AI-Driven Research Tools: A Catalyst for Innovation in Higher Education Project-Based Courses

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Abstract

The integration of AI-driven research tools in education offers transformative potential, particularly in fostering innovation within project-based courses in higher education. This study examines the efficacy of these tools in improving student performance and happiness, while also analyzing their contribution to innovative learning processes. A mixed-methods strategy was utilized, integrating quantitative and qualitative methodologies. Surveys and pre/post-tests assessed enhancements in academic achievement, project quality, and student happiness. Interviews and focus groups with students and educators concurrently yielded insights into their experiences, issues, and perspectives regarding the use of NVIVO tool and thematic analysis. The results indicate substantial enhancements in student grades, superior project outcomes, and elevated satisfaction levels, highlighting the tools' efficacy in fostering academic and practical excellence. The findings theoretically enhance the comprehension of AI's role in educational innovation, emphasizing its capacity to revolutionize teaching and learning paradigms. The study offers practical insights for educators and administrators to effectively integrate and enhance AI-driven technologies in curriculum design. Nonetheless, constraints encompass dependence on certain instruments and a sample limited to certain institutions, thereby hindering the generalisability of the results. Subsequent research may broaden its focus to various educational environments and investigate the enduring effects on learning dynamics. This study highlights the crucial importance of AI in influencing the future of education, illustrating its ability to foster innovation and enhance results in project-based learning settings.

Keywords: AI-driven research tools, project based courses, curriculum design

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Introduction

The integration of Artificial Intelligence (AI) into higher education is rapidly transforming teaching and learning landscapes, particularly within project-based learning (PBL) environments. In recent years, a growing number of studies have explored the adoption of AI-driven tools to enhance educational practices (Holmes et al., 2019; Tsai et al., 2020; Zawacki-Richter et al., 2019). These tools offer powerful support for data collection, analysis, literature review, idea generation, and collaboration—core elements of PBL.

Several studies highlight AI's role in improving learning efficiency, creativity, and autonomy in higher education (Luckin et al., 2016; Roll & Wylie, 2016). For example, Wang et al. (2021) demonstrated how AI-supported formative assessment tools can enhance student feedback loops. Similarly, Chen et al. (2020) emphasized the ability of natural language processing (NLP) applications like GPT-3 to assist students in drafting and refining research content. Meanwhile, McArthur et al. (2021) discussed AI's influence on student engagement and personalized learning pathways, while Xu et al. (2022) found that AI-integrated platforms encouraged more meaningful collaboration in group-based projects.

Despite these advancements, current research tends to focus on AI in general pedagogy or personalized learning systems rather than in the specific context of PBL (Mou et al., 2023). Furthermore, most studies assess tool performance in isolation, neglecting the broader ecosystem in which students apply AI-driven tools for ideation, research design, and peer interaction (Ifenthaler & Yau, 2020; Smutny & Schreiberova, 2020). While existing literature establishes the efficacy of AI in improving learning outcomes, there remains a lack of empirical studies that investigate how AI-driven research tools—such as ChatGPT, Scite.ai, Elicit.org, or Research Rabbit—act as catalysts in supporting innovation within the iterative and collaborative processes central to PBL in higher education. This study aims to fill this gap by examining how AI-driven research tools influence student innovation, creativity, and knowledge construction within project-based courses at the university level. The contribution lies in offering a practical framework that educators and curriculum designers can use to effectively integrate these tools, thereby fostering higher-order thinking and research capabilities among students.

Artificial Intelligence in Higher Education

AI in higher education is widely applied in areas like learning analytics, assessment, adaptive learning, and content generation. Holmes et al. (2019) classify AI use into intelligent tutoring systems, learner modeling, automated feedback, and data-driven curriculum design. However, Zawacki-Richter et al. (2019) note that many studies remain conceptual, lacking empirical depth and contextual focus—particularly in project-based or interdisciplinary courses. The growing presence of AI also raises ethical and pedagogical concerns, including data privacy, algorithmic bias, and over-reliance on AI outputs (Selwyn, 2019). As universities adopt AI more extensively, the emphasis is shifting from novelty to evaluating its effectiveness and long-term impact on learning. Despite AI's success in structured adaptive learning, its role in unstructured, inquiry-based formats like project-based learning (PBL) remains unclear. In such settings, students require adaptable, context-aware tools that aid in comprehension, exploration, and innovation. While AI has significant potential to support these needs, research into its application in PBL contexts is still limited.

Project-Based Learning (PBL) in Higher Education

Project-Based Learning (PBL) emphasizes problem-solving, collaboration, and real-world relevance (Blumenfeld et al., 1991; Thomas, 2000). It encourages students to take ownership of the learning process by engaging in authentic, complex tasks. However, PBL's success often hinges on students' access to adequate research, time management, and support systems—areas where AI tools can intervene effectively (Krajcik & Blumenfeld, 2006).

The PBL environment fosters autonomy and creativity but also introduces challenges, especially for students unfamiliar with navigating open-ended research problems. These challenges include identifying relevant scholarly sources, constructing coherent arguments, managing feedback loops, and working collaboratively across different stages of the project lifecycle. Given these complexities, students often require support that is timely, adaptive, and non-intrusive—traits that AI systems can potentially embody.

Instructors, too, face difficulties in guiding diverse student groups through PBL activities, particularly in large classrooms where personalized mentoring is impractical. AI tools could bridge this gap by offering scalable, context-aware assistance, enabling instructors to focus on higher-order facilitation rather than basic troubleshooting or content delivery. However, such integration must be grounded in an understanding of how students use these tools and perceive their contributions to the learning experience—an area still lacking in research.

AI-Driven Research Tools

AI-driven research tools such as ResearchRabbit, Connected Papers, Elicit, and ChatGPT have transformed how students conduct literature reviews, map citations, and receive feedback. Park et al. (2023) found that tools like Elicit improve efficiency in identifying research gaps, while Wu et al. (2022) highlight AI's role in reducing cognitive load during complex tasks. Natural language processing tools—such as ChatGPT, Grammarly, and QuillBot—further support students in paraphrasing, summarizing, and refining their writing, enhancing the iterative and creative aspects of project-based learning (PBL). These tools promote rapid idea development and immediate feedback, fostering innovation. However, existing studies often examine single-tool usage, offering little insight into how students integrate multiple AI tools across research stages. The impact of multi-tool engagement on inquiry depth, creativity, and collaboration in group settings remains underexplored.

Moreover, the pedagogical and cognitive effects of AI use in interdisciplinary, student-centered environments like PBL are not well understood. There is also a growing need to examine students' perceptions and ethical considerations: Do they see AI as a shortcut or a legitimate academic aid? As AI becomes more embedded in education, understanding its influence on critical thinking and academic integrity is increasingly vital.

AI and Innovation in Learning

Innovation in learning involves generating new ideas or approaches to solve academic or real-world problems (Sawyer, 2012). AI supports this process by enabling divergent thinking, pattern recognition, and rapid prototyping (Luckin et al., 2016; Shibani et al., 2020). McArthur et al. (2021) highlight that AI fosters creativity by automating routine tasks, allowing students to focus on ideation. However, scholars warn that overreliance on AI may lead to deskilling and diminished critical thinking (Selwyn, 2019; Sinha et al., 2022). Thus,

effective AI use in project-based learning (PBL) must balance automation with student agency.

While much research has explored AI's role in personalized learning and research support, few studies examine how multiple AI tools collectively influence innovation in collaborative PBL settings. There is limited empirical evidence on how students use these tools throughout semester-long academic projects. Most existing work overlooks how students adopt, combine, and adapt various tools to support the iterative and creative processes central to PBL. Additionally, little is known about how students perceive the strengths and limitations of AI tools in enhancing creativity, problem-solving, and innovation. This study addresses these gaps by examining how university students engage with AI-driven research tools in a semester-long PBL course. It explores how these tools are integrated across research stages, how students assess their impact on innovation, and what pedagogical strategies can support more meaningful AI integration into higher education curricula.

Research Method

Research Design

This study employs a qualitative case study approach to explore the integration of AI-driven research tools in project-based learning (PBL) within higher education. This design enables an in-depth understanding of student experiences, perceptions, and behaviors in their natural academic context (Merriam, 2009). The case study allows detailed analysis of how AI tools shape innovation and collaboration within a specific PBL course.

Research Context and Participants

The research was conducted at a public university in Indonesia known for interdisciplinary PBL. One semester-long undergraduate course with 30 students from education, engineering, and business was selected due to its collaborative structure and focus on real-world problem-solving. Purposive sampling identified students who actively engaged with AI tools, including ChatGPT (ideation, writing), Elicit (literature synthesis), ResearchRabbit (citation mapping), Scite.ai (citation analysis), Julius.ai (data analysis), and Grammarly or Quillbot (writing refinement). Thirty students participated in semi-structured interviews and submitted weekly reflection journals (three from each project group). Additionally, two faculty members were interviewed to provide instructional and pedagogical insights into AI integration. The collected data offered a comprehensive view of both learner experiences and educator strategies, enabling a deeper understanding of how AI tools influenced collaboration, critical thinking, and project outcomes within the course.

Data Collection Methods

Three data collection techniques were used: interviews, document analysis, and reflection journals. Interviews with students and faculty explored tool usage, perceived benefits, challenges, and ethical concerns. All were recorded and transcribed. Document analysis of student reports and research logs examined the role of AI in shaping project outcomes. Reflection journals offered longitudinal insights into evolving tool usage and attitudes throughout the course.

Data Analysis and Ethical Considerations

Data were analyzed using thematic analysis (Braun & Clarke, 2006), with both deductive and inductive coding. NVivo supported coding, and themes were cross-validated among researchers to ensure reliability. Data saturation confirmed analytical completeness. All participants gave informed consent, with confidentiality maintained via pseudonyms. Ethical approval was obtained from the university's research ethics board.

Results

This study employed thematic analysis (Braun & Clarke, 2006) to interpret qualitative data drawn from interview transcripts, journals, and documents related to AI tool usage in academic contexts. A hybrid approach of deductive and inductive coding was used. Deductive codes were informed by predefined categories aligned with the research objectives and existing literature on AI-enhanced learning tools. Concurrently, inductive coding allowed for the emergence of unanticipated yet relevant themes from the data. Deductive coding categories included:

1. **Tool Functionality & Use Cases** – How students employed AI tools (e.g., ideation, writing).
2. **Perceived Benefits** – Reported advantages (e.g., speed, clarity).
3. **Perceived Challenges** – Issues experienced (e.g., over-reliance).
4. **Ethical Considerations** – Dilemmas around use (e.g., plagiarism).
5. **Learning Impact** – Influence on academic learning (e.g., deeper understanding).
6. **Collaboration & Communication** – Impact on group work and peer dynamics.

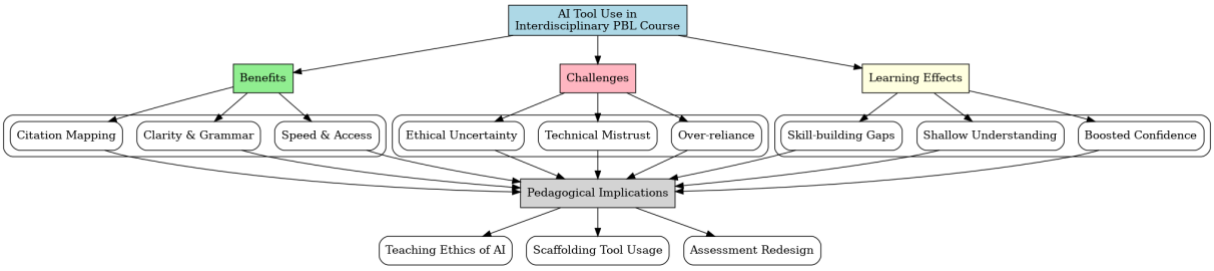
Themes were refined through iterative coding cycles, ensuring both the integrity of the data and alignment with the research questions.

Table 1
Thematic Analysis Results

Theme Category	Code	Sample Extract	Interpretation / Insight
Tool Functionality & Use Cases	Ideation	"I used ChatGPT at the start of every phase—just to brainstorm ideas."	AI tools support early-stage idea generation in project-based learning.
	Data Analysis	"Julius.ai helped me make graphs…"	Tools are used for visualizing and processing data.
	Literature Search	"The literature review… covers 17 sources within two weeks."	AI supports fast and comprehensive source retrieval.

			Citation Evaluation	"Scite.ai showed me which articles were supported or disputed."	AI enhances evaluation of source credibility.
Perceived Benefits			Efficiency	"The literature review… within two weeks."	AI accelerates traditionally time-consuming academic tasks.
			Enhanced Critical Thinking	"It changed how I evaluated my sources."	Use of citation evaluation tools fosters evaluative judgment.
Perceived Challenges			Over-Reliance	"Sometimes I felt like I was relying on it too much."	Some students develop dependency on AI tools.
			Shallow Learning	"…but I didn't fully understand the analysis."	Use of AI tools may bypass deep conceptual engagement.
Ethical Considerations			Dependency	"Sometimes I felt like I was relying on it too much."	Ethical questions arise around authorship and originality.
Learning Impact	Early Stage Support	"I used ChatGPT… to brainstorm ideas."	AI is often used during the ideation phase, shaping initial project design.		
	Critical Thinking	"At first, I just used the AI to summarize articles. But then I realized I could ask it to show me opposing viewpoints or check if something was outdated. That made me rethink which sources to include and how to present the arguments. It's like it pushed me to read more carefully and critically."	AI tools, when used critically, enhance deeper analytical engagement.		

Figure 1
Thematic Visualization of AI Usage in Research



The study's mean scores reveal a nuanced understanding of how students perceive AI tools across various aspects of their academic learning. *Efficiency* received the highest average score (3.63), showing that students value AI for saving time and streamlining tasks—highlighting its strong role in boosting productivity. *Ideation* (3.37) and *Early Stage Learning Support* (3.13) also scored well, suggesting that students find AI particularly helpful during brainstorming and planning stages. These findings indicate that AI is most embraced as a supportive partner in initiating academic work. However, perceptions shift when deeper learning is considered. *Enhanced Critical Thinking* had the lowest mean score (2.40), pointing to concerns that AI may not foster—or could even hinder—analytical depth. Scores in *Dependency* (2.73) and *Over-Reliance* (2.87) further suggest unease about excessive reliance on AI tools, potentially limiting students' development of independent problem-solving skills. Dimensions such as *Citation Evaluation***,** *Shallow Learning*, and *Critical Thinking* hovered around 2.67, reflecting mixed views. Some students appreciated AI for organizing sources and simplifying understanding, while others worried it encouraged superficial engagement or careless citation practices. Specific tool use revealed further insights. *ChatGPT* was frequently used for ideation and drafting outlines, while *Elicit* and *ResearchRabbit* sped up literature discovery. *Grammarly* and *Quillbot* helped refine academic writing, particularly for non-native speakers. *Scite.ai* aided more informed citation decisions. A business student noted, "I could find relevant papers in minutes, something that used to take hours."

Despite these benefits, challenges emerged. Over-reliance was a recurring theme, with some students too readily accepting AI-generated content without question. Users of *Julius.ai* voiced doubts about interpreting data outputs, revealing reduced critical engagement. Ethical concerns, such as unclear authorship and temptation to plagiarize AI-generated content, were also raised. An education student shared, "It was too easy to just accept what AI gave me without questioning it."

The learning impact of AI tools was described as both empowering and problematic. Many students reported increased confidence and autonomy, especially in tasks like literature reviews and data analysis. AI enabled self-paced, exploratory learning. Yet, this autonomy sometimes resulted in shallow understanding when students used outputs without grasping the underlying processes. As one noted, "Julius.ai gave me the graphs, but I didn't know if I was interpreting them right." Faculty interviews revealed evolving instructional responses. Educators recognized AI's potential but emphasized the need for ethical, reflective use. They recommended scaffolded AI tool training and redesigned assessments focused on learning processes rather than just final outputs. As one faculty member put it, "We want students to use these tools, but with reflection, not substitution." While AI tools enhance productivity, ideation, and learner confidence, they also raise critical concerns around over-reliance, ethics,

and deep engagement. These findings underscore the importance of thoughtful AI into educational practice.

Discussion

This study examined how students and instructors engaged with AI-driven research tools within an interdisciplinary project-based learning (PBL) environment. Four major themes emerged: enhanced ideation and topic refinement, accelerated literature discovery, improved academic writing and synthesis, and concerns around dependency and critical thinking. In the early stages of projects, students frequently used *ChatGPT* to shape research ideas, brainstorm topics, and simulate problem-solving. It acted as a 24/7 tutor, helping students refine vague ideas into actionable questions. Faculty also observed clearer, more focused project proposals from students who used AI during this phase.

During the research stage, *Elicit* and *ResearchRabbit* allowed students to explore literature more efficiently by identifying semantically related studies. Students described these tools as "smart Google Scholars" that helped uncover relevant and novel research directions. *Scite.ai* added a critical layer, enabling users to assess the reliability of citations by showing whether claims were supported or disputed in the literature. In the writing phase, *Grammarly*, *Quillbot*, and *ChatGPT* were widely used to improve clarity, tone, and structure. These tools were especially helpful for students with limited academic English skills. Students who used AI reflectively—not just for content generation—showed stronger analytical and synthesis skills. Faculty confirmed improvements in writing quality and organization in work submitted by students who regularly used these tools.

Despite the benefits, over-reliance on AI emerged as a concern. Some students admitted to accepting AI-generated content without verification. This passive use often led to superficial engagement with key concepts. One student noted, "It was so easy to just paste my research question into ChatGPT and copy the response—I realized I wasn't learning anything." Faculty echoed these concerns, particularly regarding citation evaluation and conceptual understanding, which are critical to academic development. The findings reflect AI's dual role in higher education—as both enabler and potential crutch. On one hand, AI supported student autonomy, reduced cognitive overload, and promoted efficiency and innovation, aligning with prior research (Luckin et al., 2016; McArthur et al., 2021). Students reported feeling more confident and independent in tackling complex academic tasks. NLP tools like Grammarly and Quillbot offered writing feedback that extended beyond proofreading, enhancing tone, coherence, and structure (Morrison et al., 2023). Tools like Scite.ai fostered more informed citation practices. On the other hand, risks of shallow learning and overdependence emerged, especially when students failed to critically evaluate AI outputs. These findings align with previous warnings from Selwyn (2019) and Sinha et al. (2022) about the erosion of critical thinking due to AI overuse.

To address these issues, the study recommends structured pedagogical interventions. These include workshops on ethical AI use, clear guidelines on acceptable tool usage, and assessments that emphasize learning processes over final outcomes. Students could also maintain research logs documenting how AI influenced their thinking and decisions—encouraging transparency and critical reflection. These strategies echo calls for digital literacy integration in higher education (Ifenthaler & Yau, 2020). AI tools were also found to support creativity, idea generation, and data visualization—core elements of innovation in PBL. Students used *ChatGPT*, *Elicit*, and *ResearchRabbit* to explore novel angles and trace

citation networks. *Julius.ai* helped interpret data and generate visualizations, extending students' problem-solving capacity. Reflection journals revealed that many students gained confidence and a sense of ownership over their work—indicators of an emerging innovative mindset.

The study's findings align with the 21st-Century Skills Framework, particularly in creativity, collaboration, and communication. However, while AI facilitated tasks related to understanding, applying, and analyzing—aligned with Bloom's mid-level cognitive skills—there was limited evidence of consistent engagement at the highest levels of evaluating and creating. Without proper scaffolding, AI may inadvertently promote surface-level learning. In conclusion, AI tools offer meaningful support for ideation, research, writing, and innovation in project-based learning. Yet, their benefits are maximized only when paired with ethical guidance, reflective practices, and thoughtful integration into the curriculum. Institutions must focus not just on adopting AI, but on cultivating critical, responsible users who can collaborate effectively with these tools in deeper, more meaningful ways.

Learning Depth and Experiential Engagement

When evaluated through the lens of Kolb's Experiential Learning Theory (1984), students were clearly engaging in the stages of abstract conceptualization and active experimentation by testing the capabilities of various AI tools within their projects. However, the data also indicated that many learners neglected the reflective observation phase—arguably the most critical for deep learning and meaning-making. Several students reported accepting AI-generated outputs at face value without questioning their validity or considering alternative perspectives, thereby limiting the development of their metacognitive skills. That said, some students showed signs of adaptive learning. Their journals revealed a progression in their thinking over time, as they learned to question the information generated by AI and adjusted their strategies accordingly. These students demonstrated a growing awareness of the limitations of AI, coupled with a willingness to engage more critically with its suggestions. Such behavior suggests the presence of nascent self-regulation—an essential feature of experiential and transformative learning (Bransford et al., 2000). Conversely, students who relied too heavily on tools like ChatGPT and Quillbot often exhibited passive consumption, indicating a need for more intentional instructional support to foster deeper cognitive engagement.

Instructional Gaps and Areas for Improvement

Insights from faculty interviews revealed important instructional gaps that must be addressed to maximize the educational value of AI in PBL environments. While many instructors acknowledged the enhanced quality of student output, they also voiced concern that students were shortcutting critical parts of the learning process. The convenience of AI often led students to skip important phases of research, such as evaluating the credibility of sources or articulating their rationale for specific methodological choices.

To address these gaps, instructors emphasized the need for early integration of AI ethics and critical use workshops. They also advocated for the redesign of assessments to focus not only on final outputs but also on the process behind them—how students used AI, what decisions they made, and what reflections they drew from those experiences. Furthermore, collaborative critiques of AI-generated content were proposed to foster dialogue about tool limitations and cognitive bias, allowing students to develop a more nuanced understanding of

AI as a fallible, context-dependent tool rather than an infallible authority. This approach is consistent with constructivist pedagogy, which posits that meaningful learning occurs when learners actively construct knowledge through experience, inquiry, and reflection—not automation. For AI to truly contribute to innovation and deep learning, it must be embedded in pedagogical designs that challenge students to think critically and independently.

Innovation Skill Development: Level and Trajectory

The data suggest that students' innovation skills developed along a continuum, primarily within foundational and intermediate levels. At the foundational stage, students used AI tools to brainstorm ideas, summarize readings, and organize their thoughts. These activities reflect basic creative engagement and information management. Intermediate-level skill development was evident in students' ability to synthesize diverse sources, identify thematic patterns, and use data visualization tools such as Julius.ai or Elicit to generate novel insights.

However, instances of advanced innovation skill—such as challenging the outputs of AI, reframing problems from multiple disciplinary angles, or co-creating with AI—were rare. These higher-order skills were mostly observed among students who consciously reflected on their research processes and recognized the limitations of their tools. To help more students reach this advanced stage, educators must provide deliberate opportunities for critical reflection, cross-disciplinary collaboration, and algorithmic literacy. Encouraging students to examine the assumptions behind AI-generated content and to engage in iterative dialogue about its strengths and flaws will be essential for deepening their innovative capacity.

Conclusion and Recommendations

Conclusion

This study examined the role of AI research tools in supporting innovation skill development within an interdisciplinary PBL course at a public university in Indonesia. Drawing on multiple data sources—including interviews, project documentation, and student reflection journals—the findings reveal that AI significantly contributed to students’ ability to generate ideas, explore literature, and articulate academic arguments. These tools enhanced students’ confidence, autonomy, and efficiency, laying the groundwork for foundational and intermediate innovation skills.

At the same time, the study uncovered important limitations. Many students exhibited a tendency to rely too heavily on AI outputs, often without adequate critical engagement. This behavior limited their depth of understanding, impeded the development of metacognitive skills, and risked creating a superficial learning experience. Faculty members observed that while student work had improved in terms of clarity and polish, it frequently lacked depth, originality, or evidence of critical inquiry.

Therefore, the educational promise of AI in PBL contexts will only be fulfilled if accompanied by purposeful scaffolding, ethics training, and assessments that prioritize learning processes over finished products. AI tools, when used reflectively and responsibly, can act as catalysts for innovation. But without guided instruction, they can also become crutches that hinder deeper cognitive growth.

Recommendations

To advance both student learning and responsible AI integration, this study recommends a multi-pronged approach:

Andragogical Redesign

AI ethics and literacy should be introduced early in the course to cultivate responsible usage habits. Project assessments must evolve to include documentation of decision-making processes, critical reflections on AI outputs, and ethical considerations. Regular reflective practices—through journals or debriefs—can help foster deeper metacognitive engagement.

Instructional Scaffolding

Faculty should develop curated AI toolkits and example workflows that demonstrate effective use of platforms like Elicit, ResearchRabbit, and Julius.ai. Instructors can scaffold cognitive development by using questioning frameworks to push students beyond surface-level tasks. Collaborative challenges, where students critique and revise AI-generated content, can further develop critical and creative skills.

Policy and Institutional Support

Universities must establish clear policies on acceptable AI use and provide professional development opportunities for instructors. Training faculty to integrate and assess AI meaningfully will ensure that PBL remains a space for authentic learning and innovation.

Future Research

Further longitudinal studies are needed to explore how sustained AI use shapes innovation skills over time. Cross-cultural and cross-institutional comparisons can uncover contextual differences in adoption. Finally, deeper investigation into how students perceive AI credibility—and the strategies they use to validate AI-generated knowledge—will be key in shaping future pedagogical frameworks.

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