FUTURITY OF SOCIAL SCIENCE

DOI: https://doi.org/10.57125/FS.2026.06.20.02

How to cite: Tereshchenko, D. (2026). Artificial intelligence and hybrid learning in education: a conceptual synthesis for deep learning (6C). *Futurity of Social Sciences, 4*(2), 26–41. https://doi.org/10.57125/FS.2026.06.20.02

Artificial Intelligence and Hybrid Learning in Education: A Conceptual Synthesis for Deep Learning (6C)

M. J. Dewiyani Sunarto

Professor, Faculty of Technology and Informatics, Dinamika University, Surabaya, Indonesia, https://orcid.org/0000-0001-9232-1714

Ayouvi Poerna Wardhanie*

Lecturer, Faculty of Technology and Informatics, Dinamika University, Surabaya, Indonesia

https://orcid.org/0000-0001-6097-3339

***Correspondence Email:** *ayouvi@dinamika.ac.id.*

Received: November 26, 2025 | **Accepted:** March 22, 2026 | **Published:** April 13, 2026

Abstract: Changes in learning patterns are essential to prepare the younger generation with 21st-century competencies. Six competencies (6Cs) are creativity, critical thinking, communication, collaboration, citizenship, and character developed through deep learning, constitute a learning

framework that must be conceptually designed. Although Hybrid Learning and Artificial Intelligence (AI) are increasingly used in education, conceptual studies that align the roles of Hybrid Learning and AI in supporting deep learning remain limited. This study employs a qualitative conceptual approach by reviewing and synthesising scholarly articles indexed in reputable international journal databases to explore the complementary roles of Hybrid Learning and AI. The findings reveal that Hybrid Learning functions as an adaptive learning ecosystem that facilitates social interaction, contextual engagement, and experiential learning, thereby supporting the development of communication, collaboration, citizenship, and character. In parallel, AI operates as an intelligent cognitive support system that enhances creativity and critical thinking through data-driven insights, adaptive feedback, learning analytics, and personalised learning pathways tailored to individual learner profiles. Furthermore, the integration of Hybrid Learning and AI enables a more holistic learning environment by bridging human-centred pedagogical approaches with technology-driven personalisation. This synergy not only strengthens learner autonomy and engagement but also promotes continuous assessment and real-time feedback mechanisms. The proposed conceptual framework offers significant theoretical contributions by extending the discourse on deep learning within digitally mediated environments and provides practical implications for educators, instructional designers, and policymakers in designing future-ready learning models. Future research is recommended to empirically validate the proposed framework across diverse educational contexts, investigate the ethical implications of AI integration, and explore its long-term impact on learner outcomes and competency development in dynamic learning environments.

Keywords: artificial intelligence, conceptual analysis, deep learning, education, hybrid learning.

Introduction

Traditional learning that emphasises content mastery itself is no longer adequate (Kain et al., 2024). Contemporary learning systems require the development of higher-order thinking skills as well as social skills, which are understood as a set of social competencies including effective communication, collaboration, empathy, and social responsibility. This need arises from educators' and researchers' awareness of the necessity for educational change in response to technological advancement, which has increased the complexity of everyday life problems. Other studies (Tushar & Sooraksa, 2023) indicate that current education systems remain predominantly focused on academic achievement, resulting in limited student readiness to face the rapidly changing world of work and life. Among various educational studies, the concept of Deep Learning developed by Michael Fullan, as presented in the book *Deep Learning: Engage the World, Change the World* (Fullan et al., 2018), offers a framework to address current educational needs. This concept is selected because of its ability to bridge cognitive and non-cognitive demands in learning, which are often treated separately in other approaches, while maintaining a strong focus on student development (Tuomi, 2022). Deep Learning skills, critical thinking, creativity, collaboration, communication, citizenship, and character, commonly referred to as the 6Cs, have become essential

competencies in the 21st century. Empirical studies show that the development of critical and creative thinking skills is crucial to students' ability to solve real-world problems. In contrast, communication and collaboration skills form a vital foundation for teamwork across diverse, cross-cultural and professional contexts. Meanwhile, character and citizenship strengthen integrity, ethics, and social responsibility, which are prerequisites for the emergence of ethical and constructive global citizens (Sarip, M., Ilham, 2024). This indicates that integrating all six competencies constitutes a strategic form of learning for 21st-century life skills.

In addition, studies on Deep Learning emphasise meaningful learning that, theoretically, enables students to apply knowledge in a balanced manner across both cognitive and non-cognitive domains (Icela, 2022). Learning is categorised as deep learning, not based on the learning mode or technology used, but rather on the quality of students' cognitive engagement and learning outcomes. Learning is considered deep when students demonstrate meaningful conceptual understanding, the ability to transfer knowledge to new and complex situations, engagement in higher-order and metacognitive thinking processes, and the integration of cognitive and non-cognitive competencies. Thus, deep learning is achieved when learning experiences allow students to actively construct knowledge, apply it flexibly, and reflect on their learning processes. Regarding Deep Learning, it is widely recognised that the transition from traditional learning to Deep Learning requires a comprehensive, continuous ecosystem. Deep Learning demands not only mastery of content but also the creation of flexible learning environments that employ diverse strategies and provide adaptive support for each learner. In this context, Deep Learning is not understood as an autonomous agent that directs learning, but rather as a conceptual framework that guides educators' pedagogical decisions. A significant shift from conventional learning is required to facilitate active student engagement, individualised learning experiences, and learning connected to real-world contexts. To further enhance the achievement of Deep Learning, Fortuna et al. (2025) and Gudoniene et al. (2025a) found that learning systems that account for individual learning needs and personality traits enable students to develop deep conceptual understanding and apply knowledge in complex and dynamic situations.

The demand for learning transformation that emphasises flexibility, personalisation, and the integrated development of cognitive and non-cognitive competencies, such as Deep Learning, highlights the need for learning systems that are adaptive to current educational contexts. One such system that aligns well with contemporary conditions is Hybrid Learning. In Hybrid Learning, face-to-face interaction and online learning are systematically integrated to form a learning ecosystem. (Arfat et al., 2025) found that Hybrid Learning serves as a strategic platform because it harmoniously integrates in-person and online learning within a unified instructional design. Through Hybrid Learning, social interaction and expanded opportunities for independent and collaborative learning can be achieved, alongside flexibility in time and place and deeper learning experiences, as students become fully and actively engaged in complex and authentic learning processes (Essa, 2023).

Nevertheless, although Hybrid Learning offers flexibility by combining face-to-face and online learning, the optimal achievement of Deep Learning objectives still requires personalised learning facilitation responsive to individual student needs (Gudoniene et al., 2025b). Although recent

literature identifies various challenges and risks associated with the use of Artificial Intelligence (AI) in education, such as ethical concerns, assessment validity, and potential technological dependency, numerous studies also demonstrate AI's significant potential to meaningfully enhance learning quality when applied pedagogically and in a human-centred manner. Research indicates that AI-driven learning systems can support personalised learning by adapting content, learning pace, and feedback to individual student needs, positively impacting engagement and learning outcomes (Vieriu, 2025). These findings emphasise that AI should not be positioned as a replacement for educators, but rather as a supportive tool that strengthens personalised, reflective, and deep-learning–oriented facilitation. Artificial Intelligence (AI) can support the achievement of Deep Learning as a facilitator, as it is capable of delivering adaptive learning based on individual learner profiles, learning styles, and learning progress(Casteleijn & Franzsen, 2024). Furthermore, Merino-Campos (Merino-campos, 2025) argues that beyond instructional personalisation, AI can design and implement meaningful learning processes that are contextual and learner-centred. AI can thus be viewed as an advanced facilitator that enables the achievement of Deep Learning objectives through adaptive, learner-oriented instructional processes.

In summary, based on the discussion of Hybrid Learning and the use of AI in education, achieving Deep Learning objectives requires the involvement of Hybrid Learning as a learning environment and Artificial Intelligence as an adaptive facilitator. This combination provides a strong theoretical and practical foundation for developing learning models that meet the demands of 21st-century education and digital-era transformation. Learning models are necessary to operationalise conceptual frameworks into systematic pedagogical practices, enabling implementation, evaluation, and continuous development in real educational contexts. However, despite the rapid growth of studies on Hybrid Learning and the use of Artificial Intelligence in education over the past decade, these studies are generally partial and have not yet been integrated into a unified pedagogical framework that mutually supports Deep Learning models(Liu; et al., 2025; Mizza; & Huang, 2025). Some studies position Hybrid Learning as a structural solution for learning flexibility, while others focus on AI as a tool for personalisation or learning analytics in isolation (Bond et al., 2020; Zawacki-Richter et al., 2019). (Dziuban et al., 2018) Note that the absence of such an integrative framework has resulted in inadequate synergy between Hybrid Learning and AI's adaptive capabilities in producing holistic Deep Learning. Consequently, developing a conceptual framework that explicitly integrates AI and Hybrid Learning to support Deep Learning (6C) has become an urgent need in education. The lack of an integrative framework can lead to significant challenges. For instance, Hybrid Learning may become a mere combination of face-to-face and online instruction without fostering meaningful learning. Similarly, AI used independently or loosely combined with Hybrid Learning without a strong conceptual foundation is insufficient to support Deep Learning. While the integration of learning technologies (including Hybrid Learning models and artificial intelligence) has been shown to enhance generative skills, higher-order thinking, and personalised learning, without a pedagogical framework that synergises Hybrid Learning and AI, the development of Deep Learning remains elusive. AI-supported Hybrid Learning has primarily influenced student engagement across modern learning contexts rather than the full realisation of Deep Learning goals (Jairo & Andrés, 2024).

Research Problem

The main research problem addressed in this study is the lack of an integrative conceptual framework that aligns the roles of Hybrid Learning and Artificial Intelligence (AI) in fostering deep learning competencies (6Cs).

Research Focus

This study examines how Hybrid Learning and AI can conceptually complement each other in supporting the development of deep learning competencies.

Research Aim and Questions

This study aims to develop an integrative conceptual framework that explains the synergistic roles of Hybrid Learning and AI in fostering deep learning competencies. Based on the identified conceptual gaps and the need for more adaptive and integrated learning models, this study seeks to address the following research question: How can a conceptual framework that systematically integrates Artificial Intelligence (AI) and Hybrid Learning facilitate Deep Learning oriented toward the development of the six 21st-century competencies (6C)?. This article proposes a conceptual framework that systematically maps the roles of AI and Hybrid Learning in supporting the development of each dimension of the 6C competencies.

Research Methodology

General Background

This study employs a conceptual approach to construct a theoretical framework through analysis of relevant literature (Naserrudin et al., 2022; Omland et al., 2025). The approach is not designed to conduct empirical cause-and-effect evaluations, but rather to develop a conceptual understanding of the integration of Hybrid Learning and Artificial Intelligence (AI) in supporting the achievement of Deep Learning. This section outlines the research design and approach, the literature analysis strategy, and the systematic stages of conceptual framework development, resulting in a conceptual structure that can serve as a foundation for future research, including the development of learning models and implementation-oriented studies in educational contexts. The research design adopts a conceptual approach, selected to enable theoretical analysis of the integration of Hybrid Learning and Artificial Intelligence (AI) as a foundation for achieving Deep Learning. To establish a theoretical conceptual framework for developing Deep Learning by utilizing Hybrid Learning as the learning environment and AI as a facilitator, a conceptual research design was chosen. This approach, widely used in educational research, enables systematic examination of complex relationships among concepts without empirical data collection (Carrion et al., 2025). It is considered appropriate for addressing the research question because it enables the logical synthesis of prior findings and supports the development of conceptual understanding that can guide subsequent studies, such as model development (Luft et al., 2022). Through this approach, an in-depth analysis of the roles of Hybrid Learning and AI as supporting elements can be conducted, leading to Deep Learning as the primary learning orientation.

Participants / Sample

In this study, no human participants were involved, as the research employed a conceptual approach that analysed and synthesised existing academic literature. The data sources consisted of scholarly articles related to Deep Learning, Hybrid Learning, and AI in education, obtained from reputable academic journal databases.

Instrument and Procedures

As the basis for in-depth analysis, a systematic search was conducted of articles published in reputable scientific journals indexed in international databases. The review focused on studies related to Hybrid Learning, Artificial Intelligence, and Deep Learning, in line with the objectives of conceptual framework development. Articles published within the past five years were selected to ensure the latest relevance. The literature analysis focused on four main clusters of conceptual relationships: (i) the relationship between Hybrid Learning and AI, (ii) the relationship between Hybrid Learning and Deep Learning, (iii) the relationship between AI and Deep Learning, and (iv) the integration of Hybrid Learning, AI, and Deep Learning within one pedagogical framework. The conceptual framework was developed based on the focus of the literature analysis, as summarised in Table 1.

Table 1

Conceptual Synthesis of Literature on Hybrid Learning, AI, and Deep Learning

Conceptual Relationship	**Focus of Literature Analysis**
Hybrid Learning – AI	The role of AI within the Hybrid Learning ecosystem
Hybrid Learning – Deep Learning	Pedagogical opportunities from Hybrid Learning
AI – Deep Learning	AI support for cognitive and non-cognitive roles
Hybrid Learning – AI – Deep Learning	Integration of the three approaches

The synthesis of findings across these four main clusters of conceptual relationships provides novel insights that form the basis for the proposed conceptual framework, in accordance with the objectives of this study.

Results

This section presents the results of the conceptual analysis, derived from a review of the literature, for the four conceptual relationships outlined in Table 1. The results do not consist of empirical findings, but rather of a mapping of consistent conceptual patterns intended to construct a conceptual framework aligned with the objectives of this study. The conceptual analysis focuses on identifying how Hybrid Learning and Artificial Intelligence (AI), both independently and in an integrated manner, contribute to the development of the six Deep Learning competencies (6C).

Conceptual Relationship: Hybrid Learning – AI

Based on a synthesis of the literature, the role of AI in Hybrid Learning, its impact on learning outcomes, and its influence on student engagement toward the learning subjects reveal four fundamental points regarding AI's function within the Hybrid Learning ecosystem. First, AI is widely utilised as a supplementary tutor and teaching assistant. Studies by (Hu, 2025; Khalique et al., 2025) indicate that in the non-face-to-face components of Hybrid Learning, the role of AI tools such as ChatGPT and AI teaching assistants with NLP–ML-based (Neuro Language Programming–Machine Learning) plays a substantial role. Personalised support, needs-based feedback, and assistance in asynchronous learning environments strengthen continuity of learning within the hybrid ecosystem. Second, in terms of personalisation and learning adaptability, research by (Chilambarasan N, 2025) (Elfirdoussi, 2025) shows that AI-based planning, optimisation, predictive analytics, and adaptive learning platforms enhance the alignment of content, learning time, learning pathways, and hybrid scheduling based on the profiles of individual students, educators, and institutions. One of the most significant findings is that Hybrid Learning is no longer static but instead becomes dynamic and driven by data. These findings indicate that the combination of Hybrid Learning and Artificial Intelligence yields a pedagogically more powerful learning model than either approach applied separately, because AI serves as a core driver of personalisation, adaptivity, engagement, and self-regulation throughout the hybrid learning cycle. This ecosystem perspective has rarely been emphasised in prior literature, which tends to utilise AI as merely a support tool or Hybrid Learning as a delivery strategy, rather than as an integrated, data-driven learning system that operates synergistically.

Conceptual Relationship: Hybrid Learning – Deep Learning

Hybrid Learning forms an integrated learning ecosystem that systematically combines face-to-face interaction and online learning. Within this ecosystem, Deep Learning serves as the pedagogical orientation, emphasising deep conceptual understanding, meaningful knowledge construction, and the development of higher-order thinking skills. From the synthesis of relevant literature, which examines the role of hybrid learning on the deep learning ecosystem, impact on the learning outcome and its influence on student engagement toward the learning subjects, reveals five fundamental points regarding the role of Hybrid Learning on the deep learning ecosystem. First, research by (Hongli, 2025) found that Hybrid Learning provides an integrated learning ecosystem that enables adaptive and personalised learning, which promotes the development of 21st-century competencies (6C) and enhancing students' cognitive abilities. Second, the conceptual integration of online and face-to-face learning in Hybrid Learning supports meaningful knowledge construction and strengthens Deep Learning processes through coherent learning experiences (Zhao et al., 2022). Third, (Chen, 2023) argues that Hybrid Learning designs, which are explicitly oriented toward learning objectives facilitate students' transition from surface learning to Deep Learning by reinforcing cognitive, behavioural, and mindset dimensions. Fourth, Hybrid Learning approaches based on the integration of Small Prthat Learninge-Face-to-Face) enhance inquiry-based learning and create conducive conditions to achieving Deep Learning for(Huang, 2024). Fifth, systematically designed Hybrid Learning enables the implementation of Deep Learning–oriented instruction and the development of Higher Order Thinking Skills (HOTS) through the synergy of online and offline

learning (Zhou & Zhang, 2018). These findings indicate that Hybrid Learning is not merely an instructional delivery method, but rather a pedagogical ecosystem that enables Deep Learning to be operationalized and sustained. This perspective extends beyond prior literature that often discusses Deep Learning at the level of cognitive approaches or in isolation from instructional design, by emphasising that the synergy between online and offline learning in Hybrid Learning is a critical prerequisite for more powerful learning experiences oriented toward HOTS and the holistic development of 6C competencies.

Conceptual Relationship: AI – Deep Learning

Although AI can be viewed as a strategic supporting element in Deep Learning (Heung et al., 2023), within this conceptual relationship, AI should not be positioned as a substitute for educators' pedagogical roles. Instead, it functions as a facilitator aligned with students' individual characteristics, including instructional content, assessment, and monitoring of learning progress. In this context, AI serves as a supporting mechanism that expands opportunities for the consistent, sustainable realisation of meaningful learning. Based on a synthesis of findings from (Eden, 2024; Marlina et al., 2025; Trisnawati et al., 2023), Artificial Intelligence plays a significant role in strengthening both the cognitive and non-cognitive dimensions of Deep Learning (6C) through adaptive learning, learning analytics, and intelligent tutoring systems. From the cognitive perspective, AI supports personalisation, differentiation, and needs-based feedback, which directly foster critical thinking, creativity, and character development—particularly in self-regulation and learning responsibility. From the non-cognitive perspective, AI facilitates improvements in communication, collaboration, and citizenship by supporting social interaction, emotional intelligence, and inclusive learning engagement (Eden, 2024; Marlina et al., 2025). However, the use of AI without adequate pedagogical guidance may risk undermining character development and learning independency, underscoring the importance of pedagogically oriented AI integration (Trisnawati et al., 2023).

Conceptual Relationship: Hybrid Learning – AI - Deep Learning

Although Hybrid Learning provides new opportunities and high flexibility, it does not automatically guarantee the realisation of Deep Learning. As an enabler, AI strengthens Hybrid Learning to support more personalised learning processes. The integration of Hybrid Learning and AI becomes meaningful only when it is intentionally directed toward fostering the 6C competencies of Deep Learning. Thus, the relationship among Hybrid Learning, AI, and Deep Learning is not linear, but rather interdependent and mutually reinforcing. AI mediates the design and implementation of Hybrid Learning to facilitate deep cognitive and non-cognitive engagement of the students. The conceptual framework proposed in this study aims to explain these relational mechanisms as a theoretical foundation for developing learning practices oriented toward Deep Learning. The combination of face-to-face and online learning models offers high flexibility in digital-era education and supports broad student engagement. Technology development, particularly AI, extends pedagogical capacity by enabling personality-based learning and real-time feedback that supports deep learning processes. Within a Hybrid Learning framework oriented toward Deep Learning (6C),

AI is used as a strategic supporting element to personalise learning processes for both students and educators. AI-driven Hybrid Learning enhances educational access and efficiency, while also strengthening emotional engagement and student motivation toward achieving the 6C competencies of Deep Learning (Wang; & Wang;, 2025).

AI acts as a pedagogical enabler that enables more adaptive and responsive instruction tailored to individual needs, making learning more personal and contextual within Hybrid Learning through learning analytics, content recommendation systems, and continuous automated assessment support. This aligns with findings that AI supports personalisation and interaction that strengthen both cognitive and non-cognitive engagement of the students—two core dimensions of Deep Learning (Fullan et al., 2018)—by facilitating active participation, self-reflection, and collaboration in complex learning contexts (Khadidos et al., 2025; Peng & Li, 2025). Research by Wadim Strielkowski (2024) indicates that AI equipped with adaptive learning capabilities can bring fundamental changes to learning activities by analysing students' task performance. Meanwhile (Wang; & Wang;, 2025) emphasise that integrating AI into Hybrid Learning must be approached critically, contextually, and in a balanced manner, given the importance of educators' pedagogical readiness, institutional support, and appropriate instructional processes. Therefore, the conceptual framework applies AI as a pedagogical driver that facilitates the transition from Hybrid Learning to Deep Learning (6C) through personality-based learning, adaptation, real-time feedback, and increased engagement in learning processes, thereby strengthening higher-order thinking, creativity, communication, and collaboration.

AI-Based Hybrid Learning Conceptual Framework for Deep Learning

Based on the literature analysis across the identified conceptual relation, an integrative conceptual framework was developed to explain how Hybrid Learning and AI can synergistically achieve Deep Learning oriented toward the development of 21st-century skills (6C). In the proposed framework, Hybrid Learning is applied as the learning ecosystem, AI is applied as a pedagogical enabler, and Deep Learning—focused on the development of 6C competencies—serves as the primary learning outcome. These three components are interconnected in a non-linear but mutually reinforcing manner. Hybrid Learning provides learning flexibility through synchronous learning, which strengthens social interaction, communication, and collaboration, while asynchronous learning enables deeper reflection, self-regulation, and independent knowledge exploration. Through Hybrid Learning, conducive conditions are created to develop critical thinking and foster creativity. Simultaneously, collaboration and communication are fostered through technology-enhanced social interaction, while character and citizenship are developed through reflective, responsible and engaged in socially meaningful learning contexts. AI enables learning design to become personalised in terms of content, implementation, and ongoing learning support. Within this framework, AI acts as an adaptive facilitator that bridges diverse learner needs, preferences, and learning progress within the Hybrid Learning ecosystem. AI supports more personalised learning, enhances self-regulated learning, and maximises emotional and cognitive engagement. Importantly, AI is not applied as a replacement for educators' pedagogical roles, but as a means of strengthening pedagogical capacity in designing and facilitating meaningful learning. The

deliberate integration of Hybrid Learning and AI is directed toward fostering deep cognitive and non-cognitive development, ultimately achieving the 6C competencies.

In summary, this conceptual framework emphasises that Deep Learning does not emerge automatically from the implementation of Hybrid Learning, or the use of AI alone, but rather requires a deliberately structured and integrated design. The primary novelty of this framework lies in its assertion that AI not only enhances learning efficiency but can also be used by educators to dynamically and sustainably mediate the relationship between learning environments, individual learner needs, and Deep Learning (6C) pedagogical objectives. In this framework, Deep Learning is not treated as a passive outcome of instruction, but as an instructional design principle that consciously guides the use of Hybrid Learning and AI from planning through evaluation. Moreover, the relationship among Hybrid Learning, AI, and Deep Learning is relational and non-linear, emphasising that meaningful learning results from reciprocal interactions among pedagogical components, rather than from technology adoption or integration of instructional modes alone. Consequently, this framework offers a novel conceptual approach that moves beyond partial integration by positioning pedagogy at the centre of the transformation of technology-driven learning. Based on the conceptual synthesis of the four identified relationships, the proposed conceptual framework is presented visually to clarify the relational mechanisms among Hybrid Learning, Artificial Intelligence, and Deep Learning (6C).

Figure 1

Conceptual Mapping of Pedagogical and Technological Dimensions of Deep Learning

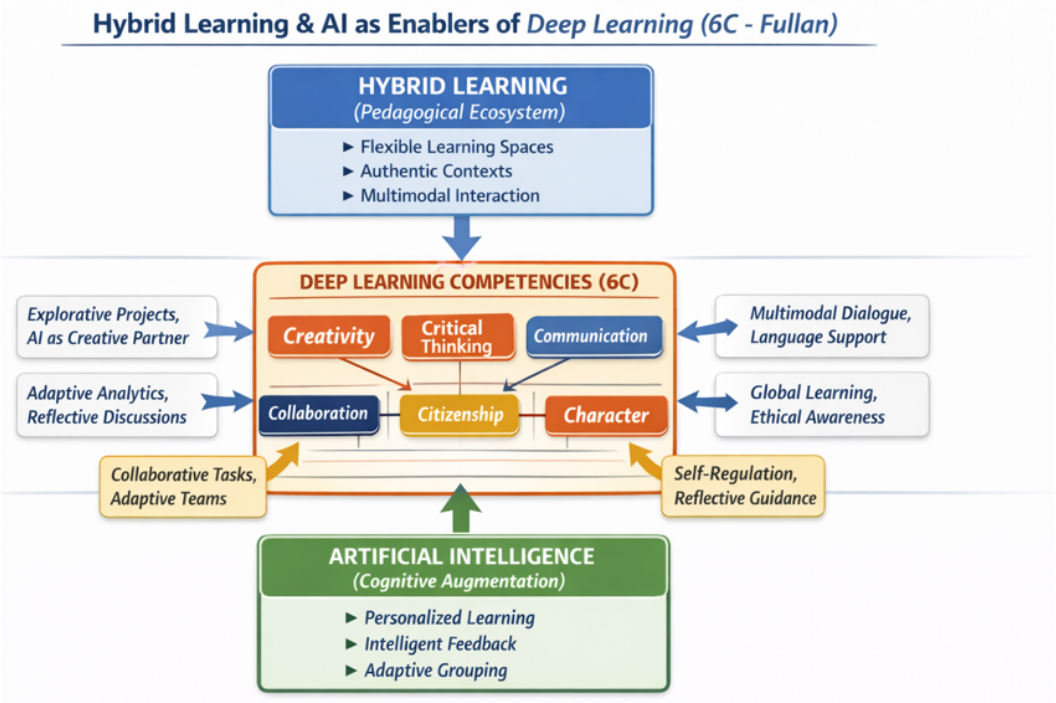

Figure 1 illustrates the novelty of this article, which lies in the proposal of a conceptual framework that explicitly differentiates and synergises the roles of Hybrid Learning and Artificial Intelligence in supporting Deep Learning (6C). The primary conceptual contribution of this model is

the specific mapping of Hybrid Learning and AI contributions to each dimension of the 6C competencies, providing a more precise explanation of how and in which competency technology and pedagogical design contribute to deep learning. Although this study adopts a conceptual approach, the proposed framework is grounded in strong theoretical foundations. It provides a foundation for future empirical research to examine its applicability and effectiveness across diverse educational contexts. The synthesis of conceptual findings in this study indicates that the integration of Hybrid Learning and Artificial Intelligence establishes a sufficient pedagogical foundation for developing learning models oriented toward Deep Learning (6C). Therefore, this conceptual framework serves not only as a theoretical analytical tool, but also as an initial foundation for designing learning models that formalise the relationship among hybrid design, AI support, and the development of 21st-century competencies.

Discussion

The study presents a conceptual synthesis of AI and hybrid learning in education to support deep learning by developing six key competencies (6Cs). Compared to existing models, the proposed framework offers a more integrative perspective by explicitly linking AI capabilities with hybrid learning environments and competency-based outcomes. Previous frameworks in educational technology tend to focus either on technology adoption or on pedagogical approaches such as blended or hybrid learning. In contrast, this framework bridges that gap by positioning AI not merely as a tool, but as an enabler of deeper learning experiences within hybrid settings. Moreover, while traditional models of deep learning emphasise student-centred pedagogies and active engagement, they do not always incorporate the transformative role of AI in personalising learning, providing real-time feedback, and supporting adaptive instruction. The proposed framework advances existing approaches by embedding AI functionalities into the hybrid learning structure, thereby enhancing the potential to cultivate the 6Cs in a more systematic and scalable manner. This synthesis also reflects the evolving nature of education in the digital era, where learning is no longer confined to physical classrooms but extends into flexible, technology-mediated environments.

Despite its contribution, the framework has several limitations inherent to its conceptual nature. First, the model has not yet been empirically validated, which limits its ability to demonstrate causal relationships between AI integration, hybrid learning design, and the development of 6C competencies. Second, the framework may oversimplify the complexity of teaching and learning processes. Third, the framework assumes a certain level of technological readiness and pedagogical capability, which may not be equally available across different educational institutions. From an implementation perspective, several practical challenges need to be considered. One major challenge is the readiness of institutions to adopt AI-driven hybrid learning systems. This includes not only technological infrastructure but also the availability of skilled educators who can effectively integrate AI into their teaching practices. Many educators may require additional training to design learning experiences that meaningfully incorporate AI while still aligning with the goals of deep learning and competency development.

Conclusions

Through a conceptual framework approach that integrates Hybrid Learning and Artificial Intelligence to realize the six 6C competencies proposed by Fullan through the development of Deep Learning, this article arrives at the understanding that Hybrid Learning functions as the primary learning ecosystem due to its flexible interactions, authentic learning experiences, and student engagement. At the same time, AI serves as a bridging mechanism that supports personality-based learning, individualized feedback, and deeper cognitive processes, personality based learning refers to personalised learning. Deep Learning, with 6C competencies as its learning outcomes, emerges from the harmony between pedagogical design and intelligent technology, rather than from the mere adoption of technological advances. The contribution of this conceptual framework analysis lies in the explicit mapping of the complementary roles of Hybrid Learning and AI across each dimension of the 6C competencies, thereby providing conceptual clarity regarding the mechanisms through which contemporary learning environments can foster deep learning competencies. The proposed framework not only enriches theoretical perspectives on technology-enhanced learning but also offers a conceptual foundation for the development of learning models, instructional design, and pedagogical practices oriented toward strengthening 21st-century competencies. Based on the resulting conceptual synthesis, future research will focus on developing learning models that systematically integrate Hybrid Learning and Artificial Intelligence to support the achievement of Deep Learning and the 6C competencies. This next stage will include the design of learning syntax, implementation scenarios, and the use of AI as a pedagogical support, which will subsequently be empirically tested across diverse educational contexts.

Suggestions for Future Research

Future research should advance this study by undertaking rigorous empirical validation of the proposed conceptual framework through diverse methodological approaches. Experimental and quasi-experimental designs are particularly recommended to establish causal relationships between AI-supported hybrid learning environments and the development of the six core competencies (6Cs). In addition, longitudinal studies are needed to capture the sustained and developmental impact of these competencies over time, especially for higher-order dimensions such as citizenship and character. Future investigations should also incorporate comparative analyses across educational levels—including primary, secondary, and higher education—as well as across diverse institutional contexts with varying levels of technological readiness, to assess the generalizability and scalability of the framework. Moreover, cross-cultural and international studies are essential to examine how sociocultural factors influence the integration of AI and hybrid learning in fostering deep learning outcomes. Further research should also focus on the development and validation of robust measurement instruments for assessing the 6Cs, as well as exploring the alignment between AI functionalities and pedagogical strategies within hybrid environments. Finally, critical attention must be given to ethical considerations, including data privacy, algorithmic bias, and transparency, to ensure responsible, equitable, and sustainable implementation of AI in education. These directions will not only strengthen the empirical foundation of the framework but also enhance its practical relevance and impact in diverse educational settings.

Acknowledgements

The authors would like to thank Universitas Dinamika for providing institutional support, resources, and an academic environment that contributed to the successful completion of this study.

Data Availability

The data that support the claims and findings of the study are openly available in international repositories such as Google Scholar, WOS, Scopus, and DOAJ.

Conflict of Interest

The authors declare no conflict of interest related to the conduct, authorship, and publication of this study.

Funding

The authors received no funding for this research.

References

Arfat, Y., Khalid, M., Al-Tayyar, R. S., & Mahmood, K. (2025). Building inclusive learning environment through hybrid learning system: Role of technology and corresponding engagement. *Sustainable Futures*, *10*, Article 100887. https://doi.org/10.1016/j.sftr.2025.100887

Bond, M., Buntins, K., Bedenlier, S., Zawacki-Richter, O., & Kerres, M. (2020). Mapping research in student engagement and educational technology in higher education: A systematic evidence map. *International Journal of Educational Technology in Higher Education*, *17*, Article 2. https://doi.org/10.1186/s41239-019-0176-8

Carrion, C., Llamas, C. A., Safitri, E. D., Panicello, C. D., Downward, G. S., Findyartini, A., Greviana, N., Murni, I. K., Lee, S. M., Llimós, M., & Moreno, A. (2025). Conceptual frameworks, competencies, contents and teaching methods in planetary health education for health students and professionals: A global systematic scoping review. *BMC Medical Education*, *25*, Article 3. https://doi.org/10.1186/s12909-025-07450-x

Casteleijn, D., & Franzsen, D. (2024). Personalized adaptive learning in higher education: A scoping review of key characteristics and impact on academic performance and engagement. *Heliyon*, *10*, Article e39630. https://doi.org/10.1016/j.heliyon.2024.e39630

Chen, Y. (2023). Exploration and practice of blended teaching model based on deep learning: The example of a high school information technology course. In *Proceedings of the 2023 ACM Conference* (pp. 55–61). Association for Computing Machinery. https://doi.org/10.1145/3591139.3591154

Chilambarasan, N. R. (2025). AI-powered personalized learning: Ethical and practical integration into contemporary education. *Research Square*, *12*(2), 1–12.

Dziuban, C., Graham, C. R., Moskal, P. D., Norberg, A., & Sicilia, N. (2018). Blended learning: The new normal and emerging technologies. *International Journal of Educational Technology in Higher Education*, *15*, Article 3. https://doi.org/10.1186/s41239-017-0087-5

Eden, C. A. (2024). Integrating AI with emotional and social learning in primary education: Developing a holistic adaptive learning ecosystem. *Open Access Research Journal of Multidisciplinary Studies*, *7*(2), 42–51. https://doi.org/10.53022/oarjms.2024.7.2.0025

Elfirdoussi, S. (2025). Enhancing personalized education through an adaptive framework: Assessing the impact of an optimized planning generator. *Engineering, Technology & Applied Science Research*, *15*(4), 25263–25269. https://doi.org/10.48084/etasr.9438

Essa, E. K. (2023). The effectiveness of hybrid learning in enhancing academic mindfulness. *International Journal of Research in Education and Science*, *9*(1), 188–202. https://doi.org/10.46328/ijres.3081

Fortuna, A., Prasetya, F., Dwinggo, A., Rawas, S., & Azis, R. (2025). Artificial intelligence in personalized learning: A global systematic review of current advancements and shaping future opportunities. *Social Sciences & Humanities Open*, *12*, Article 101355. https://doi.org/10.1016/j.ssaho.2025.101355

Fullan, M., Quinn, J., & McEachen, J. (2018). *Deep learning: Engage the world, change the world*. Corwin Press.

Gudonienė, D., Stanevičienė, E., Huet, I., Dickel, J., Dieng, D., Degroote, J., Rócio, V., Butkinė, R., & Casanova, D. (2025). Hybrid teaching and learning in higher education: A systematic literature review. *Sustainability*, *17*(2), Article 756. https://doi.org/10.3390/su17020756

Heung, I., Yim, Y., & Su, J. (2023). Artificial intelligence (AI) learning tools in K–12 education: A scoping review. *Journal of Computers in Education*. Advance online publication. https://doi.org/10.1007/s40692-023-00304-9

Hongli, F. (2025). A deep learning-based blended teaching model for enhancing English proficiency in English education. *International Journal of Research and Innovation in Social Science*, *8*, 6247–6266. https://doi.org/10.47772/IJRISS

Hu, Z. (2025). AI teaching assistants in hybrid learning: Strengths and limitations in healthcare education. *International Journal of Learning, Teaching and Educational Research*, *24*(7), 556–575. https://doi.org/10.26803/ijlter.24.7.27

Huang, R. (2024). Seeking the optimal SPOC-based blended learning approach to enhance deep learning from the community of inquiry perspective. *Contemporary Educational Technology*, *16*(4), 1–17.

Icela, L. (2022). Components of Education 4.0 in 21st century skills frameworks: Systematic review. *Sustainability*, *14*(3), Article 1493. https://doi.org/10.3390/su14031493

Jairo, J., & Andrés, J. (2024). The AI-driven classroom: A review of 21st century curriculum trends. *PROSPECTS*, *54*(3), 645–660. https://doi.org/10.1007/s11125-024-09704-w

Kain, C., Koschmieder, C., Matischek-Jauk, M., & Bergner, S. (2024). Mapping the landscape: A scoping review of 21st century skills literature in secondary education. *Teaching and Teacher Education*, *151*, Article 104739. https://doi.org/10.1016/j.tate.2024.104739

Khadidos, A. O., Manoharan, H., Khadidos, A. O., & Alanazi, M. N. (2025). Personalized learning in hybrid education. *Scientific Reports*, *15*, Article 3361. https://doi.org/10.1038/s41598-025-03361-5

Khalique, A., Honggang, W., & Ali, M. (2025). Empowering creativity and engagement: The impact of generative artificial intelligence usage on Chinese EFL students' language learning experience. *Computers in Human Behavior Reports*, *18*, Article 100627. https://doi.org/10.1016/j.chbr.2025.100627

Liu, C.-C., Wang, H.-J., & Gu, X.-Q. (2025). From access to mastery: Integrating AI in blended learning for equitable, inclusive, and accessible music theory education. *The Internet and Higher Education*, *66*, Article 101018. https://doi.org/10.1016/j.iheduc.2025.101018

Luft, J. A., Jeong, S., Idsardi, R., & Gardner, G. (2022). Literature reviews, theoretical frameworks, and conceptual frameworks: An introduction for new biology education researchers. *CBE—Life Sciences Education*, *21*(3), 1–10. https://doi.org/10.1187/cbe.21-05-0134

Marlina, S., Leba, R., Nggaruaka, T., & Butarbutar, R. (2025). Smart teaching in rural Indonesia: Harnessing AI-assisted deep learning for teacher professional development. *Eth-Alca*, *984*, 1–20. https://doi.org/10.56294/ai2025419

Merino-Campos, C. (2025). The impact of artificial intelligence on personalized learning in higher education: A systematic review. *Trends in Higher Education*, *4*(2), 1–15. https://doi.org/10.3390/higheredu4020017

Mizza, J. W. T. S. D., & Huang, M. S. L.-P. R. (2025). Unlocking the potential of artificial intelligence in improving learning achievement in blended learning: A meta-analysis. *Frontiers in Psychology*, *16*, Article 1691414. https://doi.org/10.3389/fpsyg.2025.1691414

Naserrudin, N. A., Jeffree, M. S., & Kaur, N. (2022). Study on the development of a conceptual framework to identify the risk factors of diabetic retinopathy among diabetic patients: A concept paper. *International Journal of Environmental Research and Public Health*, *19*(19), Article 12426. https://doi.org/10.3390/ijerph191912426

Omland, M., Hontvedt, M., Siddiq, F., & Amundrud, A. (2025). Co-creation in higher education: A conceptual systematic review. *Higher Education*, *90*(4). https://doi.org/10.1007/s10734-024-01364-1

Peng, J., & Li, Y. (2025). Frontiers of artificial intelligence for personalized learning in higher education: A systematic review of leading articles. *Applied Sciences*, *15*(18), Article 10096. https://doi.org/10.3390/app151810096

Sarip, M., & Ilham, A. (2024). Enhancing the 6Cs as 21st century skills among higher education students through an entrepreneurial project learning. *Jurnal Kependidikan*, *10*(4), 1528–1536. https://doi.org/10.33394/jk.v10i4.13117

Strielkowski, W. (2024). AI-driven adaptive learning for sustainable educational transformation. *Sustainable Development*, *33*(2), 1921–1947. https://doi.org/10.1002/sd.3221

Trisnawati, W., Putra, R. E., & Balti, L. (2023). The impact of artificial intelligence in education toward 21st century skills: A literature review. *PPSDP International Journal of Education*, *2*, 501–513.

Tuomi, I. (2022). Artificial intelligence, 21st century competences, and socio-emotional learning in education: More than high-risk? *European Journal of Education*, *57*(1), 1–24. https://doi.org/10.1111/ejed.12531

Tushar, H., & Sooraksa, N. (2023). Global employability skills in the 21st century workplace: A semi-systematic literature review. *Heliyon*, *9*, Article e21023. https://doi.org/10.1016/j.heliyon.2023.e21023

Vieriu, A. M. (2025). The impact of artificial intelligence (AI) on students' academic development. *Education Sciences*, *15*(3), Article 343. https://doi.org/10.3390/educsci15030343

Wang, S. Z. S., & Wang, H. D. Y. Z. (2025). Enhancing student acceptance of artificial intelligence-driven hybrid learning in business education: Interaction between self-efficacy, playfulness, emotional engagement, and university support. *The International Journal of Management Education*, *23*(2), Article 101184. https://doi.org/10.1016/j.ijme.2025.101184

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education—Where are the educators? *International Journal of Educational Technology in Higher Education*, *16*, Article 39. https://doi.org/10.1186/s41239-019-0171-0

Zhao, J., Lu, J., Zou, X., & Zhu, Z. (2022). Research on the application of blended teaching mode with "deep learning" orientation. *Security and Communication Networks*, *2022*, Article 4128995. https://doi.org/10.1155/2022/4128995

Zhou, Y., & Zhang, Z. (2018). A study of blended learning design to promote deep learning. In *Advances in Social Science, Education and Humanities Research* (Vol. 189, pp. 450–453). Atlantis Press. https://doi.org/10.2991/mehss-18.2018.91