A human-centered blended learning model for curriculum reconstruction in the industry 5.0 era

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Article Info

ABSTRACT

The emergence of Industry 5.0 presents new demands for curriculum models that are not only technologically adaptive but also human-centered. This article proposes a conceptual model for curriculum reconstruction based on blended learning, combining digital and face-to-face modalities to promote flexibility, personalization, and deeper engagement. Positioned as a strategic response to the pedagogical and ethical challenges of Industry 5.0, the model integrates interdisciplinary content, learner autonomy, and authentic assessment practices. Findings suggest that blended learning, when designed as a core curricular architecture rather than a delivery method, enables the formation of future-ready learners. The proposed model is structured around five adaptive pillars: learning objectives, content design, pedagogical approaches, digital infrastructure, and assessment strategies. It is concluded that integrating blended learning into curriculum frameworks is essential for creating inclusive and resilient education systems, and institutions are encouraged to adopt this model as a foundation for long-term transformation.

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Introduction

The emergence of Industry 5.0 marks a new phase in technological development that emphasizes harmonious collaboration between humans and intelligent machines (Khosravy et al., 2023). Unlike the previous industrial revolution that prioritized automation and efficiency, this new era introduces values such as empathy, personalization, and sustainability into various social systems—including education (Tavares et al., 2022). In this context, conventional curricula oriented toward linear knowledge transmission are becoming obsolete and inadequate in preparing a generation of learners who are expected to be adaptive, creative, and collaborative (Henry, 2025). This paradigm shift calls for a comprehensive reconstruction of educational curricula to produce human resources who are not only technologically literate but also socially aware and metacognitively competent (Doorsamy, 2025).

Blended learning, which combines the strengths of online and face-to-face instruction, has been shown to enhance flexibility, student autonomy, and instructional quality when properly integrated (Niyomves et al., 2024;McHone, 2020). In higher education, blended learning has proven to increase interaction, flexibility, and access without compromising instructional quality (Castro, 2019). However, recent reports indicate that its implementation across many institutions remains fragmented and ad-hoc, often treated as a temporary solution during crises such as the COVID-19 pandemic rather than as a coherent curricular strategy. For

instance, UNESCO (2021) noted that more than 40% of higher education institutions in developing countries adopted online-blended modes without sufficient curriculum redesign, leading to learning loss and inequities in access. This illustrates a critical weakness in conventional curricula that fail to integrate digital pedagogy systematically (Muhuro & Kangethe, 2021).

To date, scholarly discourse on curriculum reconstruction through blended learning has not yielded a comprehensive conceptual model that integrates technological affordances with humanistic values in the context of Industry 5.0. Most literature remains focused on the technical aspects of blended instruction without addressing the broader necessity of curriculum redesign (Yonezawa et al., 2022; Tondeur et al., 2021). This gap underscores the need for a strategic and human-centered framework that connects blended learning with the educational aims of Industry 5.0, including digital literacy, creativity, ethical reasoning, and sustainability.

The novelty of this study lies in proposing a holistic, human-centered conceptual model of curriculum reconstruction based on blended learning that directly responds to the challenges of Industry 5.0. By articulating the model's key pillars—learning objectives, content design, pedagogical approaches, digital infrastructure, and assessment strategies—this study contributes both theoretically and practically to curriculum innovation. Accordingly, the aim of this article is to develop and present this conceptual model as a foundation for building inclusive, resilient, and future-oriented education systems.

Method

This study adopts a conceptual research design aimed at developing a human-centered model of curriculum reconstruction based on blended learning in response to the challenges of Industry 5.0. Rather than relying on empirical fieldwork, the model was formulated through a systematic synthesis of existing theories, frameworks, and empirical studies in curriculum development, blended learning, and educational transformation.

The literature reviewed in this study was selected with careful attention to relevance and recency. Most of the references were drawn from publications between 2018 and 2025 to ensure contextual alignment with the current discourse. Searches were conducted primarily through Scopus, Web of Science, and Google Scholar, using keywords such as blended learning, curriculum design, curriculum reconstruction, Industry 5.0, and educational innovation. In addition, earlier seminal works were included when necessary to strengthen the theoretical foundation, such as Graham's (2019) widely cited definition of blended learning.

The process of developing the conceptual model unfolded in three stages. The first stage involved synthesizing the literature to identify recurring themes and gaps in existing studies on blended learning and curriculum design. The second stage was the construction of an analytical framework by mapping these themes against the human-centered principles of Industry 5.0, which helped highlight misalignments between conventional curricula and future educational demands. The final stage was the conceptualization of the model itself, which integrates blended learning into a coherent curricular framework structured around five adaptive pillars: learning objectives, content design, pedagogical approaches, digital infrastructure, and assessment strategies.

To strengthen its theoretical validity, the model was further examined through comparative and expert-based approaches. Comparative analysis was conducted by cross-examining the proposed framework against existing blended learning models, such as the flipped classroom and enriched virtual model, in order to demonstrate its added value in addressing Industry 5.0 requirements. Complementing this step, informal consultations with three curriculum scholars and higher education practitioners were undertaken to evaluate the coherence, applicability, and potential relevance of the model in practice. Their feedback provided critical insights that informed refinements in the articulation of the model's components and their interrelationships.

Results and Discussions

Theoretical Review

Curriculum Theory in the Context of Industry 5.0

Curriculum, in its modern conception, is no longer a static blueprint of content delivery, but rather a dynamic framework that must evolve in alignment with socio-technological transformations (Barrot, 2022). Industry 5.0 introduces a paradigm shift where human values such as empathy, creativity, and critical thinking are expected to synergize with advanced digital technologies. This shift necessitates a progressive and adaptive curriculum—one that places learners at the center while cultivating skills that are both technological and humanistic in nature (Longo & Padovano, 2020). Curriculum design, therefore, must move beyond

competency-based models to incorporate broader elements of personal growth, digital fluency, and ethical reasoning, aligning with the values and demands of a human-centered technological society.

Blended Learning: Definitions, Models, and Pedagogical Implications

Blended learning refers to an intentional combination of face-to-face instruction with online learning components, designed to optimize both physical and digital affordances of the learning environment (Graham, 2019). Its pedagogical strength lies in its flexibility, learner autonomy, and potential for deeper personalization. Several models of blended learning have been developed—such as the rotation model, flipped classroom, and enriched virtual model—each offering varying degrees of integration and learner control (De Villiers, 2024). Empirical studies confirm that blended learning can significantly improve learning outcomes, engagement, and student satisfaction when implemented with coherent pedagogical strategies (Vodovozov et al., 2024).

However, most existing applications of blended learning remain technocentric, focusing primarily on the integration of platforms and tools rather than a systemic rethinking of learning goals, pedagogy, and curriculum architecture. Therefore, blended learning must be framed not just as a delivery mode but as a transformative pedagogical approach that can reshape curricular content, learner pathways, and assessment practices to align with the future demands of education in the Industry 5.0 era.

Industry 5.0 and Its Educational Implications

Industry 5.0 is characterized by the re-humanization of technology—a departure from the mechanistic logic of automation toward the personalization of production and services, including education (Aberšek et al., 2023). As AI and robotics become increasingly embedded in everyday life, the role of education is no longer limited to preparing workers for industrial tasks, but rather to cultivate resilient individuals capable of navigating ethical, social, and technological complexities. Thus, curriculum design must incorporate themes such as AI literacy, sustainability, emotional intelligence, and digital ethics, in order to remain relevant and transformative (Aberšek, 2024).

Educational institutions must thus transition from rigid, content-heavy curricula to agile and integrative models that foster interdisciplinary knowledge, collaborative problem-solving, and global citizenship (Hamedani et al., 2024). Within this context, blended learning offers a strategic bridge—combining the efficiency of digital platforms with the emotional and social depth of face-to-face engagement—toward the realization of education that is both technologically advanced and deeply human.

Research Gaps and Conceptual Necessity

While numerous studies have addressed blended learning and curriculum innovation separately, there is a notable lack of conceptual frameworks that systematically connect blended learning to curriculum reconstruction in the specific context of Industry 5.0. Existing models often treat blended learning as a supplementary modality rather than as a foundational philosophy for curriculum redesign (Bakir & Dahlan, 2023). Furthermore, the human-centric vision of Industry 5.0 remains underrepresented in curricular discourse.

This theoretical gap highlights the urgent need for a conceptual model that integrates blended learning as a strategic, value-driven curriculum architecture—one that is responsive not only to technological advancements but also to the evolving social and ethical dimensions of learning in the digital era.

Figure 1 illustrates the interconnected framework of curriculum reconstruction through blended learning in the context of Industry 5.0. At its foundation are the challenges of Industry 5.0, including human-centered innovation, technological disruption, personalization of education, and sustainable development imperatives. These challenges directly inform the blended learning approach, which acts as a mediating mechanism between external demands and internal curriculum design.

The model advances through three interrelated layers. The first layer involves curriculum mapping and redesign, where traditional content structures are reconfigured to embed digital literacy, creativity, and ethical reasoning as essential competencies. The second layer emphasizes personalization of learning experiences, supported by the synergy between synchronous and asynchronous modalities that allow students to exercise autonomy while maintaining meaningful social interaction. The third layer highlights the integration of future skills, particularly critical thinking, problem-solving, and collaborative innovation, which ensure the curriculum remains adaptive to evolving professional and societal needs.

These processes culminate in an adaptive curriculum characterized by flexibility, inclusivity, and alignment with the expectations of Industry 5.0. The outcome is the development of future-ready graduates who are

equipped not only with technical proficiency but also with social-emotional resilience, ethical judgment, and the capacity for lifelong learning. The interrelationships among these elements demonstrate that blended learning functions not as an isolated instructional method but as the core architecture of curriculum transformation.
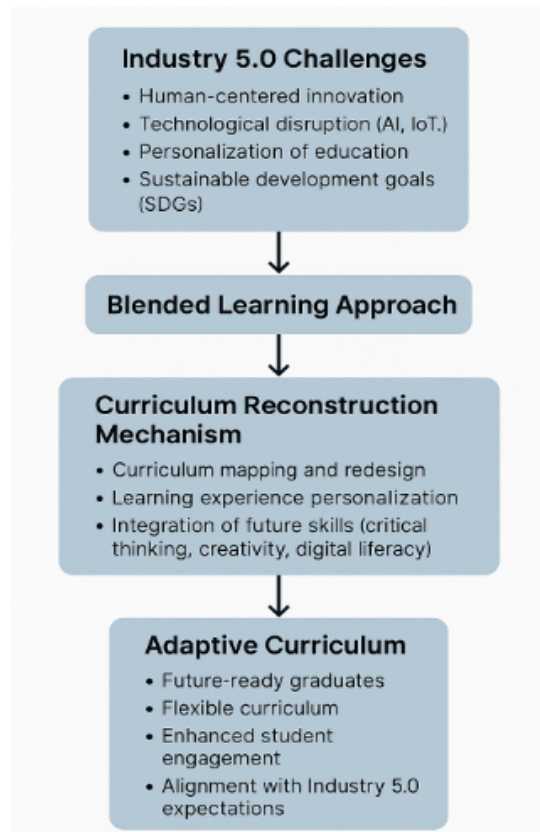

Figure 1. Conceptual Model of Curriculum Reconstruction through Blended Learning in Facing the Challenges of the Industrial Revolution 5.0

Discussion

The model developed in this study differs substantially from previous frameworks of blended learning, such as rotation or flipped classroom models, which primarily structure the delivery sequence of face-to-face and online elements. Instead of focusing only on delivery, the present model elevates blended learning into a guiding curricular philosophy, one that integrates learning objectives, content design, pedagogy, digital infrastructure, and assessment into a coherent and value-driven system. This shift is critical in addressing the widespread fragmentation of blended learning practices observed in many institutions, where digital tools are often appended to conventional curricula without systemic redesign.

Empirical studies support the superiority of such integration. Castro (2019) reported that higher education institutions aligning blended learning with curriculum frameworks achieved 20–30% higher levels of student engagement compared to ad-hoc implementations. Similarly, Vodovozov et al. (2024) found that students in engineering programs designed with blended, project-based curricula demonstrated stronger collaborative and problem-solving competencies than those in purely traditional systems. These findings highlight that the effectiveness of blended learning increases significantly when embedded in the curricular architecture, rather than when used as an auxiliary instructional method.

The model also offers a human-centered orientation that directly aligns with the ethos of Industry 5.0. Earlier blended learning frameworks tended to emphasize efficiency and technological integration, whereas the present model deliberately foregrounds empathy, personalization, sustainability, and ethical reasoning. For example, UNESCO (2021) emphasized that equitable access to digital infrastructure is not merely a logistical requirement but a matter of educational justice. By explicitly situating infrastructure and inclusivity as pillars of curriculum design, this model responds to that concern and ensures that technology enhances, rather than exacerbates, inequality.

Moreover, the model underscores the evolving role of educators. As argued by Adera (2025), the true potential of blended learning lies not simply in mixing online and offline spaces, but in enabling teachers to become designers of personalized learning experiences. In this sense, educators shift from being content deliverers to mentors and facilitators who guide learners toward autonomy and innovation. This reconceptualization of pedagogy is another distinguishing feature that sets the model apart from previous frameworks.

Assessment represents a further domain where the proposed model demonstrates added value. Traditional reliance on standardized summative tests does not align with the complex learning demands of Industry 5.0. The model calls for dynamic assessment strategies—including e-portfolios, peer review, digital badges, and AI-driven analytics—that provide continuous feedback while capturing the multidimensional growth of learners. Shepard (2018) emphasized that assessment should not only measure but also shape learning, a principle operationalized in this framework.

Taken together, these features demonstrate that the proposed model provides a more comprehensive, adaptive, and ethically grounded approach to curriculum reconstruction. By embedding blended learning at the core of curricular philosophy, it addresses the deficiencies of conventional and fragmented approaches, while simultaneously preparing learners to navigate the human-technology partnerships central to Industry 5.0.

The implications of the reconstructed curriculum model are wide-ranging for education systems globally. For policymakers, the model highlights the necessity of investing not only in digital infrastructure but also in institutional policies that promote equity and sustainability. For curriculum developers, it provides a blueprint for designing programs that balance technical literacy with ethical and humanistic competencies, ensuring relevance in a rapidly changing world. For educators, the model redefines professional roles, calling for continuous development in instructional design, digital pedagogy, and mentorship.

On a broader scale, the model reinforces the importance of inclusive and equitable access to education. The blended learning approach, when structured through this conceptual framework, has the potential to reach diverse populations, including students in remote areas or those with limited resources, thereby narrowing educational disparities. Furthermore, the model suggests avenues for institutional reform, such as strengthening teacher training programs, developing adaptive assessment systems, and fostering interdisciplinary collaboration.

Finally, the study opens opportunities for future research. While the present work provides a conceptual foundation, empirical validation remains necessary. Pilot studies could test the model's feasibility in diverse educational contexts, ranging from higher education to vocational training. Comparative analyses across different cultural and institutional settings would further refine the model's adaptability and impact. Such empirical extensions will be critical to transforming this conceptual framework into a practical strategy for long-term educational transformation in the Industry 5.0 era.

Conclusions

The transformation toward Industry 5.0 demands a fundamental rethinking of educational paradigms that transcends conventional curriculum structures. While prior studies have often treated blended learning as a supplementary mode of instruction, this research addresses a critical gap by positioning it as the core architecture for curriculum reconstruction. The novelty of the proposed model lies in its human-centered orientation, integrating technological affordances with values of empathy, personalization, and sustainability. By articulating five adaptive pillars—learning objectives, content design, pedagogical approaches, digital infrastructure, and assessment strategies—the study contributes both theoretically, by extending curriculum theory into the context of Industry 5.0, and practically, by offering a framework that institutions can adapt for systemic transformation.

This reconstruction is not merely a response to technological change but a proactive strategy to cultivate critical, creative, and ethical learners who are prepared for a hyper-connected, interdisciplinary future. The integration of blended learning into curriculum frameworks should therefore be viewed as an imperative rather than an option, driven by the need to build inclusive, innovative, and resilient education systems.

Future research should focus on empirically testing the applicability and effectiveness of the model in diverse educational contexts. Pilot projects in higher education, vocational training, and teacher professional development can provide evidence of feasibility and impact. Comparative studies across different cultural and institutional settings are also necessary to refine the model's adaptability and ensure its relevance globally. Such empirical validation will strengthen the theoretical foundations of the model while informing practical strategies for long-term educational transformation in the Industry 5.0 era.

Acknowledgments

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