

# **Enhancing Higher Education Through Kaizen 4.0: Bridging Human and Artificial Intelligence through Kaizen Methodologies**

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## **ABSTRACT**

**Purpose:** This research explores the interconnection of Kaizen methodologies and Artificial Intelligence (AI) to foster holistic learning in 21st-century higher education (HE). The goal is to leverage AI as a catalyst for expanding and transforming human skills in educational settings.

**Design/Methodology/Approach:** The research employs a comprehensive literature review incorporating worldwide studies on the proposed topics, with a focus on implementing Kaizen methodologies in educational settings.

**Findings/Outcomes:** The study reveals a synergistic relationship between Kaizen and AI, shaping educators' comprehensive learning experiences. It collects insights present in the current literature regarding Kaizen, AI, and cognitive processes, and ties them together, showcasing Kaizen's methodological principles, their contribution to leveraging AI in a HE setting, and how Kaizen methodologies contribute to integrating AI into daily teaching methodologies.

**Research Limitations/Implications:** The generalizability of findings may be affected by cultural and geographical variations, as certain geographical regions may not be included

in the sample. Future research should explore tailored implementation strategies and conduct comprehensive evaluations.

**Practical Implications:** Provides evidence-based insights to understand trends in educational practices toward knowledge development on the academic side and a growth adoption of Kaizen practices to enhance teaching and learning experiences via the strategic integration of AI tools.

**Social Implications:** The integration can lead to social benefits such as improved access to personalized learning, enhanced research capabilities, and increased collaboration between academia and industry.

**Originality/Value:** This research offers a comprehensive exploration of the intersection between Kaizen methodologies and AI in HE, a topic not widely addressed yet in the literature.

**Keywords:** Kaizen, Artificial Intelligence, Higher Education, Cognitive Learning, Adaptive Teaching.

## 1. Introduction

This paper explores the interconnection of Kaizen methodologies and Artificial Intelligence (AI) to foster comprehensive learning in 21st-century higher education (HE). AI tools present an unprecedented opportunity to redefine foundational competencies such as information acquisition and knowledge development. However, fully realizing this potential requires a nuanced understanding of cognitive development mechanisms and their integration with AI as catalysts for expanding and transforming human skills. Therefore, this research aims to address two primary questions: (1) How do Kaizen's methodological principles contribute to leveraging AI as a catalyst for expanding and transforming human skills in higher education? and (2) How do Kaizen methodologies enhance and drive higher education institutions by integrating AI into daily teaching methodologies?

The significance of this research lies in its potential to revolutionize learning processes in higher education through the integration of AI and Kaizen methodologies, which focus on expanding human cognition and fostering sustainable growth. The objectives include conducting a literature review to identify theoretical frameworks, prevalent studies,

techniques, and instruments used to explore the relationship between AI, Kaizen, and learning processes within higher education (HE). Ultimately, this research seeks to contribute with practical recommendations for enhancing educational practices and bridging the gap between human and AI intelligence in an educational context.

## **2. Literature review**

This section introduces and explores key concepts relevant to the paper based on existing literature, focusing on cognitive learning mechanisms, the Kaizen philosophy, its application in Higher Education (HE), and Artificial Intelligence (AI) within HE contexts.

### **Cognitive learning mechanisms and potential development during the HE period**

In education, understanding brain cognition and cognitive development across university-age students is crucial for adapting educational policies (Wolf, 2004; Dehaene, 2009). The brain undergoes major developmental stages from ages 0 to 3 and 6 to 12, profoundly influenced by experiences that shape cognitive abilities through stimuli, training, and emotions (Wolf, 2004; Dehaene, 2009). These stages are pivotal for developing competencies such as reading, writing, logical reasoning, and critical thinking, essential for decision-making in diverse life contexts.

Repetition and correction have been extensively debated over the past two decades. Contrary to common belief, memorization enhances intelligence rather than weakening it (Castro-Caldas, 2008). It plays a crucial role in learning skills and improving the overall quality of the learning process. Moreover, correction is essential as repeated actions solidify behavioral patterns, particularly those associated with positive emotions.

Despite neuronal plasticity, the window for developing capabilities is finite, with significant developmental strides occurring in early stages (Dehaene, 2009; Wolf, 2004). Educators must understand these dynamics and employ pedagogical strategies that nurture and empower capabilities over time, adapting to cultural challenges within formal learning contexts.

## **Kaizen philosophy**

Kaizen, originating from Japan, focuses on continuous improvement, as indicated by the word itself: KAI (meaning “change”) and ZEN (“to improve”) (Newitt, 1996). It extends to personal, home, social, and work life, involving everyone in the workplace (Imai, 1986). Initially applied to manufacturing (Imai, 1986), some attribute its beginnings to William Deming and Joseph Jurán, or the Toyota Motor Corporation's processes in the 1950s/60s.

Several authors have explored Individual Kaizen (Imai, 1986; Brunet and New, 2003; Suárez-Barraza et al., 2011; Macpherson, 2018), focusing on Kaizen Teian, which involves producing ideas to improve oneself. Imai (2006) emphasizes the need for “Kaizen people” for “Kaizen companies” to exist. These individuals improve their work and life quality continuously (Aoki, 2008; Suárez-Barraza, 2023).

Kaizen 4.0, the modern iteration, includes strategies and methodologies to enhance organizational performance without significant investments (Smadi, 2009). Successful implementation requires a culture fostering creativity and a mindset of never settling for the status quo, along with strong top management commitment (Nguyễn, 2019).

Kaizen is vital in various industries such as manufacturing, construction, healthcare, and services (Omotayo et al., 2018; Shatrov et al., 2021). Integrating Kaizen with Industry 4.0 practices combines continuous improvement strategies with digital transformation, essential for organizational success (Vinodh et al., 2020; Dang-Pham et al., 2022).

## **Kaizen in HE**

The philosophy of Kaizen promotes discipline, organization, communication, and habit formation, contributing significantly to educational values (Arsyad, 2021). Higher education institutions recognize the importance of Kaizen practices for fostering continuous improvement (Hashim et al., 2022), aligning with the goal of creating lifelong learners through incremental process improvement (Jones et al., 2019).

Kaizen optimizes educational forms, enhances creativity, and contributes to professional growth and new pedagogical competencies (Trubavina et al., 2021). The Plan-Do-Check-Act (PDCA) cycle improves learning outcomes, evidenced by better test results and dissertation quality (Bednarek et al., 2020). Implementing Kaizen in education fosters

new pedagogical competencies and resources for integrating creative technologies (Trubavina et al., 2021), enhancing competitiveness against traditional and for-profit education sources (Emiliani, 2005).

Kaizen can be applied at both the macro level (entire university) and micro level (individual courses) (Suárez-Barraza & Miguel-Dávila, 2020), though the complexity of educational processes and diverse stakeholders can pose challenges (Suárez-Barraza et al., 2021).

Kaizen improves course quality and promotes lecturer-learner interaction (Kregel, 2017). When integrated into national higher education policies, it contributes effectively to quality assurance systems (Dewi et al., 2022). Continuous improvement, a core Kaizen principle, expedites teaching quality evaluation and facilitates immediate responses from lecturers (Kregel, 2019).

### **Artificial Intelligence in Higher Education**

With current advances in technology, the expansion and democratization of artificial intelligence (AI) over the past year have prompted a rethinking of formal pedagogical strategies. This is evident in the recent surge of literature: a search for "learning" and "AI" in the SCOPUS database retrieves 29,389 papers from January 2023 to May 2024. While over half (17,710) are in Computer Science, there are also 8,708 papers in fields like Medicine, Social Sciences, Neuroscience, and Psychology, illustrating the broad impact of AI.

Most research in the past year has focused on clinical and non-clinical specialists' perspectives on AI's future role and its potential to enhance educational materials. Studies have analyzed and evaluated the perceptions, benefits, and drawbacks of AI in learning across all educational levels (e.g., Dessimoz & Thomas, 2024; Moulin, 2024; Syahrizal et al., 2024).

A review of the existing literature reveals a clear gap in connecting the three main topics of this paper: Kaizen, Artificial Intelligence, and Higher Education. While there are studies that explore each topic individually and some that connect two of them, a comprehensive interconnection among all three has not been described, which highlights the novelty of this study.

### 3. Methodology and Methods

This research was conducted through an exploratory literature review, carried out through content analysis (Pickard, 2013). The importance of using this methodology is that the topic explored in this paper is incipient and therefore, the relationship of Kaizen with AI in the HE context is practically null. To explore these academic fields without losing the validity of the research, the literature review of the three was triangulated.

This approach seeks via a literature review to identify theoretical frameworks and prevalent studies, techniques, and instruments used to explore the relation between AI, Kaizen, and learning processes. To do so, scientific databases were utilized, with the definition of search equations and a search time frame. The search was structured to include relevant keywords such as "Kaizen," "continuous improvement," "higher education," "quality management," "lean manufacturing", and "AI". The sampling was conducted across reputable academic databases such as PubMed, Scopus, Web of Science, and Google Scholar. Boolean operators like AND, OR, and NOT were used to combine keywords effectively.

Regarding the search's time frame, it was set to capture recent developments in the field. For instance, articles published within the last 10-15 years can provide insights into current trends and practices related to Kaizen methodologies in higher education settings. This time frame ensures that the search results are relevant and up to date. The initial criteria for inclusion in the research are as follows: indexed in databases previously indicated, with the defined search terms (also indicated in the title, abstract, and keywords), written in English or with an abstract in English. All selected paper abstracts were read, as well as full texts where needed, to identify the papers relevant to our research context and to remove any duplicate resources. A total of 38 papers were analysed.

The analysis of the data collected in the literature review and the research questions allowed us to carry out a four-step process based on the steps of Miles and Huberman (1994):

**1.- Database construction** - Based on articles from the Kaizen, HE, and IA literature, a database was built in Excel in a macro to begin to analyze the possible link and enhancing trends between the three theoretical components.

**2.- Initial coding** - Once all the papers were registered, a thematic analysis began (Suárez-Barraza and Lingham, 2008) of the data to generate the first link codes between Kaizen, HE, and the AI, and thus begin to answer the research questions posed.

**3.- Determine the final codes** - Once the initial codes are integrated, a final coding is carried out based on the literature studied and answering the research questions posed. The final codes allowed us to determine the fundamental findings of this exploratory research.

**4.- Integrate into the discussion and final conclusions** - The final codes in the form of findings were integrated into the discussion section regarding the literature to fill the research “gap” and the final conclusions.

#### 4. Results & Discussion

This section aims to summarize the patterns seen in the several papers analysed throughout this research, and to cross them with the research questions. The intent is to infer how these findings contribute to the application of AI and Kaizen methodologies in universities and how their integration can collaboratively enhance higher education, namely by focusing on continuous improvement, engagement, data-driven decisions, cognitive development, and professional growth. Table 1 synthesizes how Kaizen’s principles contribute to leveraging AI as a catalyst for expanding and transforming human skills in higher education, as well as how Kaizen methodologies can enhance and drive higher education institutions through the integration of AI into their daily teaching methodologies.

**Table 1. Contribution of Kaizen Methodological Principles in Enhancing AI in Higher Education**

		<b>Principle</b>	<b>AI Application</b>
<b>Kaizen's Methodological Principles and</b>	<b>Continuous Improvement and Iterative Learning</b>	Kaizen emphasizes continuous improvement through	AI tools can facilitate personalized learning pathways, allowing students to receive continuous feedback and adjust their learning strategies

<b>AI as a Catalyst</b>		iterative processes (Imai, 1986)	iteratively. This aligns with Kaizen's principle of small, incremental changes leading to significant improvements over time (Smadi, 2009)
	<b>Engagement and Involvement</b>	Kaizen involves everyone in the process of improvement, from managers to workers (Imai, 1986; Jones et al., 2021)	AI can engage students actively in their learning processes through interactive platforms and adaptive learning technologies, thus fostering a culture where students take an active role in their education, akin to Kaizen's inclusive approach. In a HE setting, besides students, professors and deans should also be highly involved in the improvement process from the start (Kregel, 2017)
	<b>Data-Driven Decision Making</b>	Kaizen uses data to identify areas for improvement and track progress (Pozzi, 2024)	AI can analyze vast amounts of educational data to identify gaps and trends in knowledge and skills. By providing real-time analytics and insights, AI helps educators and students make informed decisions about where to focus efforts for improvement, mirroring Kaizen's data-centric approach (Dang-Pham et al., 2022)
	<b>Enhancing Cognitive Development</b>	Kaizen's focus on repetition and correction enhances learning and cognitive skills (Castro-Caldas, 2008)	AI-powered tools can provide repetitive, adaptive learning exercises that enhance cognitive skills such as critical thinking and problem-solving, crucial for university students' development (Dehaene, 2009)
<b>Kaizen Methodologies Enhancing HE with AI Integration</b>	<b>Plan-Do-Check-Act (PDCA) Cycle</b>	Kaizen's PDCA cycle promotes continuous assessment and refinement of processes (Imai, 1986; Aoki, 2008;	AI can facilitate the PDCA cycle in educational settings by providing tools for planning lessons, executing them, assessing outcomes through data analytics, and refining teaching methods based on feedback. For example, AI can analyze test results and suggest adjustments in teaching strategies to improve learning



		Brunet and New, 2003; Wolf, 2004)	outcomes (Bednarek et al., 2020)
	<b>Fostering a Culture of Continuous Improvement</b>	Kaizen requires a culture that supports ongoing improvement and innovation (Smadi, 2009)	By integrating AI, HE institutions can create an environment where continuous improvement is part of the institutional culture. AI tools can streamline administrative tasks, enhance research capabilities, and support innovative teaching methods, thereby fostering a culture that embraces technology and constant improvement (Nguyễn, 2019)
	<b>Professional Development and Pedagogical Competencies</b>	Kaizen promotes the development of new competencies and professional growth (Trubavina et al., 2021)	AI can assist in the professional development of educators by providing personalized training programs, analyzing teaching performance, and offering suggestions for improvement. This aligns with Kaizen's emphasis on skill enhancement and professional growth (Suárez-Barraza & Miguel-Dávila, 2020)
	<b>Quality Assurance and Immediate Feedback</b>	Kaizen's methodologies ensure quality assurance through continuous monitoring and feedback (Dewi et al., 2022)	AI systems can provide immediate feedback on students' work, enabling timely corrections and adjustments in teaching methods. This immediate feedback loop helps maintain high educational standards and improves the overall quality of teaching (Kregel, 2019)
	<b>Double loop learning process</b>	The double-loop learning process is a concept centered on the importance of reflection and critical thinking. Students	Artificial intelligence supports double-cycle learning with students of this millennium by having programs such as Chat GPT that reinforce applied knowledge and provoke deep reflection on exercises, projects and academic tasks. In addition, Kaizen improvement projects in academic courses are reinforced through manual and electronic

		should follow and adapt to instructions and reflect and question them (Argyris, 1999)	simulators for double loop learning (Abdillah et al., 2023)
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Through the findings we can see that by integrating AI with Kaizen methodologies, higher education institutions can significantly enhance their educational processes, fostering an environment of continuous improvement and innovation that benefits both educators and students. This integration not only optimizes the learning experience but also prepares students with the necessary skills to thrive in a rapidly evolving technological landscape.

Therefore, leveraging insights from these studies, and taking full advantages from the knowledge about the way cognition impacts on learning, HE institutions can utilize Kaizen methodologies to drive continuous improvement, enhance operational processes, and elevate teaching quality. Implementing readiness factors, integrating comprehensive Kaizen frameworks, and focusing on service quality improvement can foster a culture of continuous improvement within the HE sector.

## 5. Conclusion

Kaizen and AI are two relevant topics to consider in a 21st-century educational scenario, where higher education institutions strive to keep updated and to continuously improve themselves. However, these three areas are seldom explored together in the existing literature. The triangulation between previous research on Kaizen, HE, and AI allowed us to construct a basis for the integration of the three concepts.

This paper explores that AI can be used for the improvement of human skills in HE, and this could be enhanced with the application of Kaizen principles, namely through continuous improvement and iterative learning with AI-generated feedback, promotion of engagement and involvement of all HE-related stakeholders, data-driven decision making based on AI to identify trends and gaps, and enhancement of cognitive development with tailored AI-created exercises.

Plus, a continuous improvement culture with a focus on skills enhancement and the application of concrete Kaizen methodologies such as the PDCA cycle, Kaizen teams, quality assurance, immediate feedback and double loop learning processes can also contribute to improving HE with an AI Integration.

Research limitations and implications include the potential limitation of generalizability of the findings due to cultural and geographical variations. Plus, the measurement of the effectiveness of Kaizen practices in HE may be subjective and reliant on self-reported data, posing challenges in assessing the true impact of these methodologies.

The identified gaps underscore the necessity for further research to address these critical issues and advance the comprehension of these challenges in higher education. Plus, future works should also aim to provide practical insights for educators and administrators. This includes studies focusing on the implementation of Kaizen in diverse HE settings, longitudinal studies tracking the impact of Kaizen initiatives over time, and comparative studies analyzing the effectiveness of different Kaizen approaches in HE institutions to contribute to best practices and guidelines for successful implementation.

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