Learning in the Digital Age: The Educational Revolution with Artificial Intelligence and LKT

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Abstract: This study explores the transformative impact of Artificial Intelligence (AI) and Learning and Knowledge Technologies (LKT) on contemporary education, emphasizing how digitalization redefines teaching and learning processes. Within a constantly evolving society, AI has emerged as both a driver of innovation and a source of educational challenges, particularly regarding the roles of teachers and students and the nature of learning itself. Empirical findings indicate that students improve their academic performance, attention, and motivation by an average of 85% in core subjects such as mathematics, language, history, and science. The research adopts a positivist paradigm with a quantitative, hypothetical-deductive approach and a correlational design, combining documentary and fieldwork methods. Data collection involved surveys, interviews, and observations conducted with both teachers and students. The results demonstrate that the integration of AI and LKT fosters active, personalized, and meaningful learning experiences, contributing to the development of essential skills such as digital literacy, critical thinking, and collaborative problem-solving—key competencies for thriving in a global and dynamic digital society.
Keywords: AI, LKT, TICCAD, Learning, Digital age, Disruption, Teaching.

1 Introduction

Since the origin of humankind, it has been observed how important it is to analyze the evolutionary and adaptive process it has undergone over the years. Unlike other species, it possesses a fundamental element: cognitive capacity, which allows it to reason about the events and processes that occur in its environment, establish relationships among them, and become a protagonist in historical and social changes.

Along this path, scientific knowledge has enabled the development of innovations that today make a significant difference in everyday life. Among them, Artificial Intelligence (AI) stands out as one of the most meaningful advances, with its ability to design, create, build, and innovate technological systems, machines, or programs capable of performing complex tasks that previously could only be executed by the human mind. This potential has incorporated AI into various spheres of society and, in particular, into education, where its impact on teaching–learning processes is being analyzed.

According to various authors, AI has been established as one of the most fascinating and challenging fields in computer science, since it stems from the premise that intelligence is the characteristic that differentiates humans from other species, whether living or inanimate, with the purpose of creating intelligent programs or computers. Today, it is recognized as a fundamental discipline at the intersection of science and technology, aiming for technological systems to replicate activities derived from human reasoning. What is relevant is not only simulating ways of thinking, but also analyzing the scope and limitations involved in integrating AI into cognitive processes.

The emergence of AI in education has generated both amazement and uncertainty, transforming the way learning is conceived and experienced. This social phenomenon is part of what several researchers have called learning in the Digital Age: The Educational Revolution with Artificial Intelligence and Learning and Knowledge Technologies (LKT), where knowledge is permanently constructed and reconstructed through access to devices, digital applications, platforms, and an overabundance of information available online. This context has given rise to new educational possibilities which, at the same time, raise profound questions about what is actually being learned and how it is being learned.

Learning and Knowledge Technologies become strategic allies of this educational revolution, offering a set of tools designed to strengthen teaching processes and foster meaningful learning. The use of LKT seeks to ensure that technology is not an end in itself, but rather a means to support innovative methodologies that enhance students' cognitive skills. Within this framework, Artificial Intelligence has not only contributed to the development of these technologies but has also driven a disruptive change in the way knowledge is constructed.

However, this change is not exempt from risks. The mass adoption of digital technologies entails challenges related to the responsibility of those who use them, the quality of learning they promote, and the ethical implications of delegating reasoning processes to technological systems. The disruption generated by AI in learning not only questions traditional methodologies but also forces a rethinking of the roles of teachers and students in a scenario where knowledge is constantly transformed.

Therefore, it becomes essential to reflect on the following questions: Where does responsibility lie in the use of AI and LKT? What is truly being learned? To what extent is this learning meaningful and not just a mere automated reproduction? These questions gain greater strength in a society that is experiencing an educational revolution marked by technological innovation, but that at the same time demands a critical and pedagogical perspective capable of guiding learning toward the integral development of the human being.

2 Theoretical Framework and State of the Art

2.1 The Role of AI and LKT in the Transition from Traditional Education to Education 4.0

Citing Schwab (2016) in the work of Sifuentes, Sifuentes, Rivera (2022), throughout history there have been four industrial revolutions: the first driven by the implementation of hydroelectric and steam-powered machines; the second by the introduction of mass production and assembly lines; the third by the automation of production through electronics and computing; and the fourth by the use of disruptive technologies to ensure total quality in production processes (Sánchez et al., 2021). The current so-called connectivity revolution has had a profound impact on contemporary societies, as it has disrupted certain paradigms, bringing a series of changes to educational processes through the implementation of new methodologies, models, instructional strategies, platform use, and system design, ultimately moving away from traditional models.

The National Polytechnic Institute emphasizes that Education 4.0 is grounded in key trends of innovation and change. Learning in the context of the 4.0 revolution focuses on 21st-century competencies such as self-direction, self-assessment, and teamwork (Hernández Sampieri, Fernández Collado, Baptista Lucio, 2014). In the current context, this Education 4.0 revolution involves constant interaction between humans and artificial intelligence systems within cyber-physical environments, which lay the foundation for the so-called smart industries that transform life and social and productive relations in modern societies.

According to Sifuentes, Sifuentes, Rivera (2022), Industry 4.0 has generated a new revolution that combines innovative production techniques through the use of intelligent systems designed to integrate with organizations and individuals. It is known as the Fourth Industrial Revolution, which is erasing the boundaries between physical, digital, and biological spheres Sánchez et al. (2021). Humanity constantly experiences changes, and it is necessary to acknowledge that societies are dynamic; they are undergoing rapid transitions, affecting the way people live, relate, work, and educate themselves. This represents an interesting growth process and adaptation to artificial intelligence and LKT, whose adoption has expanded globally.

Giber Delgado et al. (2023) affirm that Education 4.0 represents a new era in education, driven by technology and focused on improving learning outcomes and student experiences. The integration of AI and LKT in educational environments has the potential to transform traditional approaches, significantly enhancing teaching and learning processes. These technologies serve as alternatives for in-person, online, and distance learning by leveraging all available digital tools and virtual realities to meet the needs of all social actors involved.

Education remains one of the essential pillars and instruments for progress, as it can be accessed by more people in a shorter time due to its speed and accessibility, aiming to improve, update, and meet human needs. Toro (2020) as cited in Sifuentes, Sifuentes, Rivera (2022) notes that Education 4.0 is an approach reflected in academic models, prompting reconsideration of what to teach, how to teach, and how to evaluate learning (Sánchez et al., 2021). This technological process represents a revolution shaping innovation across production systems, with the goal of creating new intelligent systems to transition from traditional educational models to Education 4.0, where the systematization and interaction of cyber-physical systems prevail, ushering in a new educational paradigm.

Artificial intelligence represents a fundamental component of computing, aiming to develop systems capable of performing tasks once thought to require human intelligence. According to Bolaño García (2024), AI has revolutionized multiple fields, education included. From automating administrative tasks to personalizing learning, AI offers numerous opportunities to enhance educational quality (Becerra, Magnani, 2024). In the educational sector, AI and LKT have rapidly evolved, becoming essential components in societal transformation.

Learning and Knowledge Technologies (LKT) focus on leveraging technology to promote learning, guiding humans toward knowledge construction. These technologies consist of effective tools used to design enriching and meaningful educational strategies, adaptable to the needs of both teachers and students. Education 4.0 is transforming not only how subjects are conceptualized but also the educational reality itself, observable in how education is delivered and adapted through LKT in classrooms.

As emphasized by Chimbo, Triviño, Ortiz, Cordero (2025), LKT have opened new opportunities for teachers, students, educational environments, and institutions, requiring attentiveness not only to their formative use and content development but also to the interactive and contextualized methodologies applied in teaching-learning processes. This progress points toward a generation focused on generating globalized knowledge and collaborative work, enabling changes and transformations in learning processes, in which the educational sector cannot remain passive. Rather, it represents a crucial moment for development and implementation in new contexts.

As Proaño Zambrano, Marcillo Arboleda (2024) suggests that the use of LKT has gained prominence in recent years, particularly in education, as an essential tool to address diverse learning needs (Blanco Alarcón, 2021). The rise of AI and LKT has been highly favorable for the development and growth of high-quality resources and programs, simplifying educational tasks in creative and innovative ways that previously required human execution.

As Herrera et al. (2024) states that the Fourth Industrial Revolution is characterized by the introduction of highly innovative technologies, processes, and practices, with AI as one of the most prominent elements (Gutiérrez Esteban, 2022). The adoption of these technologies seeks to enable a transition from traditional educational systems, requiring reorganization and management of classroom processes, assessment methods, pedagogical theories, methodologies, and professional development.

As Fidalgo Blanco et al. (2022) asserts, technologies used in Education 4.0 must facilitate competency transfer processes, enabling real-time communication, knowledge exchange, and cloud-based data and knowledge management. Research efforts are developing tools to measure competencies associated with 4.0 technologies (Diego Olite et al., 2023). These changes have led to AI and LKT fostering digital competencies for both students and teachers, as well as skills such as critical thinking, creativity, decision-making, and problem-solving, making them fundamental for learning success.

According to Sifuentes, Sifuentes, Rivera (2022), disruptive innovation so called for rendering previous methods abruptly obsolete offers modern educational options, influencing educational policy, learning theories, curricula, and educational values, and encouraging the integration of knowledge through dual training that combines academic and labor skills (Sánchez et al., 2021). A key aspect of Education 4.0 is fostering skill development and creating well-rounded individuals capable of enhancing knowledge creation, skills, and attitudes for life, work, and school.

Education 4.0 aims to adapt to the new reality. AI and LKT play a supportive role in the transition from traditional to Education 4.0 models; they do not fully replace traditional education but transform it to meet contemporary needs.

As Coronel Guillén (2024) emphasizes, educating in the 21st century goes beyond knowledge transmission; it requires developing competencies related to current issues, demanding a flexible and dynamic approach (Bolaño García, 2024). This context presents challenges for the educational system, highlighting deficiencies in outdated policies and models. The new

system requires efficient structures clearly adapted to modern contexts to facilitate the transition from traditional systems to Education 4.0.

AI and LKT are effective allies for educators, contributing to the development of both specific and transversal competencies across educational levels, enhancing learning outcomes, productivity, and engagement. This signifies a reconfiguration of how reality is perceived, positioning us within an educational revolution that demands critical analysis.

2.2 Artificial Intelligence as a Driver of Personalized Learning

Satya Nitta, in the work of Fernández de Silva (2023), states that artificial intelligence in education represents an exciting opportunity to create a more personalized and effective learning experience for each student (Diaz Guecha, Marqués, 2020). AI has proven to be a powerful tool that has enhanced education in various ways. Today, technology has become an integral part of human life over many years and across multiple domains, not only in daily routines. In the educational context, however, it has facilitated the learning process and the completion of various activities, including administrative tasks. Thus, AI has emerged as one of the most significant innovations in recent years.

As noted by Becerra, Magnani (2024), the term "artificial intelligence" carries social connotations that invite discussion. The concept was coined in the 1940s 50s, arising from pioneering developments in cybernetics a convergence of mathematicians, psychiatrists, and computer scientists seeking to model and replicate human cognitive processes and abilities through technology, in order to understand their functioning (Arreola Marín et al., 2024). Consequently, the advances and growing interest in recent years have marked a turning point in the field of learning, encompassing a range of knowledge through the creation of technological tools such as ChatGPT, which prompt reflection on the successes, achievements, or disruptions AI introduces to human learning.

According to Fernández de Silva (2023), the first research in the field of Artificial Intelligence emerged during this era, when scientists and researchers began exploring the possibility of creating machines capable of thinking and learning in ways similar to humans. As AI has progressed, its potential for integration across different fields of study, including education, has been explored. AI has been used in various projects, applications, and systems that enable the creation of more personalized, accessible, and efficient educational environments.

As Mujica (2024) highlights that the historical trajectory of AI is profoundly fascinating, spanning more than half a century filled with intensive research, remarkable advancements, and significant paradigm shifts in understanding and applying this scientific discipline (Licona Quiterio, 2024). The history of AI is a narrative of progress, challenges, hypotheses, theories, studies, and discoveries that have fueled the interest in understanding how it has been implemented in education, marking a turning point in learning and assessing its societal impact. Its implementation is highly efficient, allowing students to optimize their time, develop their learning potential, and consequently improve academic performance by ensuring precise and effective education.

AI can be conceptualized as the ability of certain technological tools to perform tasks and make decisions by simulating human intelligence, with evident impact when applied in education. This has transformed knowledge paradigms and significantly influenced how humans learn. Paredes et al. (2024) assert that AI has become an essential tool that helps personalize learning, providing a more inclusive education and enabling participation tailored to individual learning needs and styles. Today, AI acts as a facilitator in education, simulating aspects of human intelligence and reinforcing content and skills through personalized, meaningful learning experiences.

In education, AI is becoming a central pillar and is projected to see increasing demand in the future. It is radically transforming the educational system, the roles of social actors involved in learning, and classroom learning processes through the use of intelligent tools capable of providing guidance for research projects, essays, or reports. As technology continues to advance, AI will play a key role as an engine of personalized education across different levels, as these innovative technologies are now essential for accessing quality knowledge.

Similarly, AI has transformed educational processes by simplifying activities such as assignments, making learning techniques more accessible, as a wide range of digital teaching resources are currently available. The goal is to make classroom content innovative and creative, highlighting the importance of transforming the teacher's role and recognizing the necessity of AI for personalized learning.

In other words, AI in education is used to analyze data, generate content, and adapt learning to individual needs, providing personalized recommendations, resources, and strategies. This enables students to access an educational model tailored to their interests, prior knowledge, and skills, ultimately enhancing their learning process and academic success.

This implies that AI can be employed to identify frameworks for quantitative and qualitative assessment of academic performance through various parameters or indicators. It enables the design of more effective lessons, supporting teachers in adjusting their methodology to improve educational practice. By implementing these tools, AI serves as a fundamental driver for personalized learning both inside and outside the classroom. In recent years, intelligent learning systems have been developed to help students learn at their own pace while also designing and establishing virtual learning environments.

One of the most striking benefits of personalized learning is that AI can analyze content, identify both group and individual learning pace, design assessment instruments, and provide formative, co-, and hetero-evaluations. By implementing educational resources and suggestions, AI generates a personalized learning impact, enabling each student to progress according to their needs. Teachers can continuously monitor and provide feedback, making AI a tool for more inclusive and accessible education.

According to Chen (2022), cited in González (2023), various AI applications are currently being explored in education, including personalized learning, automated assessment, intelligent tutoring, and early detection of learning difficulties. One of the most prominent areas of research in AI in education is personalized learning, which focuses on using machine learning algorithms to address student-specific needs and characteristics, thereby improving the learning process.

AI has the potential to adapt to the individual needs of each student. Based on academic performance analysis, AI can provide immediate feedback on student outcomes, enhance learning processes, and introduce innovative teaching methods more effective than traditional approaches. Over time, AI has become increasingly accessible across diverse learning contexts, enabling students to access high-quality educational resources.

Thus, AI has become a valuable tool for significantly enhancing education, acting as a transformative engine capable of delivering personalized, effective learning experiences and expanding access to quality education. It supports teachers in their work while driving innovation in teaching and learning processes.

2.3 Challenges and Future Prospects of the Synergy between AI and LKT

According to Murga Menoyo (2023), synergy is a concept embedded in the fundamental framework of systemic theories, which allows for the designation of a property of systems that manifests as the effect resulting from the reciprocal interaction among two or more of their constituent elements (Martínez Godínez, 2013). Synergy emerges as a priority strategy in the integration of AI and LKT, particularly in education, where it represents a significant advancement for the evolution of this system within 21st-century learning processes, both as a challenge and a projection for the future. Questions have arisen such as: What will the future offer us? How will education evolve in the coming years? Will AI and LKT remain two substantial phenomena in the educational system?

It is necessary to understand how transformation processes have been occurring and the impact they have generated in different societies. Accordingly, Fernández de Silva (2023) notes that in recent years AI has had a significant impact worldwide, particularly in education, and it is expected that this influence will continue to grow in the future, improving the efficiency and effectiveness of educational processes (Diaz Guecha, Marqués, 2020). AI emerges from the need to rethink education and seeks opportunities to address the challenges of the modern world by preparing future generations for comprehensive development in a highly competitive and technologically driven labor market, where mastery of digital environments is essential for the advancement of critical thinking.

Currently, societies are influenced by the digital era, and the impact of AI and LKT is evident, having revolutionized teaching practices. The teacher plays a key role as a facilitator of learning supported by these technological resources, expanding their role beyond traditional instruction. Simultaneously, students play an important role in hybrid learning environments, constructing their own learning. AI in education provides tools to personalize learning through adaptive systems that respond to students' individual needs, optimizing their academic progress. Likewise, LKT have been integrated into educational environments from various perspectives, offering a wide range of uses by proposing new ways to teach and learn, transforming the education model, and establishing new challenges and projections for the future.

From the perspective of Solís Garmendia (2024), artificial intelligence is catalyzing a profound transformation in the educational field, not only redefining teaching and learning tools but also global pedagogical strategies (Sánchez Flores, 2019). The challenge lies in understanding how AI and LKT have transformed contemporary learning by stimulating curiosity and the desire to explore new knowledge. This occurs when social phenomena significantly alter existing systems, as seen in the area of educational technology and innovation. AI and LKT now take center stage in teaching, being accessible, innovative, versatile, and motivating. It is essential to identify needs and available resources, as this integrated approach promises a learning experience that is balanced, inclusive, and personalized, better preparing students for future challenges.

Thus, the synergy between AI and LKT represents a substantial advance in achieving comprehensive, personalized learning, an indispensable challenge for 21st-century societies. Despite ongoing exploration, study, and the potential still to be unlocked, this synergy can transform learning into an essential tool for educational progress across different social contexts and educational levels, aiming to consolidate a strong, inclusive, and effective foundation. Consequently, authors Paredes et al. (2024) explain that integrating these two areas creates a more holistic educational environment, facilitating timely interventions and teaching strategies that address both intellectual needs and technological implementation.

Currently, AI and LKT are increasingly used together to create new applications and services. As AI continues to develop, its relationship with LKT is expected to strengthen, deepening future exploration of this domain, as both have the potential to transform the educational system, enhancing access and quality. Carbonell (2023), cited in (Paredes et al., 2024), highlights that AI in education provides unprecedented opportunities for the sector to adapt to emerging technological trends. In this context, both students and teachers must innovate to meet new challenges and make the most of available tools to improve the teaching and learning experience.

Today, AI and LKT are fundamental for learning, present in both virtual and physical spaces, enabling students to acquire and create knowledge, develop skills, and explore educational tools that serve as instructional resources. Their implementation goes beyond mere usage, reflecting the evolving role these technologies play in contemporary education. Licona Quiterio (2024) notes that this evolution prepares students for a future in which AI will be a common instrument, emphasizing the importance of adapting the educational system to emerging technological realities.

The correlation between AI and LKT offers opportunities to enhance accessibility and quality in teaching and learning, personalizing educational environments based on the experiences and needs of students and teachers. This includes materials, tools, platforms, apps, and other elements that enable tracking and analyzing individual and group progress while facing the technological challenges of contemporary societies. When both converge, active learning is consolidated, giving students autonomy, decision-making capacity, creativity, and agency over their learning process by interacting with real-world problems.

As these phenomena continue to shape technology and society, the teacher's role is crucial to ensure students are competent to face future challenges. As stated by Mujica (2024), looking forward, integrating AI in education represents the use of advanced technologies to improve the quality, accessibility, and personalization of education. The ultimate goal is to prepare students to thrive in an increasingly technology-driven world, anticipating challenges and adapting educational strategies to overcome them.

It is essential to consider how to prevent education from becoming dehumanized due to misuse or lack of knowledge of AI. This is a significant challenge, now and in the future, requiring reflection on practice, use, and implementation. Many authors emphasize the irreplaceable value of human interaction in teaching, with AI and LKT serving as complementary support tools. Society must recognize the responsibility involved in using these technologies to preserve the human role in education, understanding that they are tools that enhance human knowledge and ingenuity, fostering critical thinking and independent judgment. Excessive or poorly implemented use could threaten the humanization that has historically characterized education, highlighting the need to balance AI and LKT usage with human skills.

Diaz Guecha and Marqués (2020) proposes accompanying extensive use with ethical and academic regulations to ensure content acquisition for professional practice, focusing on comprehensive training, values, and ethical behavior, as well as a strong influence on teaching and learning. It is critical to rethink the educational paradigm, ensuring that learning analysis and application are continuous and guided by ethical and academic standards, maintaining learning patterns while identifying strengths and weaknesses for informed decision-making (Proaño Zambrano and Marcillo Arboleda, 2024). Working with AI requires a preventive and ethical approach across all areas, particularly in education. Teachers and students need to acquire knowledge on managing platforms, plagiarism detection, and alternative strategies to strengthen and develop students' analytical capabilities.

This forward-looking perspective is essential to harness the full potential of AI and LKT in educational transformation, continuously analyzing challenges such as technological dependence, social and emotional issues, and evaluating learning to validate the use of these tools.

2.4 State of the art

It is important to consider the background of research conducted in this same line, as it serves to support and assess its relevance within the educational field. In this regard, one notable article is "TICCAD: A Resource for Higher Education During and After SARS-CoV-2" by Arreola Marín et al. (2024), which emphasizes the importance of the teaching-learning process both inside and outside the classroom through the use of Communication, Knowledge, and Digital Learning Technologies (TICCAD). TICCAD tools are fundamental, primarily used to strengthen teachers' work in developing digital competencies. Currently, the evolution within the educational sector has allowed for the analysis and identification of benefits as well as areas of opportunity that should be considered in the development of curricula and study plans established by the SEP, ensuring a meaningful learning environment in the classroom, as these educational technologies have become invaluable allies.

This study also analyzed the integration of Artificial Intelligence (AI) in higher education, highlighting that AI has been employed to enhance teaching and student learning by providing tools such as intelligent tutoring systems, educational data analytics, and adaptive learning platforms. These technologies have enabled personalized learning, allowing teachers to better address individual student needs and optimize educational resources. Moreover, the article explores the ethical challenges and considerations associated with implementing AI in education (Arreola Marín et al., 2024).

In a second article, "Digital Pedagogy to Transcend Education: Using Emerging Technologies" by (Arreola Marín et al., 2024), the authors argue for the importance of emerging technologies that are transforming digital pedagogy and education in general. The article discusses how teaching innovation involves integrating and utilizing new educational technologies, AI, augmented and virtual reality, and autonomous learning, all of which are redefining teaching and learning methods and strategies.

In this context, the use of technologies to adapt educational content to individual student needs is highlighted, improving accessibility and inclusion. These digital tools facilitate collaboration between students and teachers, promoting interactive and participatory learning. Ethical and practical challenges of implementing emerging technologies in education are also discussed, such as data privacy, equitable access, plagiarism (partial or total), and the ongoing debate about whether technology and AI truly enhance student learning (Arreola Marín et al., 2024).

Furthermore, the article invites reflection on how these technologies can shape the future of education, fostering a more innovative and effective pedagogy. It reminds us that the ultimate goal of education is student learning (Instituto Politécnico Nacional, 2025) and raises several controversial questions: Is it possible that excessive use of TICCAD diminishes students' social and communication skills? What are the ethical challenges associated with using AI in education? What is the role of AI in teacher training and professional development? Can dependence on LKT, TICCAD, or AI lead to a loss of critical thinking and problem-solving skills in students?

In a third article, the authors Proaño Zambrano and Marcillo Arboleda (2025) present their work "Technologies for Learning and Knowledge (LKT) Applied to Special Educational Needs in the Ecuadorian Context" (Blanco Alarcón, 2021). They discuss the impact of LKT in promoting inclusive education, showing favorable outcomes when effective technological tools developed with AI are implemented. These tools have enhanced teaching and learning, particularly for students who previously experienced learning difficulties, becoming a transformative element in inclusive education and fostering students' interest in using and exploring these technological resources.

Similarly, in today's society, LKT represent a significant advancement in educational development due to their positive impact in the digital era. By designing tools aimed at improving and incorporating new teaching and learning processes, LKT reflect meaningful progress enabled by the evolution, implementation, and accessibility of AI in the educational sector.

In a fourth article, "Use of LKT as Didactic Tools in the Teaching-Learning Process of Basic Education" by Romero et al. (2024), the authors discuss digital competence in basic education students through the use of LKT as didactic tools in the teaching-learning process. They propose a didactic strategy that provides actions contributing to skill development (Proaño Zambrano and Marcillo Arboleda, 2024), based on scientific and methodological work that enables teachers to implement AI and LKT in their educational practice, aiming for students to become competent in the digital environment of the future.

Furthermore, this approach allows students to develop a range of skills and attitudes through the creation of meaningful activities that enhance their learning. This strategy is essential, as it serves as a didactic support resource for teachers in their professional practice, enabling their teaching methods to be applied effectively in new digital scenarios.

3 Methodology

This research was developed based on the principles of the positivist paradigm, primarily because it allows an approach to reality through the study of a social phenomenon within a specific context, and even operationalizes using the hypothetical-deductive method, as it is a research model applicable to social aspects that are usually based on studies aiming to test a formulated hypothesis, which is the second characteristic of this paradigm.

According to Diego Olite et al. (2023), the positivist paradigm seeks the facts or causes of social phenomena independently of individuals' subjective states; here, the only acceptable knowledge is scientific. One of its prominent elements is the use of the quantitative approach, which aims to identify and ensure precise results obtained from statistical data. In this way, this paradigm demonstrates interest in verifying knowledge.

For the feasibility and development of the research, the approach that supports the study is quantitative, considering that this approach allows for the identification of the sample and reflection on a broader perspective of the phenomenon by using data that can be quantified, representing social reality through graphs and statistics collected and analyzed using informatics, statistical, and mathematical tools. This allowed for the identification and analysis of results, which will be presented in another section.

According to Fidalgo Blanco et al. (2021), the hypothetical-deductive method consists of generating hypotheses from two premises one universal and one empirical with the purpose of perceiving phenomena and explaining their origins or causes. The deductive procedure is equally important for analyzing the information collected from the phenomenon, serving as a means to control the validity or acceptability of scientific theories.

For this reason, the research is supported by the hypothetical-deductive method, which is evident in the proposed series of essential steps: observing the phenomenon under study to create a hypothesis that explains it, and then proceeding through a series of elementary deductions that form the hypothesis to obtain verification or confirmation of reality, subsequently comparing them with experience.

The research conducted is both documentary (also known as desk research) and field-based. Its realization relied on consulting various primary and secondary documentary sources to provide a theoretical foundation. The fieldwork was conducted to obtain first-hand information through participant and non-participant observation.

Consequently, the fieldwork took place at the site where the social phenomenon occurs, involving direct contact with the object of study. This included designing the research plan, selecting the sample, considering the methods for data collection and analysis through techniques and instruments, with the purpose of interpreting, analyzing, and presenting results to support the investigation.

One of the purposes of conducting both documentary and field research was supported by a correlational approach. According to Coronel Guillén (2024), correlational research aims to determine the relationship or degree of association between two or more concepts, categories, or variables within a sample or specific context. These correlations are based on hypotheses subjected to testing. The key aspect of this approach lies in analyzing how one variable behaves in relation to others that are connected, seeking to understand, measure, and evaluate the correlation between variables in the study.

Data collection occurs directly from reality, without manipulating, controlling, or altering critical information about any variable. The goal is to obtain data through scientifically designed and appropriate techniques and instruments that facilitate analysis, interpretation, and projection of results. Techniques and instruments serve as the means for gathering information during the research process to understand and analyze the behavior, changes, and attributes of the phenomenon studied. They can include any resource, device, or format either paper-based or digital that not only enables the collection but also allows recording and storage of data, facilitating subsequent measurement and presentation.

The techniques used in this scientific research are surveys, interviews, and participant and non-participant observation, as each technique has a specific purpose for data collection. According to Guacán Tandayamo, Lozada, Cruz Gaibor (2023), a survey is

defined as research conducted on a representative sample of a larger group, using standardized questioning procedures to obtain quantitative measurements of a wide range of objective and subjective characteristics of the population. In other words, the survey is a descriptive technique that allows for detecting significant elements to record observable circumstances and questioning key informants on aspects relevant for hypothesis verification.

The interview is a highly useful technique for collecting information during the research process due to its flexibility, allowing dialogue between the researcher and the key informant to obtain verbal responses to questions designed for analyzing and understanding the social phenomenon. The information obtained presents advantages, as it allows for clarification during the process.

Observation gains credibility because it provides direct and reliable information through contact with the study group, provided it is conducted in a systematic and controlled manner. This technique focuses on detailed and systematic visualization of the social phenomenon, whether naturally occurring or resulting from human intervention in the social environment.

This study is characterized by using this technique through interaction and involvement in the context, thus employing both participant and non-participant observation. The goal is to achieve knowledge through direct involvement, seeking inclusion in the reality of the object of study, which increases its value and reliability.

All instruments must meet two essential requirements: reliability and validity. The instruments used include the closed-ended questionnaire for the survey, the interview guide, and the observation guide. The questionnaire is a fundamental instrument for data collection, comprising questions related to facts or aspects relevant to the research, to be answered by key informants.

Due to the characteristics of this research, the questionnaire was considered the primary instrument for data collection. Its design considered several specific features to ensure reliable data collection.

The interview guide serves as the key instrument, outlining questions to identify the points to be addressed, specifying the type of interview to be conducted. The researcher uses this instrument to analyze the development of the activity.

The observation guide is designed to record and identify characteristics of the context under study, allowing for in-depth recording of information. This instrument also considers detecting special needs identified at the group or individual level, as applicable.

The unit of analysis is essential in research, as it includes the main environment and sample studied, considering the determination, type, calculation, and identification of population elements involved, including students and teachers, who meet the sampling parameters.

Once the methodology was established, the essential elements contributing to the development of the research are highlighted. The general objective of this exploration was to determine whether AI in relation to LKT generates learning in basic-level secondary education students. The specific objectives are:

- To understand the concept of AI and LKT and their use as technological tools in education.
- To identify the characteristics of the learning process to determine how AI supports student learning.
- To analyze the effect of access to and use of LKT on learning development.
- To promote the integration of AI and the use of LKT by teachers and students in secondary education to improve learning outcomes.
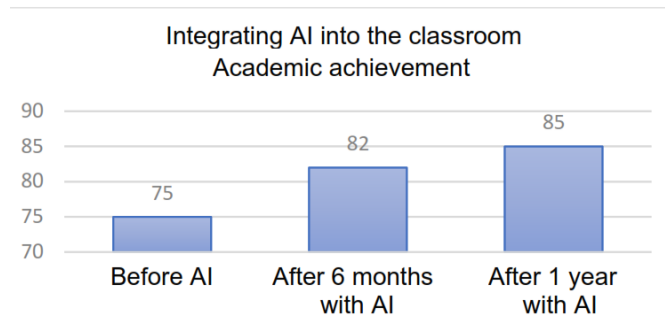
Furthermore, the guiding hypothesis for this inquiry is: AI in relation to LKT fosters meaningful learning among secondary-level students. The research variables are defined as follows (see Table 1):

Table 1. Categories of analysis.

VARIABLE X *AI-LKT*	*X1. Technological Tools* *X2. Educational Technology* *X3. Learning and Knowledge Technology (LKT)*
VARIABLE Y *Learning*	*Y1. Teaching Process* *Y2. Learning Process* *Y3. Autonomous Learning* *Y4. Digital Learning* *Y5. Meaningful Learning*

3 Results

According to the analysis conducted using the instruments applied in this basic-level inquiry at Escuela Secundaria Técnica No. 32 "Emma Palmer," located at Libramiento Sur No. 400, San Miguel Curahuango, Maravatío, Michoacán, surveys were administered to second-grade students (34 pupils) in the morning shift, as well as to the entire teaching staff, totaling 17 teachers. In addition, interviews were conducted, and relevant observations were made to determine whether the integration of AI and the use of LKT support student learning. This study was carried out during the 2022–2023 school year. In this regard, the following results are highlighted: To assess whether AI fosters learning in students, a comparison of academic performance before and after implementing AI was conducted. The results showed that at the beginning of the school year, the group's average grade was 75, by midterm it had risen to 82, and by the end of the cycle, the overall average reached 85, considering the subjects previously mentioned. This demonstrates a clear improvement in students' learning (see Graph 1).

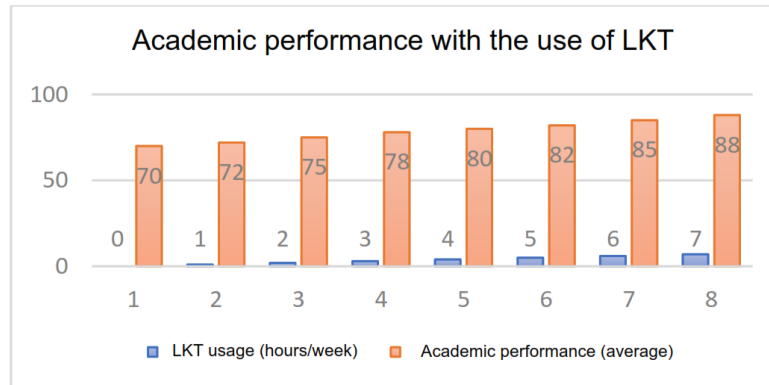**Graph 1**. Assessment Applied to Students: Implementation of AI.

In this regard, the following tools were responsibly used to conduct classes and develop student activities:

Table 2. Classification of AI-Based Tools.

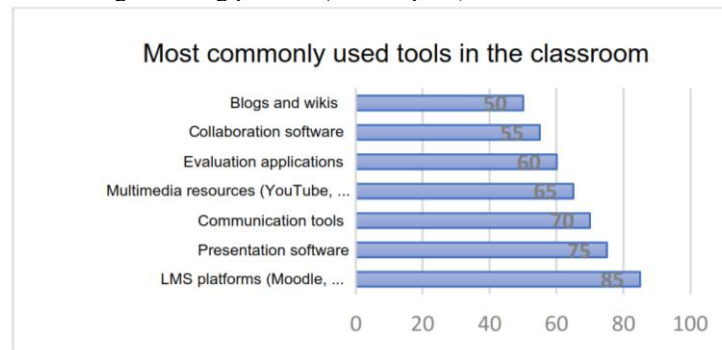| Tools (Aplication)	AI
ChatGPT	✓
Alexa in music	✓
Avatar (interaction)	✓
Canva	✓
Genially	✓
Siri	✓
Duolingo	✓
Grammarly	✓
Brainly	✓
Dragon Speech Recognition	✓

As can be seen in Table 2, all the tools already incorporate AI to support the completion of activities for both students and teachers; these are just some of the most well-known tools applied in this research. The following sections present the results obtained through various graphs, which highlight the outcomes achieved.

Graph 2 allows for the identification of the use and impact of LKT in the classroom, providing valuable information to improve teaching and learning processes through the effective integration of technologies. The following indicates the distribution regarding the relationship between LKT use and students' academic performance.
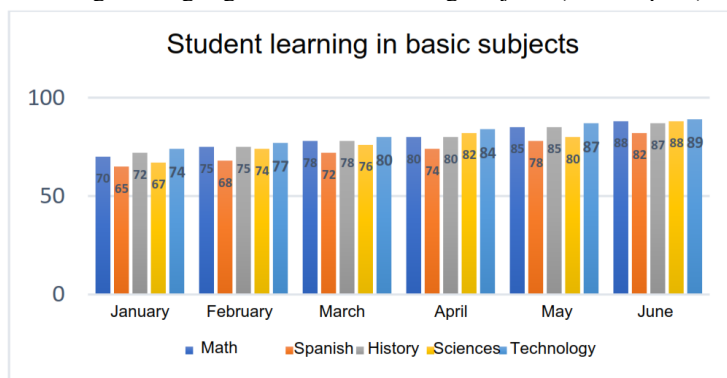

Graph 2. Assessment Applied to Students: Use of LKT.

The following graph shows the LKT tools most frequently used in the educational field, based on usage frequency reported by teachers and students during the teaching–learning process (see Graph 3).

Graph 3. Frequency of Use of LKT Tools.

To determine students' progress in different subjects over the course of this observation and experimentation period, the disruption of AI in their learning was highlighted in the following subjects (see Graph 4):

Graph 4. Students' Learning through AI/LKT.

Once these results have been analyzed in the graphs presented, the following characteristics are determined:

- The implementation of tools that combine AI and the integration of LKT undoubtedly improves students' academic performance, as it was identified that there is an upward trend in grades.
- Progress was achieved in different subjects and topics that were somewhat complex to understand. The impact of AI and its relationship with LKT was evaluated across various areas of knowledge.
- Student satisfaction, and even that of teachers, can be correlated with academic performance and motivation, as well as with the application of digital teaching strategies that favor student learning.
- The relationship between the implementation of AI, learning, and the use of LKT clearly shows that they are a valuable complement for student development, successfully capturing their attention. This disruptive innovation impacts the classroom, particularly in students' learning.
- Therefore, the disruption of AI in student learning and its relationship with LKT lies in its ability to personalize and enhance the educational experience. This is achieved through personalized learning, accessibility and inclusion, task automation, the creation of collaborative environments, and the promotion of autonomous and digital learning.

Undoubtedly, the integration of Artificial Intelligence with Learning and Knowledge Technologies (LKT) not only enriches the learning process but also transforms education into a more dynamic, inclusive, and needs-based environment for the 21st century. Its potential to personalize teaching, improve accessibility, and facilitate data analysis makes it an invaluable tool in the educational field, driving students toward more effective and meaningful learning.

Therefore, the initial hypothesis is confirmed: AI, in relation to LKT, fosters meaningful learning among secondary-level students. The answer is yes it transforms the way learning takes place. Below is Table 3, which presents the contrast of the verified hypotheses that emerged during the research process in this inquiry:

Table 3. Hypothesis testing.

Hypothesis	Description	Status
H1	AI, in relation to LKT (X), promotes meaningful learning (Y) among secondary-level students.	Accepted
H2	The use of LKT (X) contributes to the development of didactic materials that strengthen students' learning (Y).	Accepted
H3	Teachers who integrate LKT (X) into their pedagogical practice achieve effective teaching (Y) of the study content.	Accepted
H4	The incorporation of LKT (X) and the integration of AI constitute fundamental tools for optimizing the teaching–learning process (Y) among students and teachers at the basic education level.	Accepted

The Learning and Knowledge Technologies (LKT) presented in this article were aimed at supporting teaching for the development of content, fostering autonomous and meaningful learning, stimulating self-esteem, promoting a positive attitude toward change, and facilitating adaptation to technology at the higher education level. In this way, students were able to enhance their academic performance in core subjects.

As a result of this exploration, students strengthened their ability to identify errors during the management of activities, generated problem-solving guides, and developed logical thinking through technological applications. The user-friendly interface allowed for easy manipulation, measurement of progress, and self-assessment, while also improving proficiency in the use of both LKT and AI. It also enhanced communication, encouraged the application of new teaching-learning methods, promoted the use of diverse digital tools, fostered competency development, and supported both personalized and collaborative work.

4 Discussion

The analysis of these findings made it possible to understand that Artificial Intelligence and Learning and Knowledge Technologies (LKT) are not merely complementary resources but constitute structural pillars of the transition toward Education 4.0. Evidence presented by authors such as Schwab (2016) places this transformation within the framework of the Fourth Industrial Revolution, where the convergence of cyber-physical systems, artificial intelligence, and digital processes redefines production, social relations, and, in particular, educational processes.

In this regard, it can be stated that education in the digital era is undergoing a reorganization of paradigms, methodologies, and formative objectives. The National Polytechnic Institute points out that this new stage is oriented toward the development of 21st-century competencies, such as self-direction and teamwork, which aligns with the arguments of Giber Delgado, Gorina Sánchez, Reyes Palau, Tapia Sosa (2023), who contend that Education 4.0 is focused on improving the learning experience and outcomes through the integration of intelligent tools.

Researchers such as Paredes et al. (2024) argue that AI enables the design of experiences tailored to students' individual needs, fostering inclusion and equity in access to knowledge. In this way, education transcends the traditional homogeneous model to become a dynamic, flexible, and contextualized process. However, it also raises ethical and social questions related to data privacy, technological dependency, and the risk of dehumanizing pedagogical processes.

The review of state-of-the-art articles confirms that the incorporation of emerging technologies such as TICCAD, augmented reality, virtual reality, and LKT not only strengthens digital competencies but also reshapes pedagogical practices at different educational levels. In this context, teachers are repositioned as mediators and facilitators, while students assume a more active and autonomous role in the construction of their learning. This shift in roles, far from diminishing the importance of the teacher's role, highlights the need for teacher preparation that integrates the technological dimension with ethics and holistic education.

Significant challenges are also identified in the synergy between AI and LKT. Murga Menoyo (2023) emphasizes that true educational transformation does not lie solely in the implementation of these tools but in the ability to generate a systemic effect of reciprocal interaction that enhances meaningful learning. From this perspective, AI and LKT should not be conceived as isolated phenomena but as part of a pedagogical framework that demands a comprehensive vision of education. The absence of ethical regulations, inequality in access, and lack of technological infrastructure continue to be limitations that may deepen educational gaps rather than reduce them.

Looking to the future, the literature suggests that consolidating an educational model supported by AI and LKT requires not only technological innovation but also a philosophical and pedagogical rethinking of education. As Torres, Paz, Salazar (2001) explains, the transformation experienced by society demands a redefinition of global teaching-learning strategies, where creativity, decision-making, problem-solving, and critical thinking become indispensable transversal competencies.

The studies reviewed agree that AI and LKT are essential drivers of contemporary educational revolution. Their effective implementation allows for personalized learning, optimization of academic processes, and expanded accessibility. However, their disruptive potential also raises ethical, social, and pedagogical dilemmas that must be addressed critically and reflectively. The discussion invites us to conceive these technologies not as substitutes for human endeavor but as catalysts of a new educational paradigm in which innovation, inclusion, and the humanization of learning converge.

It is worth noting that the research conducted demonstrates the pertinence of the positivist paradigm by providing a solid methodological framework for verifying the proposed hypothesis. The combination of the quantitative approach with documentary and field techniques not only allowed for the collection of reliable and valid information but also generated a comprehensive analysis of the impact of Artificial Intelligence (AI) and Learning and Knowledge Technologies (LKT) on the secondary-level educational process.

The results show that the systematic application of AI tools, together with the use of LKT, not only has a positive impact on academic performance but also influences students' motivation, active participation, and autonomy in the learning process. This finding is directly linked to the formulated hypothesis, which states that the integration of these technologies fosters meaningful learning.

It is important to highlight that, based on the information collected through the instruments applied (survey, interview, and observation), it was confirmed that the implementation of these tools generates a substantial change in educational dynamics, leading to more interactive, collaborative, and individualized learning experiences. In this sense, it can be stated that AI and LKT do not only function as teaching aids but also become strategic resources for transforming the classroom into an innovative space.

The analysis of statistical data, as well as the interpretation of the correlations found between the use of LKT and the improvement of academic performance, shows that students exhibit gradual and sustained progress in various areas of knowledge. This confirms that emerging technologies, when applied responsibly and in a planned manner, have the capacity to improve educational quality.

This article not only demonstrates the validation of the initial hypothesis but also opens a horizon of new lines of research aimed at assessing the long-term impact of AI and LKT at different educational levels, as well as their potential to foster digital and critical thinking skills. Thus, it is reaffirmed that 21st-century education requires constant technological integration that responds to the demands of a transforming society, where autonomous and digital learning is positioned as a fundamental pillar for the holistic development of students.

5 Conclusions

Considering the way in which human beings acquire and personalize learning, this field is consolidated as one of the most promising and outstanding areas of research in education, since it enables the adaptation of content and teaching strategies to the needs and characteristics of each student. In this scenario, Artificial Intelligence together with Learning and Knowledge Technologies (LKT), emerges as an educational revolution that not only transforms the way learning is conceived, but also redefines pedagogical practices, fostering a flexible, inclusive, and contextualized education.

When applied strategically, AI facilitates the early detection of learning difficulties, allowing timely attention to situations that could otherwise become obstacles to academic development. At the same time, deep learning has positioned itself as an essential component for processing and transforming data in order to perform specific tasks, such as identifying learning patterns, assisting in assessment processes, detecting plagiarism, as well as recognizing voice and text. Similarly, generative artificial intelligence has opened a new horizon in the educational sector by enabling the creation of original and innovative materials, ranging from academic texts to audiovisual and iconographic resources that enrich the pedagogical ecosystem, such as educational chatbots and applications that optimize writing in research, reports, and essays.

The projects and experiences reviewed show that AI, in synergy with LKT, constitutes a powerful resource for optimizing and refining the teaching-learning process. Its implementation allows the design of personalized activities, the generation of immediate feedback, and the promotion of learning experiences adapted to each student's context. This is evident in programs such as computer systems, where AI supports code programming, system design, and problem-solving, as well as in the creation of educational games and interactive visualizations that strengthen the understanding of abstract concepts at basic and intermediate levels.

Despite its advantages, the incorporation of these technologies faces significant challenges: resistance to change, the absence of in-depth impact analysis, the scarcity of adequate data, and the difficulty in interpreting such data. These challenges are not only technological in nature, but also imply transformations throughout the entire educational system. However, if addressed with a critical and responsible vision, they can become opportunities to democratize access to education, ensuring that both students and teachers, as well as historically excluded social sectors, can benefit from more equitable and high-quality learning environments.

In the digital era, learning with the support of AI and LKT not only represents a methodological evolution but a true educational revolution that drives new forms of interaction between what is taught and what is learned. In this sense, AI will not replace the teaching role, just as ICT or LKT, did not in their time; on the contrary, it stands as a tool for support, enhancement, and complementarity within the educational process. Its purpose is to improve the conditions of teaching and learning, enabling students to develop skills relevant to their context and to the demands of a constantly changing society. In this way, AI and LKT are emerging not only as innovative pedagogical resources but also as strategic allies in the field of scientific research and educational transformation in the digital age.

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