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Developing 21st Century Skills: Educational Strategies to Enhance Critical Thinking and Creativity

Nur Wahyuni✉,
Universitas Ahmad Dahlan, Indonesia

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Abstract
This study explores effective educational strategies for enhancing **critical thinking and creativity** as core competencies in 21st-century learning. These skills are essential for students to להתמודד complex problems, innovate, and actively participate in global society, yet their implementation in classroom practice remains inconsistent. This research employs a qualitative approach using a Systematic Literature Review (SLR), analyzing recent peer-reviewed journal articles from databases such as Scopus, Web of Science, and Google Scholar. Data were collected through a structured selection process based on relevance, credibility, and alignment with the research focus, and analyzed using thematic and content analysis to identify key patterns across studies. The findings reveal that instructional models such as Project-Based Learning (PjBL), Problem-Based Learning (PBL), and STEM/STEAM integration significantly enhance both critical thinking and creativity. These effects are further strengthened by constructivist principles, collaborative learning, and teacher facilitation. Additionally, technology and AI integration support critical thinking and collaboration, although their impact on creativity requires complementary pedagogical design. The study concludes that a holistic and integrated approach aligning pedagogy, learning environment, technology, and assessment is essential for effectively developing 21st-century skills.
Keywords: *Critical Thinking, Creativity, Project-Based Learning, STEM Education, 21st Century Skills*

✉ Corresponding author :
Email Address : 2207050016@webmail.uad.ac.id
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Introduction
The rapid transformation of global society in the 21st century has fundamentally reshaped the competencies required for individuals to effectively participate in education, work, and civic life. Among these competencies, critical thinking and creativity are widely recognized as core skills that enable individuals to analyze complex problems, generate innovative solutions, and adapt to dynamic environments. These skills are not only essential for academic success but also for fostering lifelong learning and global citizenship. In response, educational systems worldwide have increasingly emphasized the integration of these competencies into curriculum design, pedagogy, and assessment frameworks. However, despite this growing emphasis, there remains a significant discrepancy between the theoretical importance of critical and creative thinking and their actual development in classroom practices. This discrepancy highlights a persistent educational challenge: how to effectively translate 21st-century skill frameworks into concrete, impactful learning experiences.

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Recent studies have demonstrated that traditional teacher-centered approaches are insufficient in cultivating critical and creative thinking, as they tend to prioritize content transmission and rote memorization over inquiry, exploration, and innovation. Consequently, there has been a shift toward more student-centered pedagogical models that emphasize active learning, collaboration, and real-world problem-solving. Among these, Project-Based Learning (PjBL) and Project-Oriented Problem-Based Learning (PoPBL) have emerged as highly effective strategies. Research indicates that these approaches significantly enhance students' creativity—particularly in terms of fluency, flexibility, and originality—as well as their critical thinking abilities (Li & Tu, 2024; Dilekçi & Karatay, 2023; Sungkono & Ekaputra, 2023; Alali, 2024). By engaging learners in authentic projects that require sustained inquiry and problem-solving, PjBL and PoPBL create opportunities for students to apply knowledge in meaningful contexts, thereby fostering deeper cognitive engagement and innovation.

Similarly, Problem-Based Learning (PBL) has been identified as an effective model for promoting critical and creative thinking through its focus on real-world problems and inquiry-based learning processes. Made et al. (2023) argue that PBL encourages students to explore multiple perspectives, analyze information critically, and develop creative solutions to complex issues. This approach aligns with constructivist learning theory, which posits that knowledge is constructed through active engagement and interaction with the environment. In addition, the integration of STEM and STEAM approaches further enhances the development of critical and creative thinking by combining scientific, technological, engineering, artistic, and mathematical perspectives. Studies have shown that STEM/STEAM-based learning environments support the development of computational thinking, design thinking, and creative problem-solving skills, particularly when learners are involved in interdisciplinary projects (Juliangkary et al., 2024; Mariana & Kristanto, 2023; Suherman et al., 2025; Alali, 2024).

Beyond specific instructional models, the literature also emphasizes the importance of holistic and innovative learning environments that integrate cognitive, emotional, and social dimensions of learning. Such environments have been found to significantly enhance students' dispositions toward critical thinking and creativity, including curiosity, open-mindedness, and reflective thinking (Barorah et al., 2025; Tretyak, 2024; Varías & Callao, 2022). These findings suggest that the development of 21st-century skills requires not only appropriate pedagogical strategies but also supportive learning environments that encourage exploration, risk-taking, and collaboration. In this context, the role of the teacher shifts from that of a knowledge transmitter to a facilitator of learning, who guides students in asking high-level questions, provides constructive feedback, and models critical and creative thinking processes (Mamun, 2024; Juliangkary et al., 2024; Tretyak, 2024; Made et al., 2023; Herlinawati et al., 2024).

Another critical dimension in the development of critical and creative thinking is the integration of technology and artificial intelligence (AI) in education. The advancement of digital tools and learning technologies has opened new possibilities for enhancing student engagement and cognitive development. Yilmaz (2021) highlights that the gradual integration of technology, from basic digital tools to advanced applications, can significantly improve critical and creative thinking skills, particularly among pre-service teachers. Furthermore, the use of robotics, digital mind mapping, and virtual or AI-based learning environments has been shown to enhance students' creativity, academic performance, and awareness of critical thinking processes, provided that appropriate scaffolding is in place (Juliangkary et al., 2024; Chiu & Hwang, 2024; Hasan et al., 2025; Yilmaz, 2021). However, while AI demonstrates strong potential in supporting collaboration, communication, and critical thinking, its impact on creativity remains inconclusive, indicating the need for complementary pedagogical strategies to fully harness its benefits (Hasan et al., 2025).

Despite the substantial body of research supporting various instructional strategies, several critical issues remain unresolved. First, there is a lack of integration among different pedagogical approaches, resulting in fragmented implementation of strategies aimed at developing critical and creative thinking. Many studies focus on specific models, such as PjBL, PBL, or STEM, without providing a comprehensive framework that synthesizes these approaches into a coherent instructional design. Second, there is limited attention to the alignment between pedagogical strategies, curriculum design, and assessment practices. While frameworks such as the 4C (creativity, critical thinking, collaboration, communication) have been widely adopted, their implementation often lacks consistency and systematic evaluation (Thornhill-Miller et al., 2023; Herlinawati et al., 2024). Third, the role of technology and AI

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in supporting these skills is still underexplored, particularly in terms of how digital tools can be effectively integrated with pedagogical strategies to enhance both critical and creative thinking.

These gaps highlight the need for a more comprehensive and integrative approach to understanding and implementing strategies for developing 21st-century skills. Specifically, there is a need to synthesize existing research to identify key principles, effective practices, and potential challenges associated with various instructional models. Such a synthesis would provide valuable insights for educators, curriculum developers, and policymakers in designing learning environments that effectively support the development of critical and creative thinking. Moreover, it would help bridge the gap between theory and practice by providing a clearer understanding of how different strategies can be combined and adapted to diverse educational contexts.

The novelty of this study lies in its effort to provide a comprehensive synthesis of recent research on strategies for developing critical and creative thinking in 21st-century education. Unlike previous studies that focus on individual instructional models, this research integrates multiple approaches, including PjBL, PBL, STEM/STEAM, holistic learning environments, and technology-enhanced learning, into a unified conceptual framework. This integrative perspective allows for a more holistic understanding of how different strategies interact and complement each other in fostering critical and creative thinking. Furthermore, this study emphasizes the importance of aligning pedagogical strategies with curriculum design and assessment practices, thereby addressing a critical gap in the existing literature. By incorporating insights from recent empirical studies, this research also highlights emerging trends, such as the role of AI and digital technologies, in shaping the future of education.

In addition, this study contributes to the literature by proposing key design principles for effective learning environments, including constructivist and interactive learning, open inquiry and learner autonomy, collaboration and communication, and the facilitative role of teachers. These principles are grounded in empirical evidence and provide practical guidance for educators seeking to enhance critical and creative thinking in their classrooms. By emphasizing the interconnectedness of cognitive, emotional, and social dimensions of learning, this study offers a more nuanced and comprehensive understanding of how 21st-century skills can be developed in diverse educational contexts.

Based on the identified problems, research gaps, and proposed novelty, the primary objective of this study is to systematically analyze and synthesize recent research on educational strategies that effectively enhance critical thinking and creativity in 21st-century learning. This objective aims to develop an integrative framework that highlights key instructional models, design principles, and technological innovations, as well as their implications for curriculum development and assessment practices. Through this synthesis, the study seeks to provide actionable insights that can inform the design of more effective, inclusive, and future-oriented educational practices.

Methodology

This study employs a qualitative research approach using a Systematic Literature Review (SLR) design to comprehensively analyze educational strategies that enhance critical thinking and creativity in 21st-century learning. The selection of this method is aligned with the research objective, which aims to synthesize recent empirical findings and develop an integrative conceptual framework. The data collection technique was conducted through a systematic and structured search of reputable academic databases, including Scopus, Web of Science, ERIC, and Google Scholar. The search process utilized predefined keywords such as “critical thinking,” “creativity,” “21st-century skills,” “Project-Based Learning,” “Problem-Based Learning,” “STEM/STEAM education,” and “technology integration in education.” The inclusion criteria consisted of (1) peer-reviewed journal articles published between 2021 and 2026, (2) studies explicitly addressing instructional strategies that influence critical thinking and/or creativity, and (3) empirical or review-based research with clear methodological rigor. Meanwhile, exclusion criteria included non-indexed publications, opinion-based articles without empirical evidence, and studies not directly مرتبط with educational contexts. The data collection process followed several stages: identification of relevant studies, screening of titles and abstracts, full-text evaluation, and final selection based on relevance and quality.

The data analysis in this study utilized a thematic analysis approach combined with qualitative content analysis to identify key patterns, relationships, and trends across the selected literature. Initially, open coding was applied to extract essential concepts related to instructional strategies, learning environments, technological integration, and assessment practices that influence critical thinking and creativity. These initial codes were then grouped into broader thematic categories, such as pedagogical

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models (PjBL, PBL, STEM/STEAM), design principles (constructivism, inquiry, collaboration), and technological support (digital tools and AI). Subsequently, axial coding was conducted to explore relationships among these themes and to develop an integrative framework that explains how different strategies interact in enhancing 21st-century skills. To ensure the validity and reliability of the findings, a constant comparative method was employed, allowing continuous comparison across studies to refine interpretations and ensure consistency. The final stage involved narrative synthesis, where the findings were systematically interpreted to highlight effective practices, research gaps, and implications for curriculum design and instructional innovation.

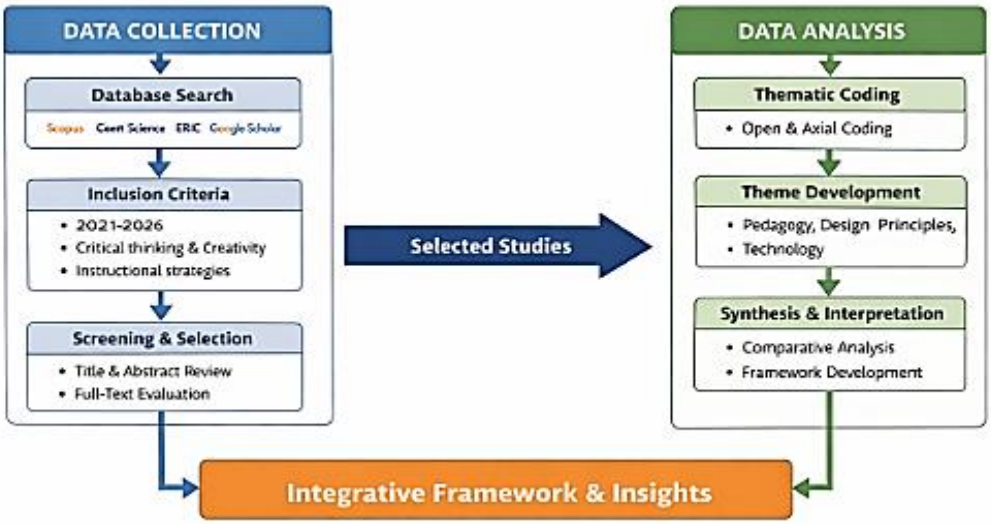

Figure 1. Diagram Conceptual Research

Results and Discussion

Based on the systematic literature review, the findings indicate that the development of **critical thinking** and **creativity** in 21st-century education is influenced by an integration of instructional models, pedagogical principles, and technological support. Rather than functioning as isolated elements, these components interact synergistically to produce meaningful learning outcomes. The following table presents a synthesized overview of the key dimensions, strategies, impacts, and challenges identified from the reviewed studies.

Table 1. Integrated Findings on Strategies for Enhancing Critical Thinking and Creativity

Dimension	Strategy / Approach	Impact on Critical Thinking & Creativity	Challenges	Key References
Instructional Models	PjBL / PoPBL	Improves creativity (fluency, flexibility, originality) and critical thinking through real-world tasks	Requires time, complex assessment	Li & Tu (2024); Dilekçi & Karatay (2023); Sungkono & Ekaputra (2023); Alali (2024)
	Problem-Based Learning (PBL)	Enhances inquiry, analysis, and creative problem-solving	Needs strong facilitation and student readiness	Made et al. (2023)
	STEM / STEAM Integration	Develops interdisciplinary thinking, computational thinking, and innovation	Integration complexity across subjects	Juliangkary et al. (2024); Mariana & Kristanto (2023); Suherman et al. (2025)
Learning Environment	Holistic & Innovative Environment	Strengthens dispositions (curiosity, reflection, open-mindedness)	Requires supportive culture and resources	Barorah et al. (2025); Tretyak (2024); Varías & Callao (2022)

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Pedagogical Principles	Constructivism & Interactivity	Promotes active learning, collaboration, and deeper understanding	Demands redesign of traditional teaching practices	Almulla (2023); Suleymanova (2026); Made et al. (2023)
	Inquiry & Learner Autonomy	Encourages analysis, synthesis, evaluation, and idea generation	Students may struggle without guidance	Mamun (2024); Varías & Callao (2022)
	Collaboration & Communication	Enhances argumentation, creativity, and social learning	Group dynamics challenges	Li & Tu (2024); Suleymanova (2026); Alali (2024)
Teacher Role	Facilitator (guidance, feedback, questioning)	Supports critical reflection and creative exploration	Requires teacher competency in facilitation	Mamun (2024); Juliangkary et al. (2024); Tretyak (2024)
Technology Integration	Digital tools, AI, robotics, virtual environments	Enhances critical thinking, collaboration, and partially creativity	Uneven impact on creativity, requires scaffolding	Yilmaz (2021); Chiu & Hwang (2024); Hasan et al. (2025)
Curriculum & Assessment	4C-based curriculum and assessment tools	Enables systematic development and measurement of skills	Implementation inconsistency	Thornhill-Miller et al. (2023); Barorah et al. (2025); Dilekçi & Karatay (2023)

The findings presented in Table 1 highlight that the development of critical thinking and creativity requires a holistic and integrative approach that combines instructional strategies, pedagogical principles, and systemic support. Instructional models such as PjBL, PBL, and STEM/STEAM provide the foundational structure for active and inquiry-based learning, while pedagogical principles such as constructivism, collaboration, and learner autonomy ensure meaningful engagement and knowledge construction. Additionally, the role of teachers as facilitators and the integration of technology further enhance learning outcomes by supporting reflection, interaction, and innovation. However, the table also reveals that challenges such as cognitive complexity, resource demands, and the need for scaffolding must be carefully addressed. Overall, the results suggest that the effectiveness of strategies for developing 21st-century skills is highly dependent on the alignment and interaction of multiple educational components, rather than any single approach in isolation.

Discussion

The findings of this systematic literature review provide a comprehensive understanding of how critical thinking and creativity—two core competencies of 21st-century learning—can be effectively developed through integrated instructional strategies, pedagogical principles, and technological support. In line with the research objective, this discussion synthesizes the evidence presented in the results table to highlight how different educational approaches contribute to the enhancement of these skills. The analysis reveals that the development of critical thinking and creativity is not the result of a single instructional model, but rather the outcome of a dynamic interaction between learner-centered pedagogies, supportive learning environments, and systemic alignment in curriculum and assessment.

One of the most prominent findings is the significant effectiveness of Project-Based Learning (PjBL) and Project-Oriented Problem-Based Learning (PoPBL) in fostering both critical thinking and creativity. These models emphasize authentic, real-world problem-solving tasks that require learners to engage in inquiry, analysis, and innovation over an extended period. Studies show that such approaches significantly enhance creativity—particularly in terms of fluency, flexibility, and originality—as well as critical thinking skills (Li & Tu, 2024; Dilekçi & Karatay, 2023; Sungkono & Ekaputra, 2023; Alali, 2024). This is because PjBL environments inherently require students to explore multiple solutions, evaluate alternatives, and refine their ideas iteratively. The open-ended nature of projects encourages divergent thinking, while the need to justify and implement solutions promotes convergent and analytical thinking. Furthermore, the integration of interdisciplinary content within projects enhances

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the relevance of learning, allowing students to connect knowledge across domains and apply it in meaningful contexts. However, the implementation of PjBL also presents challenges, particularly in terms of time management, assessment complexity, and the need for well-designed scaffolding to support students' cognitive processes.

In addition to PjBL, Problem-Based Learning (PBL) emerges as another effective instructional model for developing critical and creative thinking. Unlike PjBL, which focuses on project outcomes, PBL centers on the process of inquiry and problem exploration. Made et al. (2023) highlight that PBL encourages students to investigate real-world problems, analyze information critically, and generate creative solutions through collaborative inquiry. This approach aligns with constructivist learning theory, where knowledge is actively constructed through engagement and reflection. The iterative nature of PBL—where students continuously refine their understanding based on new information—supports deeper cognitive processing and the development of metacognitive skills. However, similar to PjBL, the success of PBL depends heavily on the role of the teacher in facilitating inquiry and providing appropriate guidance. Without sufficient support, students may struggle to navigate complex problems, leading to cognitive overload and reduced learning effectiveness.

The integration of STEM and STEAM approaches further enhances the development of critical thinking and creativity by promoting interdisciplinary learning and design-based problem-solving. The findings indicate that STEM/STEAM education supports the development of computational thinking, engineering design skills, and creative innovation, particularly when students are engaged in hands-on, project-based activities (Juliangkary et al., 2024; Mariana & Kristanto, 2023; Suherman et al., 2025; Alali, 2024). The inclusion of artistic elements in STEAM education, in particular, fosters creativity by encouraging students to explore aesthetic and expressive dimensions of problem-solving. This interdisciplinary approach reflects the complexity of real-world challenges, which often require the integration of knowledge from multiple domains. However, the implementation of STEM/STEAM education also presents challenges, including the need for curriculum integration across subjects, teacher preparedness, and resource availability. These challenges highlight the importance of systemic support and professional development for educators.

Beyond instructional models, the findings emphasize the critical role of learning environments in shaping students' critical and creative thinking. Holistic and innovative learning environments that integrate cognitive, emotional, and social dimensions of learning have been shown to significantly enhance students' dispositions toward critical thinking and creativity (Barorah et al., 2025; Tretyak, 2024; Varías & Callao, 2022). Such environments encourage curiosity, open-mindedness, and reflective thinking, which are essential for creative and critical engagement. Moreover, they provide a safe space for experimentation and risk-taking, allowing students to explore new ideas without fear of failure. This is particularly important in fostering creativity, which often involves uncertainty and the possibility of error. The findings suggest that the effectiveness of instructional strategies is closely linked to the quality of the learning environment, underscoring the need for educational systems to prioritize not only what is taught but also how it is taught.

The discussion also highlights the importance of key pedagogical principles, particularly constructivism, inquiry-based learning, collaboration, and teacher facilitation. Constructivist and interactive learning approaches, which emphasize active engagement, peer interaction, and meaningful learning experiences, have been shown to positively influence critical thinking, creativity, and academic achievement (Almulla, 2023; Suleymanova, 2026; Made et al., 2023). These approaches shift the focus from passive knowledge acquisition to active knowledge construction, enabling students to develop deeper understanding and transferable skills. Inquiry-based learning and learner autonomy further support this process by encouraging students to ask questions, explore ideas, and reflect on their learning (Mamun, 2024; Varías & Callao, 2022). This fosters higher-order cognitive processes such as analysis, synthesis, and evaluation, which are central to critical thinking.

Collaboration and communication are also identified as essential components of effective learning environments. The findings indicate that group work, peer feedback, and structured discussions enhance both critical thinking and creativity by exposing students to diverse perspectives and encouraging the exchange of ideas (Mamun, 2024; Li & Tu, 2024; Suleymanova, 2026; Alali, 2024). Through collaborative learning, students develop the ability to articulate their thoughts, justify their reasoning, and negotiate solutions, which are key aspects of critical thinking. At the same time, collaboration fosters creativity by enabling the combination and recombination of ideas. However,

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effective collaboration requires careful management of group dynamics and the development of communication skills, highlighting the need for explicit instruction and support in these areas.

The role of the teacher as a facilitator is another critical factor in the development of critical and creative thinking. Rather than serving as a source of knowledge, teachers are expected to guide students' learning by posing high-order questions, providing feedback, and modeling thinking processes (Mamun, 2024; Juliangkary et al., 2024; Tretyak, 2024; Made et al., 2023; Herlinawati et al., 2024). This shift in the teacher's role reflects the broader transition toward learner-centered education, where the focus is on supporting students' active engagement and self-directed learning. Effective facilitation requires teachers to possess not only content knowledge but also pedagogical skills and the ability to create supportive learning environments. This underscores the importance of teacher training and professional development in the successful implementation of 21st-century learning strategies.

The integration of technology and artificial intelligence (AI) represents another significant dimension in the development of critical and creative thinking. The findings suggest that technology-enhanced learning environments, including digital tools, robotics, and virtual platforms, can significantly improve students' cognitive and creative abilities when used appropriately (Yilmaz, 2021; Juliangkary et al., 2024; Chiu & Hwang, 2024; Hasan et al., 2025). Technology provides opportunities for interactive and personalized learning, enabling students to explore concepts in new ways and receive immediate feedback. For example, digital mind mapping tools can support creative thinking by helping students organize and visualize their ideas, while robotics and simulation tools enable hands-on experimentation and problem-solving. However, the impact of AI on creativity remains inconclusive, with some studies suggesting that while AI supports critical thinking and collaboration, it may not fully foster originality without complementary pedagogical strategies (Hasan et al., 2025). This highlights the need for thoughtful integration of technology, ensuring that it enhances rather than replaces human creativity.

Finally, the discussion underscores the importance of aligning curriculum and assessment with the development of critical thinking and creativity. The adoption of 4C-based frameworks (creativity, critical thinking, collaboration, communication) provides a comprehensive approach to integrating these skills into educational systems (Thornhill-Miller et al., 2023; Herlinawati et al., 2024). Assessment plays a crucial role in this process, as it determines what is valued and measured in education. The use of standardized instruments such as the Torrance Tests of Creative Thinking (TTCT), the California Critical Thinking Disposition Inventory (CCTDI), and 4C-based rubrics enables educators to evaluate the effectiveness of instructional strategies and monitor student progress (Barorah et al., 2025; Dilekçi & Karatay, 2023; Suleymanova, 2026; Thornhill-Miller et al., 2023). However, the implementation of such assessment systems remains inconsistent, highlighting the need for more systematic and coherent approaches.

In conclusion, the findings of this study demonstrate that the development of critical thinking and creativity in 21st-century education requires a holistic and integrated approach that combines effective instructional models, supportive learning environments, key pedagogical principles, technological integration, and aligned curriculum and assessment practices. By synthesizing recent research, this study provides a comprehensive framework that addresses the research objective and offers practical insights for educators and policymakers. The discussion highlights that while significant progress has been made in identifying effective strategies, challenges remain in terms of implementation, integration, and sustainability. Therefore, future efforts should focus on developing more coherent and scalable approaches to ensure that all learners have the opportunity to develop the critical and creative skills necessary for success in the 21st century.

Conclusion

The conclusion of this study affirms that the development of **critical thinking and creativity as core 21st-century skills** can be effectively achieved through an integrated combination of student-centered instructional models, supportive pedagogical principles, and strategic use of technology. In line with the research objective, the synthesis of recent studies demonstrates that approaches such as Project-Based Learning (PjBL), Problem-Based Learning (PBL), and STEM/STEAM integration significantly enhance learners' analytical, evaluative, and innovative capacities when implemented within holistic and collaborative learning environments. Furthermore, key design principles—such as constructivism, inquiry-based learning, learner autonomy, and teacher facilitation—serve as essential enablers that ensure meaningful engagement and deeper cognitive processing. The findings also highlight that

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technology and AI can strengthen critical thinking and collaboration, although their impact on creativity requires complementary pedagogical support. Importantly, the effectiveness of these strategies is highly dependent on the alignment between curriculum, assessment (particularly 4C-based frameworks), and classroom practices. Therefore, this study concludes that fostering critical thinking and creativity requires a comprehensive and systemic approach, where instructional design, learning environment, and assessment are cohesively integrated to support sustainable development of 21st-century competencies.

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