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Investigating Generative AI Utilization for Project-Based Learning: Teachers' Role, Challenges, and Strategies in Higher Education

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Abstract

Despite growing interest in generative Artificial Intelligence (GenAI) in educational technologies, limited research has explored how it specifically affects pedagogical practices in a project-based learning (PjBL) atmosphere. *This study investigates how university teachers utilize GenAI in PjBL, emphasizing their roles, challenges faced, and the strategies they employed during classroom practices. The study adopted a convergent mixed-methods approach, which involved a quantitative survey of 63 university teachers and qualitative interviews with six selected participants to gain deeper insights. The findings revealed that teachers play a central role in guiding students' use of GenAI tools as evidenced by M (3.67) and SD (0.72), acting as facilitators, instructional designers, and ethical gatekeepers. While GenAI is increasingly incorporated for tasks such as brainstorming, drafting, and feedback in student projects, the use of GenAI in PjBL raises several pedagogical and institutional challenges. Key concerns faced challenges were varying levels of digital and AI literacy among teachers, difficulties in assessing AI-generated work, and a lack of clear policies. Additionally, the study highlighted actionable strategies for structured support systems and professional development to enhance teachers' confidence and competence in using GenAI tools effectively and ethically, such as embedding AI literacy into faculty training, developing assessment frameworks adapted to AI-enhanced learning, and promoting reflective use of GenAI in collaborative settings. This research contributes to the understanding of how teachers navigate emerging technologies and offers guidance for institutions aiming to align GenAI integration with pedagogically sound and ethically responsible practices in higher education.*

Keywords: Artificial Intelligence, Generative AI, Higher Education, Project-based learning

Abstrak

Meskipun minat terhadap Generative Artificial Intelligence (GenAI) dalam teknologi pendidikan terus meningkat, masih sedikit penelitian yang secara khusus mengeksplorasi bagaimana GenAI memengaruhi praktik pedagogis dalam suasana pembelajaran berbasis proyek (Project-based Learning/PjBL). Studi ini menyelidiki bagaimana dosen di perguruan tinggi memanfaatkan GenAI dalam PjBL, dengan menekankan peran mereka, tantangan yang dihadapi, dan strategi yang diterapkan selama pelaksanaan di kelas. Menggunakan pendekatan metode campuran konvergen, penelitian ini melibatkan survei kuantitatif terhadap 63 dosen serta wawancara kualitatif dengan 6 peserta terpilih untuk mendapatkan wawasan yang lebih mendalam. Hasil penelitian menunjukkan bahwa dosen memainkan peran sentral dalam membimbing penggunaan alat GenAI oleh mahasiswa (M = 3,67; SD = 0,72), berperan sebagai fasilitator, perancang instruksional, dan penjaga etika. GenAI digunakan dalam berbagai tahapan proyek seperti brainstorming, penulisan draf, dan pemberian umpan balik, namun pemanfaatannya memunculkan sejumlah tantangan pedagogis dan institusional, termasuk perbedaan tingkat literasi digital dan AI di kalangan dosen, kesulitan menilai hasil yang dihasilkan AI, serta ketiadaan kebijakan yang jelas. Studi ini juga menyoroti strategi yang dapat diterapkan untuk meningkatkan dukungan dan pengembangan profesional dosen, seperti integrasi literasi AI dalam

pelatihan, pengembangan kerangka penilaian yang sesuai dengan pembelajaran berbasis AI, serta mendorong penggunaan GenAI secara reflektif dalam konteks kolaboratif. Temuan ini memberikan kontribusi dalam memahami bagaimana dosen menghadapi teknologi yang terus berkembang serta memberikan panduan bagi institusi dalam mengintegrasikan GenAI secara pedagogis dan etis dalam pendidikan tinggi.

Kata Kunci: Artificial Intelligence, Generatif AI, Pendidikan Tinggi, PjBL

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INTRODUCTION

Project-based learning (PjBL) has gained significant importance in higher education due to its capacity to promote active, student-centred learning that mirrors real-world problem-solving in and out of academic settings (Afzal & Tumpa, 2025). Unlike traditional lecture-based approaches, PjBL fosters collaboration, critical thinking, and creativity by engaging students in meaningful and interdisciplinary tasks (Chang et al., 2022). At the university level, PjBL helps bridge theoretical knowledge with practical application, enhancing students' ability to transfer learning to professional contexts (Lima et al., 2018). It also encourages autonomy and accountability, as students take ownership of their learning through inquiry, design, and reflection processes (Bhardwaj et al., 2025). Moreover, PjBL aligns well with the competencies required in the 21st-century competencies, including communication, teamwork, and digital literacy. As universities aim to produce adaptable and innovative graduates, integrating PjBL into curricula becomes essential for developing lifelong learners equipped to address complex global challenges (Martinez, 2020; Ratnawati et al., 2024).

In university settings, PjBL encourages students to engage deeply with course content by applying theoretical knowledge to practical tasks, often resulting in enhanced critical thinking, creativity, and communication skills (Song et al., 2024). As institutions explore innovative tools to support this pedagogy, generative AI (GenAI) is becoming a notable addition. However, effective implementation of PjBL, particularly when incorporating GenAI, relies heavily on the role of teachers as facilitators of learning. While PjBL supports interdisciplinary engagement and the development of transferable competencies (Pranjol et al., 2024), it also presents challenges, including limited faculty training and complexities in assessment (Maki, 2023). With the rise of GenAI, these challenges are magnified, necessitating a re-examination of teaching strategies and institutional support to ensure pedagogically sound integration in higher education (Price-Dennis, & Sealey-Ruiz, 2024).

Previous studies have demonstrated that PjBL is an effective pedagogical approach in higher education that promotes holistic and meaningful competences in real-life needs. PjBL encourages students to take ownership of their learning through collaboration, inquiry, and the creation of meaningful projects

(Nayak et al., 2024). In university settings, PjBL has been successfully applied across disciplines, including engineering, business, and education, enhancing both content mastery and soft skills such as teamwork and communication (Vaithianathan, 2024). Research also indicates that students engaged in PjBL show increased motivation and deeper learning outcomes compared to traditional lecture-based methods (Pratiwi et al., 2025). However, the implementations of PjBL particularly in higher education persist in several challenges such as the need for substantial instructional planning, alignment with assessment practices, and sufficient support from teachers (Zhao et al., 2023).

Recently, the integration of GenAI in higher education addresses evolving academic needs by enhancing teaching efficiency, fostering personalized learning, and supporting complex cognitive tasks (Li et al., 2025). As universities adapt to digital transformation, GenAI tools offer scalable solutions for generating content, automating feedback, and facilitating student creativity in research and PjBL (Kusam, 2024). These technologies support teachers in designing student-centred experiences that encourage critical thinking, problem-solving, and collaboration, which concerns on key competencies in 21st century education (Vidic, 2022). Moreover, GenAI supports the resolution of key educational challenges, such as large class sizes, limited faculty resources, and the growing demand for flexible and inclusive learning environments (Rashid et al., 2024). However, to fully realize these benefits, institutions and policymakers must invest in robust digital infrastructure, comprehensive teacher training, and the development of clear ethical guidelines for AI use.

Previous studies on GenAI in higher education have explored its impact on teaching, learning, and assessment practices. Research indicates that GenAI tools such as ChatGPT, Gemini, Deepseek, and other large language models are increasingly being adopted to support writing, research assistance, and personalized learning (Kerimbayev et al., 2024). Studies have shown that while students often embrace GenAI for its convenience and productivity, teachers express mixed responses, citing concerns over academic integrity and the need for pedagogical adaptation (Zhou, 2024). Moreover, early investigations suggest that the integration of GenAI into curricula challenges traditional notions of authorship, creativity, and evaluation (Luo, 2024). Some researchers emphasize the importance of fostering AI literacy among both students and teachers to ensure responsible and effective use (Zhang & Zhang, 2024). Despite growing interest, comprehensive empirical studies on teachers' roles and strategies in GenAI-supported PjBL remain limited.

In realm of academic practices with the fast growth of GenAI, teachers play a pivotal role in shaping how GenAI is integrated into higher education, particularly in guiding its ethical and pedagogical use (Đerić et al., 2025). At the university level, teachers are not only content experts but also facilitators who help students navigate AI tools responsibly for tasks such as research, writing, and problem-solving (Kim et al., 2022). Their role extends to designing learning activities that incorporate GenAI meaningfully while promoting critical thinking and academic integrity (Rasul et al., 2024). As mediators between technology and learning outcomes, teachers must also develop AI literacy to evaluate the appropriate use of GenAI in various disciplinary contexts (Kong et al., 2024). Moreover, they are instrumental in creating a culture of reflective and ethical AI use, ensuring that students understand both the capabilities and limitations of these tools (Khreisat et al., 2024). Thus, teachers serve as essential agents in aligning GenAI with student-centred pedagogies in university education.

Referring to its roles, teachers play a pivotal role in the successful integration of GenAI within PjBL at the university level. As PjBL emphasizes several facets of real-world problem solving, critical thinking, and interdisciplinary collaboration, teachers are increasingly required to shift from being content deliverers to facilitators and critical mediators in technology-enhanced learning environments (Lee et al., 2024). This transformation is particularly important as GenAI becomes more embedded in higher education, offering new opportunities to support student engagement, creativity, and collaboration. GenAI's capabilities in content generation, idea exploration, and iterative feedback align well with the goals of PjBL (Kong et al., 2023), assisting students in brainstorming, drafting reports, and refining written or visual outputs. When used responsibly, these tools can significantly enrich the learning process (Barynienė et al., 2022). However, effective use of GenAI in PjBL requires teachers to provide guidance on ethical usage, uphold academic integrity, and ensure alignment with intended learning outcomes (Rasul et al., 2024). In this context, GenAI serves as both a powerful educational asset and a pedagogical challenge.

Previous studies on the integration of GenAI in PjBL within higher education have highlighted both its transformative potential and the challenges it poses. Research by Perifanou and Economides (2025) demonstrates that GenAI enhances student creativity and streamlines collaborative project workflows by assisting in idea generation and content creation. Similarly, Tu et al. (2022) found that GenAI tools support iterative feedback processes, enabling more dynamic and personalized learning experiences. However, studies also caution about the risks of over-reliance on AI, which may hinder critical thinking and academic integrity (Zhai et al., 2024). Furthermore, Qadir (2024) emphasizes the need for educators to develop clear frameworks for integrating GenAI into PjBL, ensuring ethical use and maintaining educational rigor. Collectively, these studies underscore the importance of balancing technological innovation with pedagogical guidance to maximize the benefits of GenAI in university level of PjBL environments (Cheng et al., 2024).

Despite growing interest in the use of GenAI within PjBL in higher education, significant gaps remain in understanding the teacher's role and the practical challenges they face, and the strategies they adopt. While prior studies have explored student benefits and AI's impact on creativity and collaboration, less attention has been given to how educators navigate integrating GenAI into their pedagogical practices (Chiu et al., 2024). In particular, there is limited research on teachers' perspectives regarding institutional support, ethical concerns, and assessment strategies in AI-assisted PjBL settings. Additionally, many studies rely primarily on quantitative data from students, with insufficient qualitative insights from teachers who mediate AI use in classrooms (Molefi et al., 2024). This gap hinders the development of effective professional development and policy frameworks tailored to educators' needs. Addressing these gaps through a mixed-methods approach focused on teachers' experiences is essential for advancing responsible and effective GenAI integration in PjBL at university educational settings.

This study aims to investigate the utilization of GenAI in PjBL at higher education institutions, with a particular focus on the role, challenges, and actionable strategies of university teachers. The primary objectives are to explore how teachers integrate GenAI tools into their teaching practices, identify the challenges they encounter, and examine the strategies they employ to facilitate effective AI-assisted learning. Specifically, the study seeks to quantify teachers' experiences and attitudes through a survey of 63 participants, while gaining deeper qualitative insights from interviews with six university teachers. Finally, the research aims to develop practical recommendations for professional development and

institutional policies that support teachers in responsibly incorporating GenAI into PjBL curricula. Ultimately, these objectives contribute to enhancing pedagogical approaches and ensuring meaningful, ethical integration of GenAI in higher education. Aligning to the research objectives, the study focuses on the research questions as follows;

1. What is the teacher's role in utilizing GenAI tools in project-based learning (PjBL)?
2. What are teachers' challenges in utilizing GenAI tools in project-based learning (PjBL)?
3. How do teachers employ solution strategies in utilizing GenAI into PjBL environments?

RESEARCH METHOD

The convergent mixed-methods design (Creswell & Plano Clark, 2023) was employed in this study, which integrates both quantitative and qualitative data collection and analysis conducted in parallel, meaning that both types of data were gathered and analyzed during the same time period, rather than sequentially. This simultaneous approach allows the researchers to examine the same phenomenon from different perspectives at once. The aim of conducting the processes in parallel is to compare, contrast, and ultimately merge the findings from each method, thereby generating more comprehensive and well-rounded insights than either method could provide alone. Quantitative data were gathered through structured questionnaires administered to 63 university teachers. Simultaneously, qualitative data were collected from in-depth interviews with six purposively selected participants.The participants in this study consisted of 63 university teachers from various higher institutions in Indonesia (universities and polytechnics). Participants were selected through purposive sampling, focusing on those with experience in Project-Based Learning (PjBL) and Generative AI tools. Demographically, 64% of the participants were female, while 36% were male. The majority held a Master's degree (89%), and 11% held a Doctorate. In terms of teaching experience, 44% had 5 to 10 years, 40% had more than 10 years, and 16% had less than 5 years of experience. Additionally, 95% of the participants possessed a professional teaching certification. The data of research participants is presented in the following table:

Table 1. Demographic Information of Research Participants

Category	Classification	N	%
Sexuality	Male	23	36
	Female	40	64
Level of Education	Master	56	89
	Doctorate	7	11
Years of Teaching English	< 5	10	16
	5-10	28	44
	>10	25	40
HE Institution	University	40	64
	Polytechnic	23	36
Professional Certification	Yes	60	95
	No	3	5

This study employed both quantitative and qualitative data collection, combining surveys and interviews to collect comprehensive data on the use of Generative AI (GenAI) in Project-Based Learning (PjBL). Quantitative data were collected through an online questionnaire completed by 63 university teachers from various higher education institutions in Indonesia. The questionnaire used a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) to examine teachers' roles, challenges, and strategies in integrating GenAI into PjBL. To complement the survey findings, qualitative data were obtained through semi-structured interviews with six purposively selected participants, chosen based on

teaching experience and willingness to provide in-depth insights. The interviews, conducted online, explored participants' classroom practices and reflections regarding the ethical, pedagogical, and technical aspects of GenAI integration. By combining both data types, this study enhanced the depth and validity of its findings through triangulation, a recommended practice in mixed-methods research (Creswell & Plano Clark, 2023).

The data in this study were analyzed using both quantitative and qualitative approaches. Quantitative data from the questionnaire responses of 63 university teachers were analyzed using descriptive statistics to calculate the mean and standard deviation for each item. These statistical results helped identify general trends in teachers' perceptions regarding their roles, challenges, and strategies in using Generative AI (GenAI) in Project-Based Learning (PjBL). The findings were presented in tables to provide a clear overview of the overall response patterns. For the qualitative data, interviews with six selected participants were analyzed using thematic analysis. The transcripts were carefully reviewed to identify key ideas, recurring patterns, and significant statements. These were then grouped into main themes, such as instructional planning, assessment design, ethical concerns, and professional development. The qualitative findings served to complement and enrich the survey results, offering deeper insights into how GenAI is applied in real classroom settings. By integrating both data sets, the study provides a more comprehensive and well-rounded understanding of the research questions.

RESULT AND DISCUSSION

Teachers' Role in Utilizing GenAI in PjBL in Higher Education

This part focuses on teachers' evolving roles in utilizing GenAI within PjBL in higher education, as revealed through survey data and interview findings. The findings demonstrate that teachers are more than just technology users; they are actively influencing how technology is used in the classroom by assuming roles such as facilitating active, student-centered learning, designing instructional strategies that match the use of GenAI with learning goals and evaluation techniques, and serving as ethical mentors who guarantee ethical and responsible use of AI tools which is presented in the following table.

Table 2. Survey Result of Teachers' Role in Utilizing GenAI in PjBL

Item	M	SD	1 (Strongly Disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly Agree)
Teachers as facilitators of GenAI use	4.1	0.72	2%	5%	11%	56%	26%
Teachers as assessment designers	3.9	0.85	5%	8%	12%	50%	25%
Teachers as project consultants/planners	4.0	0.78	3%	6%	13%	52%	26%

Table 2 showed that the integration of GenAI in higher education is reshaping teachers' instructional roles in Project-Based Learning (PjBL). Survey results indicated that teachers are actively leveraging GenAI as facilitators (M = 4.1, SD = 0.72), instructional designers (M = 3.9, SD = 0.85), and project planners (M = 4.0, SD = 0.78). A significant majority (76%–82%) reported using GenAI to support collaborative planning, rubric design, and student evaluation. These findings highlight a shift toward the proactive and strategic use of GenAI, positioning it as an augmentative tool that enhances productivity and pedagogical innovation, rather than replacing traditional teaching roles. The most important point revealed

by the data is that GenAI is not perceived as a threat to teachers' roles but rather as a supportive partner—enabling educators to refine their instructional strategies, streamline planning processes, and foster deeper student engagement. This reflects a growing mindset among educators that GenAI can empower rather than diminish their professional agency in facilitating meaningful learning experiences. In addition, the result of interview aligns the previous research as elaborated in the following table.

Table 3. Interview Findings of Teachers' Roles of GenAI Utilization in PjBL

Theme	Interpretation	Excerpt example
Project Planning	Teachers use GenAI as project mentors and planners.	"Using ChatGPT really helped me outline project steps and set clear milestones for students. It saved hours of planning."
Assessment Design	GenAI supports teachers in designing fair and efficient assessments.	"I use AI to generate assessment rubrics and grading benchmarks. It helps maintain consistency and saves me time."
Facilitation	Teachers use AI to assist in facilitating student learning and mentoring.	"When students ask for feedback, I sometimes use AI to suggest improvements quickly and provide examples."

The Table 3 indicatesthat the integration of GenAI tools in PjBL has significantly transformed the roles of university teachers, particularly in the areas of project planning, assessment design, and facilitation. During the planning phase, teachers utilized GenAI as virtual mentors to structure project timelines, define milestones, and create instructional frameworks. This streamlines preparation and enables greater focus on mentoring. In assessment design, GenAI supported the development of rubrics, criteria, and sample responses, promoting consistency and efficiency. Teachers also employed AI tools to facilitate student learning by offering quick, personalized feedback and model responses. These practices highlighted that GenAI's emerging role is as a valuable instructional partner in enhancing planning, evaluation, and student engagement within PjBL.

The findings underscore that university teachers play multifaceted roles in facilitating GenAI integration in PjBL contexts. In addition to being subject matter experts, they are increasingly taking on the roles of facilitators, planners, and moral advisors (Liu et al., 2025). As mentioned by McGuire et al. (2024), they use GenAI to assist with project planning, assessment creation, and individualized student feedback. This is consistent with earlier studies showing how teachers' pedagogical duties in AI-enhanced classrooms are changing (Kohnke et al., 2025). A change from traditional instruction to a more dynamic, student-centered approach was evident in the study's teachers' use of GenAI to co-create learning materials, expedite administrative processes, and scaffold student learning (Nelson et al., 2025). However, their efficacy depends on their capacity to uphold moral principles and critically assess AI products (Jedličková, 2024). Teachers' agency remains central to ensuring that GenAI serves as a pedagogical ally rather than a replacement for human judgment (Zhai, 2024). These roles highlight the urgent need for professional development that equips teachers to integrate AI meaningfully and responsibly in PjBL environments.

Viewing from students' perspectives based on teachers' experiences, the integration of Generative AI in PjBL has shown promising benefits in academic contexts, particularly in enhancing creativity, efficiency, and self-directed learning (Fernandes et al., 2025). With the help of AI tools, students may

organize difficult projects, generate ideas, and improve their work with immediate feedback, giving them greater control over their education (Hooda et al., 2022). This is consistent with research by Mariyono and Nur alif (2025), who found that when integrated into collaborative learning frameworks, AI-supported environments can promote greater participation and critical thinking. Additionally, students gain by having more access to individualized learning support, which allows them to work more autonomously while still getting direction. AI serves as a scaffolding in PjBL, which emphasizes autonomy and iterative problem-solving, to assist students in filling knowledge gaps and increasing productivity (Vaithianathan et al., 2023). These benefits imply that, when applied carefully, AI can greatly improve students' learning outcomes and experiences in project-based learning environments.

Teachers' Challenges in Utilizing GenAI in PjBL in Higher Education

This section examines the challenges faced by teachers in integrating GenAI into PjBL in higher education settings. Based on questionnaires and interview data, several challenges highlight key concerns such as maintaining academic integrity, addressing unequal access to AI tools, preserving social interaction in learning, and enhancing teachers' digital competence, as shown in the table below.

Table 4. Survey Result of Teachers' Challenges in Utilizing GenAI in PjBL

Item	M	SD	1	2	3	4	5
Academic integrity concerns (plagiarism)	4.4	0.59	1%	3%	5%	55%	36%
Inequality in student access to GenAI tools	4.3	0.63	2%	3%	7%	54%	34%
Teachers' lack of capability in using GenAI	3.6	0.90	6%	12%	15%	42%	25%
GenAI limits student interaction	3.8	0.81	4%	9%	17%	45%	25%

The Table 4 demonstrates several key challenges faced by educators in integrating GenAI into PjBL in higher education. Academic integrity emerged as the foremost concern (M = 4.4, SD = 0.59), with 91% of respondents expressing concern over plagiarism and ethical misuse. Inequitable access to GenAI tools followed closely (M = 4.3, SD = 0.63), reflecting persistent digital divides among students. Teachers also reported limited proficiency in using GenAI (M = 3.6, SD = 0.90), indicating a need for targeted professional development. Additionally, concerns about reduced student interaction (M = 3.8, SD = 0.81) highlighted potential drawbacks in collaborative learning. These findings underscore the necessity for ethical frameworks, equitable access, and enhanced teacher preparedness in AI-supported instruction.

To align with the findings mentioned above, the interview data also showed similar challenges in utilizing GenAI within PjBL as presented in the following table.

Table 5: Interview Results of Teachers' Challenges of Utilizing Gen AI in PjBL

Theme	Interpretation	Excerpt
Academic Integrity	Reinforces concerns about academic integrity and ethical AI use.	"My main concern is plagiarism. Students sometimes submit work that seems too polished, and it's hard to verify authorship."
Inequality of Access	Confirms inequality in access to AI tools among students.	"Not all my students have the same access to AI tools. Some struggle with using them effectively, which creates imbalance."
Teachers' AI Proficiency	Highlights the challenge of limited teacher proficiency with GenAI tools.	"Honestly, I still find it difficult to fully understand how to use AI beyond basic queries."

The above table showed that while GenAI offered benefits, its integration into higher education contexts also encountered essential challenges. Academic integrity was a primary concern, as teachers reported difficulties verifying student authorship of AI-assisted work. Inequitable access to AI tools further exacerbated learning disparities, with some students lacking the resources or familiarity to use them effectively. Teachers also expressed limited proficiency in using GenAI beyond basic functions, highlighting the need for targeted training. Additionally, concerning about decreasing social interaction emerged, as some teachers also observed that reliance on AI could hinder peer collaboration. One interviewee remarked,

"I've noticed that students sometimes rely too much on AI instead of discussing ideas with their peers. It reduces real engagement." [P5]

These challenges emphasized the importance of institutional support to ensure ethical, equitable, and pedagogically sound implementation of GenAI in PjBL. Besides teachers' roles in the realm of academic practices, the findings indicate that teachers face multiple challenges in utilizing GenAI in PjBL, despite its promising educational potential. One of the most pressing issues is the concern over academic integrity (Rasul et al., 2024). Teachers are having more and more trouble identifying AI-generated content, which makes it harder to evaluate students' unique work and compromises the validity of performance reviews (Fleckenstein et al., 2024). In addition, digital equality is still a major barrier. A growing disparity in learning opportunities and achievement may result from certain students' unequal access to GenAI tools and their lack of the digital literacy needed to use them successfully (Rottner et al., 2025). The inclusive potential of GenAI-enhanced PjBL is limited since students from under-resourced schools or socioeconomically disadvantaged backgrounds are disproportionately impacted by this digital gap (Golden et al., 2024).

Furthermore, a lot of teachers themselves are not adequately trained or conversant with cutting-edge GenAI tools (Pratschke, 2024). According to Moundridou et al. (2024), a significant portion of teachers report having little knowledge of how GenAI might be effectively incorporated into student-centered pedagogies like PjBL. This lack of readiness causes hesitancy, diminished self-assurance, and a propensity to steer clear of or use AI tools in the classroom sparingly. Likewise, students may become unduly dependent on AI-generated information instead of coming up with original ideas, which could lead to a decline in critical thinking and creativity (Shah & Ashad, 2024). This dependence may result in a lack of interest in learning activities and a decline in problem-solving abilities.

Teachers' Strategies in Utilizing GenAI in PjBL in Higher Education

Based on information gathered from surveys and interviews, the section addresses how educators are tackling the difficulties associated with using GenAI in PjBL. These strategies include taking part in academic peer discussion to exchange useful insights, developing ethical guidelines to ensure responsible use, and participating in capacity-building exercises to improve AI-related competencies, as it is reported in the following table.

Table 6. Survey Result of Teachers' Strategies in Utilizing GenAI in PjBL

Item	M	SD	1	2	3	4	5
Capacity building (training/workshops)	4.2	0.68	2%	4%	10%	56%	28%
Peer discussion and collaboration	4.1	0.70	3%	5%	10%	55%	27%
Establishing ethical guidelines	4.6	0.52	1%	2%	4%	50%	43%

The Table 6 reports that teachers adopted several strategic measures to address the challenges of GenAI integration in PjBL**.** With 93% of participants agreeing or strongly agreeing and a high mean score of 4.6 (SD = 0.52), the creation of ethical guidelines was the most recommended strategy to overcome challenges encountered by teachers. The strategy demonstrated how important it is to codify the usage of AI responsibly. Additionally, teachers' knowledge of the need for institutional assistance in developing AI-related competences was shown in the strong support for capacity-building activities, such as training and workshops (M = 4.2, SD = 0.68). Peer collaboration and discussion came next (M = 4.1, SD = 0.70), with 82% agreement, highlighting the importance of group learning and experience-sharing. These findings reflected a proactive stance toward ethical, professional, and collaborative readiness. As detailed in the interview data, shown in the table below.

Table 7. Interview Results of Teachers' Strategies of Utilizing Gen AI in PjBL

Theme	Interpretation	Excerpt
Collaboration & Sharing	Peer collaboration and discussion strengthen GenAI pedagogical integration.	"We've started monthly discussions among faculty to share how we use AI in class. It's really improved our understanding and approach."
Ethical Guidelines	Institutions are adopting ethical guidelines to address responsible AI use.	"Our department drafted AI usage guidelines to help both students and staff navigate ethical boundaries."
Capacity Building	Workshops and training sessions enhance teacher readiness and confidence in GenAI use.	"I attended a training workshop on AI in education. It made me realize the potential of these tools when used carefully."

Table 7. showed that several key strategies supported the effective and ethical integration of GenAI in PjBL within higher education. Peer cooperation became a popular strategy, with teachers exchanging materials and experiences in communities of practice and faculty meetings. Monthly conversations, according to one educator, have greatly enhanced their group's comprehension of AI

applications. According to a participant who discussed his department's attempts to establish ethical limits, institutions additionally formalized AI ethics by creating explicit norms on topics like authorship and plagiarism. Another popular tactic was capacity building through professional development; educators who participated in courses centered on AI expressed more awareness and self-assurance. These results showed a proactive move toward enhancing pedagogical and institutional preparedness for integrating GenAI.

Teachers' strategies for integrating Generative AI in PjBL reflect a growing awareness of the tool's pedagogical potential and ethical implications. Furthermore, the development of moral standards and capacity-building workshops are real action of institutional initiatives that have been essential in giving teachers the skills and assurance they need to use GenAI tools ethically and efficiently (Wang, 2023). By encouraging ethical awareness in the use of AI in the classroom, these support systems help teachers better grasp the pedagogical consequences of its integration (Celik, 2023). According to previous studies from Chiu (2024); Nurani et al. (2024), and Zhai (2024), teachers who participate in professional development are more likely to delve further into GenAI's potential and use it strategically for planning, assessment, and student learning facilitation. Therefore, establishing sustainable, accountable, and creative practices in AI-assisted project-based learning requires institutional commitment to continuous training and unambiguous ethical standards.

CONCLUSION

This study examined the integration of Generative AI (GenAI) into Project-Based Learning (PjBL) in higher education, focusing on the roles, challenges, and strategies of university teachers. The findings indicate that teachers take on multifaceted roles as facilitators, instructional designers, and ethical mentors in guiding students to use GenAI effectively and responsibly. While GenAI offers clear benefits, such as enhancing project planning, feedback provision, and student creativity, its integration also poses notable challenges. These include concerns over academic integrity, unequal access to AI tools among students, and a general lack of teacher readiness and confidence in using AI technologies. To overcome these barriers, teachers employed several strategies, including professional development, peer collaboration, and the creation of ethical guidelines. Overall, the study underscores the need for institutional support, ongoing capacity-building, and ethical frameworks to ensure the meaningful and responsible integration of GenAI into PjBL. These insights offer valuable contributions to the development of future policies and practices in AI-enhanced higher education. Despite its valuable contributions, this study has several limitations that should be acknowledged. First, the research relied primarily on self-reported data from university teachers, which may introduce bias due to personal perceptions or social desirability. The absence of direct classroom observations or student perspectives limits the depth of understanding regarding how GenAI is actually implemented and experienced in practice. Second, the study's sample size and geographic scope may not fully represent the diverse contexts of higher education, reducing the generalizability of the findings. Additionally, as GenAI technologies are rapidly evolving, the data collected may quickly become outdated, potentially limiting the study's long-term relevance. Furthermore, while the study identifies strategies and challenges, it does not measure the actual impact of GenAI on student learning outcomes. These weaknesses highlight the need for future research that incorporates multiple stakeholder

perspectives, longitudinal data, and more robust methods to assess the effectiveness and ethical implications of GenAI in PjBL settings.

RECOMMENDATION

Based on the findings regarding the negative impact of Gen AI on students in PjBL environments, this study proposes three key recommendations. In order to assist students in comprehending the potential and constraints of AI tools, educational institutions should first incorporate AI literacy instruction into the curriculum. This academic action preserves crucial cognitive abilities like analysis, creativity, and problem-solving by empowering students to utilize AI critically and ethically rather than relying only on it. Second, teachers should create evaluation strategies that support process-oriented learning, like peer reviews, reflective journals, and iterative project submissions. By rewarding authentic interaction throughout the learning process, these methods make it more difficult for students to delegate all of their work to AI. Third, universities should guarantee all students equal access to AI technologies and support resources to address equity issues. For less tech-savvy students, this entails offering training, device and software access, and one-on-one mentorship. Teachers and institutions can lower the risks of AI misuse in PjBL and foster a more diverse, moral, and stimulating learning environment by putting these measures into practice. These suggestions are meant to strike a balance between the creative application of AI and the fundamental principles of higher education.

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