust and confidence among future healthcare professionals. Moreover, the variability in responses (notably in data privacy and communication) suggests diverse student experiences, possibly influenced by differences in access to technology and familiarity with AI tools.

Conclusion

In conclusion, the study highlights both the opportunities and challenges of integrating AI into nursing education. While students recognize AI's benefits in facilitating personalized learning, improving access to educational resources, and enhancing clinical preparedness, concerns regarding its ethical implications and limited practical exposure remain significant barriers. To address these gaps, nursing programs must prioritize comprehensive AI literacy training, ethical considerations, and hands-on experience with AI tools.

Moving forward, strategic initiatives, including curriculum redesign, faculty development, and collaboration with healthcare technology providers, will be critical to ensuring a balanced and effective integration of AI. By equipping nursing students with the necessary skills, technological proficiency, and ethical awareness, institutions can prepare a future-ready nursing workforce capable of leveraging AI to improve patient care and navigate the complexities of modern healthcare environments.

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TENDENCIAS

La Red Internacional de Investigadores en Educación (REDIIE) organiza el **III Congreso Internacional de Aprendizaje Activo (CIAA 2025)**, programado para el 28 y 29 de febrero de 2025, en modo híbrido en La Serena, Chile. Este evento reúne a educadores, investigadores, y profesionales de todo el mundo para compartir y explorar las mejores prácticas, innovaciones y avances en el ámbito del aprendizaje activo. A través de ponencias y diversas actividades académicas facilitaremos el intercambio de ideas y experiencias, promoviendo una comunidad global comprometida con la mejora del aprendizaje y la enseñanza. Este congreso es una oportunidad única para discutir cómo el aprendizaje activo puede transformar la educación, haciendo que los estudiantes sean participantes activos en su proceso educativo. Se aceptan propuestas en español, inglés y portugués.

Ejes temáticos:

- Innovación en metodologías activas
- Tecnología y herramientas digitales para AA
- Aprendizaje adaptativo
- Evaluación y medición para AA

NOTAS FINALES

Revista Electrónica Transformar® es una publicación científica, con sistema de pares ciegos, editada y publicada por Centro Transformar SpA, una consultora en gestión organizacional y educacional, con base en Chile, con la colaboración de investigadores chilenos y españoles. Como tal, cuenta con código ISSN 2735-6302. La abreviatura de título según las normas del ISSN es *"Rev. electron. Transform"*. Este último puede ser usado para efectos de citación y/o referencias bibliográficas.

Nuestra revista se publica tiene una periodicidad trimestral. Nuestro objetivo es mostrar las principales tendencias en educación y ayudar a diseminar las experiencias metodológicas del profesorado de educación primaria, secundaria y terciaria, a nivel nacional e internacional, permitiendo compartir sus mejores prácticas (*benchmarking*) de manera de potenciar y apalancar las competencias del estudiantado de cara a los desafíos del siglo XXI.

Para lograr nuestro objetivo, hemos definido las siguientes secciones principales: *Tendencias en educación, Experiencias docentes, Gestión educacional y Entrevistas*. Estas secciones serán desarrolladas con rigor académico, enriquecidas con los valiosos aportes experienciales del profesorado y dispuestas en la revista, según las necesidades editoriales. De este modo y teniendo como foco la construcción interdisciplinar del pensamiento pedagógico, ***Transformar*** busca el análisis de teorías y enfoques metodológicos de aprendizaje-desarrollo, la reflexión académica, la diseminación de conocimientos y el intercambio generoso de experiencias educativas. En este contexto, ***Transformar*** ofrece un espacio para el intercambio, la diseminación y promoción de la educación inclusiva y sostenible, relevando el paradigma del aprendizaje permanente (*life-long learning*) y el cuarto Objetivo de Desarrollo Sostenible (ODS 4) de las Naciones Unidas.

Actualmente, nuestra revista se encuentra corriendo bajo la plataforma Open Journal Systems.

Tipos de aportes: Artículos originales derivados de investigaciones, actividades educativas transformadoras, revisiones bibliográficas, experiencias educativas, ensayos y entrevistas de interés educativo, en idioma español, portugués e inglés.

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