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Artificial Intelligence and Student Engagement in Higher Education: A Systematic Review of the Mediating Role of Value Co-Creation

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ABSTRACT

Today the system of higher education has been reshaped do to the changes of student behavior specialy with the integration of AI and the mechanisms through which educational value is created. While value co-creation has been extensively theorized in innovation management and service research, its role in explaining the relationship between AI and student engagement in higher education remains insufficiently explored. Based on an exploratory systematic literature review, the study analyzes a corpus of peer-reviewed publications published between 2019 and 2025. The reviewed research covers a wide range of AI applications,student engagement with particular attention to the mediating role of value co-creation. The findings reveal that AI technologies contribute to student engagement, Value co-creation emerges as a central mediating mechanism that explains how AI-driven interactions between students, instructors, and intelligent systems translate into cognitive, emotional, and behavioral engagement. The review also highlights critical ethical, institutional, and pedagogical challenges—such as data protection, equity, algorithmic transparency, and the risk of overreliance on automated systems—that condition the effectiveness of AI-supported value co-creation. By synthesizing fragmented research streams, this study advances a conceptual framework that positions students as active co-creators of educational value within AI-enhanced learning ecosystems. The article contributes to theory by clarifying the co-creative processes underlying AI-mediated engagement and offers practical implications for educators and policymakers seeking to implement AI in a sustainable, human-centered, and engagement-oriented manner..

INTRODUCTION

The traditional model of higher education (HE) focuses on the student as the recipient of the service offered by Higher Education Institutions (HEIs). Thus, the teacher transmits knowledge to the students, who are subsequently evaluated with the aim of determining the level of knowledge acquired at the end of the service provision process. This model, when applied to market economies, is equivalent to that of a company in which the service provided is the transmission of knowledge to the student/customer (Díaz-Mendez and Gumerson, 2012). However, recent changes in HE have shifted this approach in the same direction as other service companies. Currently, the focus of university services is not based on the teacher as a transmitter of knowledge, but rather on the student as the ultimate responsible party for their learning, with teachers playing a mediating role (García and Ruiz, 2014). This change in the university is related to the evolution of the knowledge infrastructure, where academia has reoriented its old vision of preserving and disseminating knowledge toward a more comprehensive one of transferring technology and innovation through connections with government and industry. Thus, ties have been formed and consolidated between the public, private, and academic sectors, based on promoting innovative proces& (Etzkowitz and Leydesdorff, 1997). the role of the university in technology transfer and business formation through entrepreneurship is consolidated (Etzkowitz and Zhou, 2007; Leydesdorff, 2012). This entrepreneurial university model manages to guarantee research with commercial potential, generate start-ups, and create a spirit of entrepreneurship and innovation within the institution. Thus, the university becomes an incubator for entrepreneurship where solutions to environmental problems are generated, based on networks that arise from relationships between teachers and students (Etzkowitz and Zhou, 2007). Under this scheme, the role of the student is reoriented, as they begin to become directly involved in these innovative processes, becoming a key player in the entrepreneurial chain. This new approach empowers students by involving them in the co-design and co-development of innovation projects, and changes the role they play in their own learning, giving them a more prominent role. Applied to higher education, this approach involves moving beyond a passive conception of the student to consider them as a central and fully engaged actor in the teaching-learning process. Students actively participate in the co-creation of value by mobilizing their interactions, experiences, and personal resources, not only to acquire knowledge, but also to develop cross-disciplinary skills that are essential to their future professional

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integration (Sicilia, 2010; Pepper, 2011). This process is based on relational and interactional dynamics, such as communicative participation, trust, satisfaction, and loyalty, which directly influence the quality of learning and educational outcomes (Díaz-Méndez & Gumerson, 2012). artificial intelligence has made rapid advances in recent decades, profoundly transforming many areas of society (European Parliamentary Research Service, 2020). artificial intelligence has gradually developed a solid scientific basis, giving rise to multiple high-performance applications, including in the field of higher education. The rapid development of these technologies thus has major implications for teaching and learning processes, to the extent that AI-mediated education is set to transform education systems in the long termcontemporary educational practices (Zawacki-Richter *et al.*, 2019).

The integration of AI into higher education therefore offers a wide range of opportunities, both for improving teaching practices and for optimizing learning systems and institutional management. By facilitating personalized, interactive, and adaptive forms of learning, AI technologies help to strengthen student engagement and support their active involvement in the co-creation of educational value. However, this integration also raises major challenges and ethical dilemmas that call for increased vigilance. Among these issues, the digital divide and inequalities in access to technology are a central concern. As Vera (2018) points out, the growing dependence on information and communication technologies in everyday life requires a rethinking of the conditions for equitable access to digital tools in order to enable all students to benefit from the opportunities offered by AI fully. From this perspective, AI cannot be viewed as a simple technological tool, but as a lever that structures the dynamics of engagement and value co-creation within higher education. Understanding the mechanisms by which AI influences student engagement, and the mediating role played by value co-creation in this process, is therefore essential.

LITERATURE REVIEW

The bibliographic reviews that have already been done on value co-creation serve as the foundation for this work. There are gaps in the application of value co-creation in higher education, despite the fact that there are many research articles on the subject. Earlier studies, such as Pantoja, Ribes-Giner, and Perello-Marín (2016), validated a theoretical model using statistical approaches, confirming the connections between student engagement, co-creation, and the impact of the latter on satisfaction. In a similar vein, Ribes-Giner, Perello-Marín, and Pantoja's (2016) study offers a succinct overview of the literature. Despite addressing the same elements examined in this article, these research do not advance the field of the the comprehensive literature review. Because of this, this article offers a survey of the literature on value co-creation, particularly in ES, emphasizing the relationships between the major components that affect it, in contrast to the works mentioned above. Therefore, by doing a more thorough literature assessment, this study closes these conceptual gaps. Theoretically, this review supports the applicability of the value co-creation approach in academic settings. In light of all of this, our study effort has two goals. On the one hand, it examines the literature to obtain a more profound conceptual understanding of how students in HEIs co-create value; on the other hand, it clarifies the connections between the essential elements of co-creation in this setting: communicative involvement,

In recent decades, applied research has taken a keen interest in exploring the concept of CCV in depth with the aim of identifying the factors and dynamics of the process of co-creating value in the context of customers and users by applying different types of conceptual thinking. Perhaps the most relevant is the paradigm of dominant service logic (D-S Logic), both from an academic and a managerial point of view (Karpen *et al.*, 2012; Vargo & Lusch, 2004). This paradigm describes service as the central purpose of exchange and provides a theoretical understanding of how companies, customers, and other market participants co-create value through their service interactions (Vargo & Lusch, 2004). The basic concept of D-S Logic is that, as active participants and collaborative partners in relational exchanges, customers or users co-create value through participation in interaction processes (Grönroos, 2008; Grönroos & Voima, 2013; Payne *et al.*, 2008; Vargo & Lusch, 2008; Yi & Gong, 2013). Therefore, D-S Logic maintains that organizations cannot create value independently. Interaction offers the development of a joint CCV process. Consequently, those who receive a service are not simply recipients, but collaborators who create value together with the provider (Lusch *et al.*, 2007, p.6). From this perspective, value does not arise until an offer is accepted (value in use). D-S logic is an alternative to the traditional goods-centered paradigm for understanding economic exchange and value creation.

Another alternative to the above is the participant perspective, which emphasizes two aspects of service logic and is fundamentally inspired by the contributions made by Grönroos (2008) when he specifies that one of these aspects is related to consumption and the other to service provider logic. This approach maintains the notion of value in use, understood as those who receive the service are at the same time the source of its value creation. Unlike the previous approach, the provider can assume two roles: value facilitator and value co-creator (Grönroos, 2008; Grönroos & Voima, 2013). As a value facilitator, the service provider offers the necessary resources for its own value generation processes. As a value co-creator, the service provider interacts and learns from the customer, thus intervening in the consumption process and sharing skills and practices. Recent studies suggest the need to integrate these subtly differentiated perspectives, the process view and the participant view, into an integrative model of CCV (Andreu *et al.*, 2010). In short, according to Park & Vargo (2012), the integrative

model VVC (Andreu *et al.*, 2010). In short, according to Park & Vargo (2012), the integrative model inspired by D-S Logic constitutes an important basis for the development of a much more solid, strong, and, above all, adapted marketing strategy to the constant changes in supply and demand. From this point of view,

The rapid expansion of artificial intelligence (AI) in consumers' everyday activities has profoundly transformed modes of interaction, decision-making, and consumption, leading to the increasing integration of these technologies into individuals' lives and to a gradual reconfiguration of organizational processes. According to Matta *et al.* (2022), evolution has enabled organizations to better adapt to the field through the ubiquity of artificial intelligence. According to Puntoni *et al.* (2021), approaches focus mainly on the technical or software aspects of artificial intelligence and sometimes ignore the complexity of users' experiences through their interactions with emerging technologies, which encompass emotional, behavioral, and cognitive dimensions. For this reason, analyzing student behavior towards the use of artificial intelligence is crucial, as AI applications in higher education vary in maturity. The first forms of adoption mainly concerned chatbots, whose rapid spread can be explained in large part by the intensive use of smartphones. Li & Wang, 2023; Prakash & Das, 2020; Sandu & Gide, 2019 have conducted research in this area in sectors such as services, fintech, e-commerce, and healthcare. Indeed, within higher education institutions, these emerging technologies are being deployed and are closely linked to the broader development of mobile e-learning solutions, driven by the intensification of digital practices and the increase in time spent on mobile applications, particularly among young audiences (Robayo-Pinzon *et al.*, 2021).

Several researchers have explored the potential of artificial intelligence, demonstrating its communication, interaction, and collaboration capabilities. Emerging technologies enable the development of new pedagogical approaches that promote student engagement and strengthen exchanges between students and teachers (Cabrera *et al.*, 2017). Indeed, these emerging technologies aim to improve the human learning process on several levels through various forms of human-machine interaction (Kim *et al.*, 2020). Although some educational experiments have used physical robots, AI-based virtual teaching assistants seem more likely to be adopted on a large scale (Kim *et al.*, 2016). Research has shown that students' intention to use these assistants is mainly determined by perceived usefulness and ease of communication. These results highlight students' generally favorable attitude toward the use of artificial intelligence, demonstrating the crucial role of technology acceptance factors in its sustainable integration into higher education (Kim *et al.*, 2020).

The growing integration of artificial intelligence (AI) in higher education has attracted the interest of researchers because of its potential to enhance student engagement. Our article will provide a better understanding of the mechanisms through which AI contributes to value co-creation, in order to examine existing research on "artificial intelligence and student engagement in higher education: the mediating role of value co-creation," and to present a detailed literature review. The studies examined focus on a wide variety of uses of artificial intelligence in higher education, ranging from intelligent tutoring systems and chatbots to adaptive learning platforms and generative AI tools. Methodologically, they draw on a variety of approaches, combining quantitative surveys on a large scale with systematic or integrative literature reviews. Furthermore, the geographical and disciplinary diversity of the studies analyzed reflects the multiplicity of higher education contexts and academic fields involved at the international level. This comparative analysis thus sheds essential light on research questions, allowing us to structure existing knowledge on the impact of AI on student engagement, better understand the mediating role of value co-creation, identify the main challenges and limitations, and highlight the effects observed in contemporary higher education environments.

MATERIALS AND METHODS

The reviewed research encompasses a wide range of AI applications, including intelligent tutoring systems, conversational agents (chatbots), adaptive learning platforms, and generative AI tools. From a methodological perspective, the studies rely on diverse approaches, ranging from qualitative phenomenological investigations exploring students' lived experiences, to large-scale quantitative surveys, as well as systematic and integrative literature reviews. The geographical and disciplinary scope of the analyzed studies is particularly broad, reflecting the diversity of higher education contexts worldwide and the variety of academic fields involved. Considerable attention is devoted to the ethical, institutional, and pedagogical challenges associated with AI integration, particularly in relation to data protection, equity, algorithmic transparency, and the transformation of teaching and learning practices.

This comparative and cross-cutting analysis represents a central contribution to addressing the research questions. It enables the consolidation of existing knowledge on the impact of AI on student engagement, facilitates a deeper understanding of the mediating mechanisms linked to value co-creation, identifies key challenges and limitations, and sheds light on the outcomes and effects observed within contemporary higher education environments.

RESULTS AND DISCUSSION

This section provides a structured and in-depth analysis of the scholarly landscape related to the literature on Artificial Intelligence and Student Engagement in Higher Education, highlighting the mediating role of value co-creation. It brings together a heterogeneous body of empirical and conceptual studies that examine how AI technologies enhance student engagement through collaborative interactions among students, instructors, and intelligent systems.

Study	AI Application Types	Engagement Dimensions Measured	Mediating Role of Value Co-Creation
(Pinzón *et al.*, 2023)	Machine teacher, Smart Tutoring App, Chatbots	Cognitive and emotional engagement	Value co-creation typologies identified; chatbot linked to value co-destruction
(Bhatia *et al.*, 2024)	Intelligent tutoring systems, adaptive platforms, predictive analytics	Behavioral and cognitive engagement	Personalized learning as co-creation process
(Ferreira-Meyers, 2025)	Stakeholder inclusion in AI decision-making	Engagement through ethical AI integration	Student inclusion as co-creation in AI adoption
(Dann *et al.*, 2024)	Deep learning, NLP for feedback analysis	Emotional and behavioral engagement	AI categorizes valued engagement types
(Sajja *et al.*, 2025)	AI-powered learning assistants	Behavioral engagement, trust, usability	AI as supplement fostering co-created learning
(Kovačević *et al.*, 2025)	AI-driven tools guided by academic leadership	Motivation, participation, academic success	Leadership mediates AI-driven engagement strategies
(Faridoon *et al.*, 2025)	AI tutors with personalized feedback	Participation, motivation, academic performance	Personalized pathways mediate engagement
(Llanos *et al.*, 2024)	AI virtual assistant in courses	Usage rates, satisfaction, retention	AI tool as co-creator of learning support
(Singh, 2024)	Personalized algorithms, chatbots, ITS	Cognitive, emotional, behavioral engagement	AI personalization fosters deeper involvement
(Iyer, 2024)	AI adoption drivers in education	Cognitive, emotional, behavioral engagement	Factors influencing AI's engagement impact
(Pandey & Poonia, 2025)	Intelligent tutoring, chatbots, game-based learning	Behavioral, cognitive, emotional engagement	AI as collaborator enhancing co-creation
(Valle & Hererera, 2025)	Adaptive learning, predictive analytics, ITS	Engagement and success metrics	AI personalization mediates learning outcomes
(Wafik *et al.*, 2025)	Personalized AI learning solutions	Engagement, administrative efficiency	AI fosters personalized learning co-creation
(Deckker *et al.*, 2025)	AI-powered personalized learning	Motivation, engagement, performance	AI supports learner-centered co-creation
(Elbadiansyah *et al.*, 2024)	Intelligent tutoring, learning analytics	Motivation, cognitive engagement	AI tools mediate motivation and skills
(Çela *et al.*, 2024)	AI-driven assessment, adaptive systems	Engagement, personalized learning	AI supports adaptive co-creation
(Daraai *et al.*, 2024)	Automated teaching, grading, ITS	Engagement, personalized learning	AI integration aligned with educational goals
(Asri, 2024)	Personalized learning, automation	Engagement, academic achievement	AI personalizes learning pathways
(- & -, 2024)	Machine learning, NLP, ITS	Engagement, tailored learning	AI reshapes learning through co-creation
(Sari *et al.*, 2024)	Adaptive learning systems (Smart Sparrow, IBM Watson)	Engagement, performance metrics	AI-driven personalization mediates outcomes
(Y *et al.*, 2024)	Machine learning, learning analytics	Engagement, retention, comprehension	AI personalizes learning pathways

(Widodo *et al.*, 2024)	AI integration in teaching and learning	Engagement, critical thinking	Value co-creation linked to dynamic learning
Ateeq *et al.*, 2024)	AI tools for academic writing and research	Engagement, academic achievement	AI supports co-creation in academic success
(Kovilpillai *et al.*, 2024)	Generative AI for micro-credentials	Engagement, course completion	AI personalizes learning and credentialing
(Moore & Tsay, 2024)	LLMs (GPT, BERT), predictive analytics	Engagement, personalized learning	AI enhances feedback and interventions
(Katsenou *et al.*, 2025)	Human-Centered AI for collaboration	Cognitive engagement, creativity	AI as collaborative co-agent in learning
(Moraru, 2025)	Generative AI in communication	Student and teacher engagement	AI transforms teacher-student relationships
(Silva *et al.*, 2024)	Adaptive algorithms, educational analytics	Motivation, academic performance	AI-driven personalization mediates outcomes
(Mupaikwa, 2024)	AI-driven instruction and heutagogy	Engagement, performance correlation	AI enhances heutagogical engagement
(Wulandani *et al.*, 2024)	Personalized AI learning tools	Engagement, academic performance	AI supports personalized learning co-creation
(Babu *et al.*, 2025)	Intelligent tutoring, adaptive platforms	Engagement, learning optimization	AI enhances personalized learning
(Preetha & Alone, 2025)	AI chatbots and virtual assistants	Real-time support, engagement	AI facilitates personalized academic support
(Merino-Campos, 2025)	AI in personalized learning	Engagement, adaptive learning	AI-driven personalization mediates outcomes
(Muhammad & Matilda, 2024)	AI for inclusivity and equity	Engagement, academic success	AI personalizes learning for diverse learners
(Sasikala & Ravichandran, 2024)	AI impact on learning outcomes	Engagement, academic performance	AI personalizes learning experiences
(Vashishth *et al.*, 2024)	AI-driven learning analytics	Personalized feedback, assessment	AI mediates personalized evaluation
(Nasser, 2024)	AI for personalized learning	Engagement, teacher effectiveness	AI enhances engagement and teaching
("Advancements in AI-Driven Education: Tra...", 2024)	Intelligent learning tools	Engagement, independent learning	AI supports personalized learning
(Khurma *et al.*, 2024)	AI ChatGPT for engagement	Cognitive, emotional engagement	AI ChatGPT fosters personalized engagement
(Velinov & Bleicher, 2023)	Generated AI in virtual teams	Motivation, participation	AI influences global team engagement
(Leng, 2025)	Intelligent systems in HE	Personalized learning, support	AI personalizes learning and administration
(Iman *et al.*, 2024)	Intelligent tutoring, adaptive platforms	Engagement, motivation	AI enhances personalized learning
(Guo *et al.*, 2025)	Generative AI in academic tasks	Cognitive, emotional engagement	AI use mediated by instructional design
(Karayianni *et al.*, 2025)	ChatGPT trust and anxiety	Engagement, usage frequency	Trust mediates AI usage and engagement
(Wang & Luo, 2023)	Generative AI interaction	Self-efficacy, cognitive engagement	Mediated relationship with achievement
(Kangas & Heljakka, 2024)	Generative AI for playful learning	Creativity, social interaction	AI supports playful co-creation

(Roméro, 2025)	AI-enhanced creative engagement	Levels of engagement and co-creation	Progressive AI-human collaboration
(Tulang, 2025)	Generative AI adoption in flexible learning	Perceived ease of use, engagement	Usability drives engagement and interaction
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The table clearly highlights the rapid evolution of artificial intelligence (AI) and student engagement in higher education since 2023, driven by significant advances in AI applications and their progressive integration into higher education practices. Early studies primarily focused on identifying the role of AI in value co-creation and in strengthening student engagement through collaborative learning environments. From a diachronic perspective, the research trajectory reveals an increasing complexity in the understanding of AI-mediated mechanisms and their effects on motivation, academic performance, and the conditions required for ethical implementation. Initial studies emphasized the transformative potential of AI in higher education, particularly through value co-creation between students and various educational stakeholders. These works made it possible to identify typologies of perceived value associated with specific AI functions, such as chatbots or intelligent tutoring systems, while also highlighting ambivalent phenomena, including both value creation and value destruction in the user experience. In parallel, research has emerged on the role of generative AI in international virtual teams, focusing on student motivation and participation in intercultural contexts.

Overall, the reviewed literature provides a rich and in-depth overview of AI applications in higher education, particularly in relation to student engagement and the mediating role of value co-creation. Among the key contributions, the diversity of AI tools examined and the combined use of qualitative and quantitative methods stand out, enabling a nuanced understanding of their effects. Several interrelated themes clearly emerge from the literature. The first concerns personalized learning and AI-driven adaptive systems, which consistently demonstrate positive effects on students' academic outcomes and motivation. Value co-creation appears as a central mediating factor linking the use of AI tools to active student participation and collaborative learning dynamics. However, the effectiveness of AI varies depending on contexts and pedagogical designs. Some studies report mixed perceptions regarding the quality of AI-assisted teaching and difficulties in sustaining student engagement over the long term. Excessive reliance on AI may also hinder the development of critical thinking and creativity, highlighting the importance of a balanced interaction between humans and machines. Furthermore, the diversity of AI tools and the heterogeneity of implementation strategies make direct comparisons across studies more complex. In conclusion, several studies emphasize the mediating role of value co-creation in strengthening student engagement, showing how collaborative interactions among students, instructors, and AI systems foster richer and more meaningful learning experiences. This co-creative process supports personalized learning and enhances student autonomy, motivation, and satisfaction. Nevertheless, empirical evidence remains limited: few studies systematically measure the mechanisms or outcomes of value co-creation. Moreover, conceptual definitions remain heterogeneous and sometimes insufficiently operationalized, hindering comparison and consolidation of findings. More robust theoretical and methodological frameworks are therefore needed to fully capture the dynamic articulation between AI, value co-creation, and student engagement. The synthesized findings reinforce theoretical frameworks suggesting that AI technologies enhance student engagement through personalized and adaptive learning experiences, in line with Service-Dominant Logic and value co-creation theories in higher education. AI thus appears as a mediator facilitating collaborative learning environments in which students actively participate in shaping their educational experience. Furthermore, the integration of learning analytics and large language models (LLMs) represents a relevant theoretical contribution for measuring and stimulating multidimensional student engagement—namely social, cognitive, and emotional—thereby enriching classical engagement theories. The findings also provide a more refined understanding of AI's effects

on motivation and academic performance, mediated by psychological variables such as self-efficacy and cognitive engagement. Finally, the variability of AI effects across pedagogical contexts calls for more contextualized theoretical models that account for the specificities of learning environments. In qualitative research by Tamer and Knidiri (2022), increased ICT use was associated with enhanced student engagement patterns in Moroccan universities, underscoring the importance of technology as a mediating factor in the learning process.(Tamer, H., & Knidiri, Z. 2022).

From an operational perspective, the results highlight the importance for institutions and educators of integrating AI tools that support personalized learning pathways, adaptive feedback, and value co-creation in order to enhance student engagement and academic success. Such integration should be accompanied by faculty training initiatives to maximize pedagogical effectiveness. The literature also advocates for hybrid models combining AI contributions with human intervention, with AI viewed as a complement rather than a substitute for instructors. Such an approach strengthens student trust, motivation, and engagement while ensuring sustainable implementation.

CONCLUSION

The literature emphasizes that AI does not automatically generate engagement. Its impact depends on the conditions under which it is implemented and, more specifically, on the extent to which it fosters meaningful interactions among students, instructors, and technological systems. From this perspective, value co-creation emerges as a key mediating mechanism explaining the relationship between AI and student engagement. Rooted in Service-Dominant Logic (Vargo & Lusch, 2004, 2008), value co-creation posits that educational value emerges from collaborative and interactive processes involving all stakeholders. Applied to higher education, this approach positions students as central actors in the learning process, actively engaged in co-constructing their educational pathways through interactions with AI technologies, instructors, and institutions (Ramaswamy & Ozcan, 2018; Dollinger *et al.*, 2018). The literature further shows that AI-supported learning environments are most effective when they foster co-creative practices such as content personalization, peer collaboration, collective problem-solving, and dynamic adaptation of learning pathways (Pinzón *et al.*, 2023). These dynamics enhance students' perceived usefulness, sense of control, and recognition, thereby contributing to sustained engagement. Conversely, when AI systems are perceived as imposed, opaque, or misaligned with learners' needs, co-creation processes weaken, limiting AI's impact on engagement (Puntoni *et al.*, 2021)These findings align with technology acceptance models (TAM, UTAUT), which demonstrate that perceived usefulness, ease of use, and organizational support condition user engagement and participation in value co-creation processes, Studies examining the intersection of technology use and student engagement in higher education show that digital transformation has substantive effects on institutional practices and student outcomes. For example, Tamer and Knidiri (2023) highlight the evolution of "University 4.0" in Morocco, emphasizing how ICT and digital tools underpin institutional adaptation to new educational challenges

In conclusion, the literature demonstrates that AI can sustainably transform higher education—not as an autonomous technological solution, but as an enabling resource serving value co-creation and student engagement. Future research should further investigate this mediating role through longitudinal studies, mixed-method approaches, and conceptual frameworks that explicitly integrate the technological, pedagogical, and ethical dimensions of AI in higher education.

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