

PRE-SERVICE ENGLISH TEACHERS' PERCEPTIONS OF ARTIFICIAL INTELLIGENCE (AI) IN PROJECT-BASED LEARNING IN TEACHING ENGLISH FOR YOUNG LEARNERS

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Article Info	Abstract
Article History Received: June 2025 Revised: August 2025 Accepted: September 2025 Published: October 2025	<i>This study investigates how pre-service teachers specializing in Teaching English to Young Learners (TEYL) perceive and utilize Artificial Intelligence (AI) tools within Project-Based Learning (PBL), a context that remains underexplored in teacher education research. While AI adoption in education is growing, little is known about its role in supporting pre-service teachers' creativity, pedagogical decision-making, and reflective practice in TEYL settings. To address this gap, a sequential explanatory mixed-methods design was employed, combining a survey of 50 Indonesian pre-service TEYL teachers with follow-up interviews with six purposively selected participants. This design was chosen to capture broad patterns of perception and then enrich them with contextualized insights. Data were collected using a questionnaire grounded in the Technology Acceptance Model (TAM) and semi-structured interviews, with quantitative analysis conducted through descriptive statistics and qualitative data analyzed thematically. Findings indicate high acceptance of AI, with participants valuing its ease of use and positive contribution to project work, particularly in brainstorming ideas and supporting design. At the same time, concerns emerged regarding overreliance, reduced critical thinking, and occasional unreliability of AI-generated content. These results highlight both the opportunities and risks of AI integration in TEYL teacher education. The study concludes that teacher education programs should embed AI literacy, promote reflective pedagogy, and design scaffolded PBL activities that balance technological support with the development of creativity, ethical awareness, and learner autonomy.</i>
Keywords Artificial Intelligence; Pre-service teacher; Project-based learning; Technology acceptance model; English for young learners;	
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INTRODUCTION

In the evolving landscape of teacher education, Project-Based Learning (PBL) has been widely recognized for its ability to foster critical thinking, creativity, and authentic problem-solving—skills crucial for preparing future English teachers of young learners (TEYL) (Soviyah, 2023; Fatimah & Soviyah, 2023). Through PBL, pre-service teachers engage in designing, implementing, and reflecting upon real-world projects, thereby developing not only pedagogical skills but also reflective and collaborative dispositions (Bell, 2010; Patton, 2012; Kokotsaki et al., 2016; Mahasneh & Alwan, 2018; Aksela & Haatainen, 2019). While foundational studies have established PBL's benefits, recent debates increasingly stress the need to reexamine PBL in light of digital transformation and the growing role of Artificial

Intelligence (AI) in education (Zawacki-Richter et al., 2019; Kasneci et al., 2023; Zhai, 2023; Wang & Tian, 2025; Al-Zyoud, 2020; Işık, 2025; Jamal, 2023; Celik et al., 2022).

AI-powered tools such as ChatGPT, Grammarly, Canva AI, and QuillBot are now regularly used by teacher candidates to support stages of the project cycle—from brainstorming and material creation to editing, feedback, and design. These tools provide instant scaffolding that enhances accuracy, creativity, and efficiency (Alghasab, 2025; Tseng & Lin, 2024; Kim, 2023; Ghamrawi et al., 2023; Fatima, 2025). In TEYL coursework, where pre-service teachers must prepare age-appropriate and engaging resources, AI functions as both a co-creator and a support system, enabling richer content development and more confident instructional design (Ayanwale et al., 2024; Yu & Tao, 2025; Nazaretsky et al., 2022; Arvin, 2023; Sun et al., 2022; Salas et al., 2022). At the same time, research warns that reliance on AI may reduce pedagogical ownership, critical thinking, and originality, while also raising ethical concerns related to bias, plagiarism, and superficial learning (Cotton et al., 2023; Ismail et al., 2023; Dehouche, 2021; Arsen'eva, 2024).

Although AI adoption in education has been widely studied, the majority of scholarship has emphasized its role in improving writing, efficiency, or general teacher productivity (Lee et al., 2022; Huang et al., 2024; Zhang, 2023). Far less attention has been given to how pre-service TEYL teachers—who face the dual challenge of mastering child-centered pedagogy and learning to integrate technology—perceive and engage with AI during PBL processes. This is a significant oversight, given that PBL requires learners not only to produce outcomes but also to critically reflect on collaboration, creativity, and tool use (Boss & Larmer, 2018; Kokotsaki et al., 2016). Pre-service TEYL teachers' voices are therefore critical for shaping instructional models that balance innovation with developmental appropriateness in early language education.

Recent research highlights AI's potential to boost teacher candidates' productivity and confidence (Bensalem et al., 2024; Alkhatib, 2023; Sun et al., 2024), yet there is a notable gap in exploring its integration within reflective, collaborative models like Project-Based Learning (PBL). While studies often focus on technology acceptance and performance metrics, they tend to overlook the complexities of how pre-service teachers engage with AI in the context of pedagogical reasoning and ethical decision-making during authentic project work (Cheng et al., 2022; Felix, 2020; David & Maroma, 2025). This oversight is critical, as understanding how teachers navigate the balance between technological tools and educational ethics is essential for preparing them for real-world teaching scenarios. As AI becomes more prevalent in education, especially within Teacher Education for Young Learners (TEYL) programs, it is crucial to investigate how AI interacts with PBL frameworks, supporting both reflective practices and collaborative learning in teacher preparation.

Despite the increasing attention to AI in teacher education, research at the intersection of AI integration, project-based learning, and TEYL pre-service teacher preparation remains scarce. Existing studies have largely concentrated on general technology acceptance or on the performance outcomes of AI-assisted learning, often overlooking how pre-service teachers reflect on the pedagogical and ethical dimensions of AI use in authentic, collaborative learning contexts. This study is therefore distinctive in two ways: first, it focuses specifically on TEYL pre-service teachers, a group who must simultaneously master child-centered pedagogy and technology integration; and second, it situates AI use within the framework of PBL, a model that demands creativity, reflection, and real-world problem-solving. By addressing this gap, the present study contributes not only to the literature on AI in education but also to the broader discourse on preparing future teachers for a rapidly evolving digital and pedagogical landscape. To investigate this issue, the present study addresses the following research questions:

1. How do TEYL pre-service teachers perceive the use of AI tools in project-based learning?
2. How do TEYL pre-service teachers perceive the benefits and drawbacks of using AI tools in project-based learning?
3. In what ways do AI tools assist TEYL pre-service teachers in project-based learning?

RESEARCH METHOD

Research design

In order to fully comprehend the research problem, this study used a mixed-methods research design that combines quantitative and qualitative techniques (Creswell & Plano Clark, 2018). The study used a sequential explanatory design, with qualitative inquiry coming after quantitative data collection and analysis. A structured survey that was given to a sizable sample of participants facilitated the quantitative phase and allowed for the collection of quantifiable and broadly applicable data. After that, a qualitative phase was carried out using in-depth interviews to investigate and clarify the trends seen in the survey results, offering more profound understandings of the experiences and viewpoints of the participants and leading to a comprehensive grasp of the research issue. This design is particularly effective when the goal is to use qualitative data to help explain or interpret quantitative findings (Ivankova, Creswell, & Stick, 2006). In the context of this study, the sequential explanatory design was chosen not only because it allows for triangulation of data, but also because it is especially suited for capturing both measurable perceptions of AI through TAM constructs and the deeper pedagogical reflections of TEYL pre-service teachers, which cannot be fully understood through surveys alone.

Participants

The participants of this study consisted of 50 pre-service teachers enrolled in TEYL program of English Education Department Ahmad Dahlan University Yogyakarta, Indonesia. These participants voluntarily agreed to take part in the study and have taken TEYL related courses as part of their curriculum. They were selected using purposive sampling, a non-probability technique that allows researchers to select individuals who possess specific characteristics relevant to the research objectives (Palinkas et al., 2015). The inclusion criteria required participants to (1) be actively exposed to artificial intelligence (AI) technologies, (2) had firsthand experience of using AI tools and applications for academic tasks, (3) have used AI tools in their academic activities, and (4) have taken TEYL related courses as part of the curriculum. In addition, participants reported prior engagement in PBL-based coursework, as the TEYL-related courses in their program were designed around PBL approaches, and they demonstrated moderate to high levels of digital literacy (e.g., familiarity with productivity tools, online platforms, and basic use of AI applications). This ensured that they were adequately prepared to integrate AI into their projects. From the total sample, six participants were purposively chosen for the qualitative phase, involving semi-structured interviews. These participants were selected based on the richness of their survey responses and their willingness to elaborate further on their experiences. According to Patton (2015), purposive selection in qualitative research is effective for capturing in-depth insights from information-rich cases. This two-tiered selection approach aligns with the mixed-methods design by first capturing general trends through a broader survey and then exploring deeper perspectives through targeted interviews. Detailed demographic information of the participants is presented in Table 1.

Table 1
Sociodemographic Characteristics of the Participants

Parameter	Specification	Count	%
Gender	Female	35	70%
	Male	15	30%

Parameter	Specification	Count	%
Age	20	7	14%
	21	28	56%
	22	10	20%
	23	1	2%
	> 23	4	8%
Place of origins	Java	30	60%
	Sumatera	12	24%
	Kalimantan	2	4%
	Bali & Nusa Tenggara	3	6%
	Papua & Maluku	2	4%
	Outside Indonesia	1	2%
AI experience	Yes	50	100%
	No	0	0%

Research Setting and Context

Conducted in January – March 2025, this research was done at English Education Department of Universitas Ahmad Dahlan (UAD), a prominent private university in Yogyakarta Indonesia. EED UAD is purposively selected as the research site due to its well-established Teaching English to Young Learners (TEYL) program, which is known for integrating progressive pedagogical approaches. Within this program, there are some courses offered with Project-based Learning (PBL) serving as the core instructional method, aiming to foster student-centered inquiry, creativity, and authentic language use. The department's emphasis on experiential learning and its strategic implementation of PBL in the TEYL curriculum makes it an ideal context for investigating the interplay between instructional methods and the development of future TEYL teachers' competencies.

Instruments

This study employed two types of instruments: a questionnaire and interview guidelines. The questionnaire was used in the quantitative phase to explore pre-service teachers' perceptions and usage of AI tools in PBL, while the interview guidelines supported the qualitative phase by eliciting deeper insights into their experiences and perspectives. The use of both instruments aligns with the mixed-methods approach, allowing for a comprehensive understanding of the research problem (Creswell & Plano Clark, 2018). There were 10 Likert-scaled questionnaire items and 3 open-ended items, which were primarily generated from the Technology Acceptance Model (TAM) (Davis, 1989), a widely used framework to examine technology adoption and use. These items were also informed by relevant studies in English Language Teaching (ELT), particularly in the context of Project-Based Learning (Thomas, 2000; Bell, 2010; Stoller, 2006). All of these studies inform the adaptation of the instrument to the ELT context, particularly in relation to AI-assisted learning. Examples of survey items included: *"AI helps me understand TEYL theory and practice"* (PU) and *"AI is easy to use when working on projects"* (PEOU).

The interview guidelines were designed to expand on the quantitative findings and uncover contextual factors influencing AI integration in PBL process. Sample prompts included: *"Can you describe a specific situation where AI helped you design or refine your TEYL project?"* and *"In what ways do you think AI might hinder creativity or critical thinking during project work?"*

To ensure the instruments' construct achieve meaningful precision and reliability, the study engaged three experts in the subject matter. The experts rated the relevance of each item for its corresponding construct, suggested revisions, or removed unnecessary items. The comments offered were significant in developing the constructs. Following expert review, items were piloted with postgraduate students of English education, who confirmed clarity and accessibility. Minor wording adjustments were made based on this feedback to improve readability and alignment with the TEYL context. The survey questionnaire developed for data collection had three main sections. The first part included demographic data of the participants such as gender, age, place of origins, and experience with AI. The second part contained constructed components organized under the categorizations namely PU, PEOU, ATT, and BI (see Table 2). All items were rated on a 5-point Likert scale ranging from (1) "strongly disagree" to (5) "strongly agree". Additionally, the questionnaire included a third section with three open-ended questions to collect data on the benefits and drawbacks of using AI tools. The detailed instrument structure is outlined in Table 2 and Table 3. For its application to participants, the survey was then launched through the online mode using survey Google Forms.

Table 2
Structure of the Questionnaire

Construct	Item
Perceived Usefulness (PU)	I use AI to generate and refine ideas and materials for my projects.
	AI helps me understand TEYL theory and practice.
	Using AI makes the project design process easier and more efficient.
Perceived Ease of Usefulness (PEOU)	I do not experience any significant technical difficulties when using AI.
	AI is easy to use when working on projects.
Attitude toward Technology (ATT)	I use AI tools ethically and responsibly.
	I enjoy using these tools in my work.
	I believe the use of AI has positive benefits in the context of TEYL.
Behavioral Intention (BI)	I recommend using AI tools for similar projects in the future.
	I plan to continue using AI in my TEYL learning process.

Table 3
Question Prompts

Category	Question prompts
Benefit	What are the advantages of using AI tools when working with TEYL project?
Drawbacks	What are the obstacles/drawbacks of using AI tools when working with TEYL project?
Roles	How do AI tools help you when working with TEYL project?

Data Collecting Techniques

This study employed two data collection techniques: a survey and semi-structured interviews. The quantitative phase of data collection, which followed the sequential explanatory mixed-methods design, started with an online questionnaire to learn more about pre-service teachers' attitudes toward and use of AI tools. Google Forms was used to disseminate the survey electronically. The qualitative phase was carried out after the quantitative data analysis in order to obtain a deeper understanding and elucidate the results. A purposive sample of participants was chosen based on their survey replies, and they participated in semi-structured interviews. The purpose of the interview sessions was to examine individual experiences with a focus on two topics: the advantages, disadvantages,

and ways in which AI tools support individuals during PBL. By combining broad trends with individual viewpoints, this two-phase method improves the study's validity and depth (Ivankova, Creswell, & Stick, 2006; Creswell & Plano Clark, 2018).

Data Analysis

The sequential explanatory mixed-methods approach was used to examine the data, which included both quantitative and qualitative techniques (Creswell & Plano Clark, 2018). Using SPSS software, descriptive and inferential statistics were used to examine survey responses during the quantitative phase. Based on the TAM constructs, descriptive statistics (means, mode, standard deviations, and percentages) were employed to compile the opinions and use of AI technologies by the participants. After that, semi-structured interviews data were transcribed and subjected to thematic analysis (Braun & Clarke, 2006). Themes that provide contextual explanations and disclose nuanced viewpoints on participants' experiences using AI tools in PBL were identified in order to enhance comprehension of the quantitative data. Integration occurred during the interpretation stage, where qualitative themes were used to explain and contextualize quantitative patterns (e.g., high ease-of-use scores complemented by specific accounts of how AI simplified design tasks). This allowed the two strands to inform each other, enhancing the explanatory power and validity of the study.

RESEARCH FINDINGS AND DISCUSSION

Findings

Perceptions of Using AI tools

The questionnaire data revealed participants' perceptions and usage toward the use of AI in their TEYL project-based learning activities, as measured across four constructs of the Technology Acceptance Model (TAM): Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Attitude Toward Technology (ATT), and Behavioral Intention (BI) as presented in Table 4.

Table 4
Summary of perceptions towards using AI tools

Construct	Questions	SD	DA	N	A	SA	Mean	Mode	St.Dev
Perceived Usefulness (PU)	I use AI to generate and refine ideas and materials for my projects.	2%	6%	46%	36%	10%	3.46	3	0.84
	AI helps me understand TEYL theory and practice.	4%	6%	36%	48%	6%	3.46	4	0.86
	Using AI makes the project design process easier and more efficient.	2%	4%	38%	50%	6%	3.54	4	0.76
Perceived Ease of Usefulness (PEOU)	I do not experience any significant technical difficulties when using AI.	0%	8%	24%	54%	14%	3.74	4	0.80
	AI is easy to use when working on projects.	0%	0%	6%	72%	22%	4.16	4	0.51
Attitude toward Technology (ATT)	I use AI tools ethically and responsibly.	2%	2%	14%	58%	24%	4	4	0.81
	I enjoy using AI tools in my work.	0%	0%	14%	86%	0%	3.86	4	0.35
	I believe the use of AI has positive benefits in the context of TEYL.	0%	0%	0%	72%	28%	4.28	4	0.45
Behavioral Intention	I recommend using AI tools for similar projects in	2%	6%	34%	52%	6%	3.54	4	0.79

(BI)	the future.								
	I plan to continue using AI in my TEYL learning process.	2%	6%	34%	52%	6%	3.54	4	0.79

In terms of Perceived Usefulness (PU), the mean scores for all three items fell within the moderate range ($M = 3.46\text{--}3.54$). This suggests a generally positive but varied perception of AI's role in TEYL learning. While students recognized AI as helpful for generating/refining ideas and understanding theory, the highest value was placed on project design efficiency, indicating that usefulness was most evident in applied, task-oriented contexts. As one participant put it: *"AI is helpful in providing creative ideas and references... it can customize language styles and topics based on children's needs"* (P2). This illustrates how usefulness was often associated with both creativity and adaptability.

Responses on Perceived Ease of Use (PEOU) were more favorable ($M = 4.16$), with students reporting AI as intuitive and largely free of technical barriers. Nearly all students reported minimal technical difficulties, reflecting overall confidence in the tools' usability. One explained: *"AI is easy to access, we can use and learn anytime, anywhere"* (P6). This contrast with the moderate PU scores highlights that while students valued AI's functionality, they most strongly appreciated its ease and accessibility.

Participants' Attitudes Toward Technology (ATT) were also notably positive, with consensus on AI's benefits ($M = 4.28$). Students also reported ethical use ($M = 4.0$) and enjoyment ($M = 3.86$). One elaborated: *"AI helps me with projects because it speeds up and simplifies the process... Using these tools has boosted my confidence and improved the quality of my projects"* (P1). Such accounts suggest that positive attitudes were grounded not only in enjoyment but also in perceptions of responsibility and tangible improvements in project work. Finally, Behavioral Intention (BI) ($M = 3.54$) reflected a consistent willingness to continue and recommend AI use, though with slightly less intensity than attitudes and ease, suggesting that intentions remain positive but may depend on context and perceived need. As one noted: *"I plan to continue using AI in my TEYL learning process"* (P3).

Additionally, to gain deeper insights into participants' actual AI usage, they were asked to indicate the types of AI tools they had used during their TEYL project, with the option to select more than one tool. The results are shown through Figure 1.

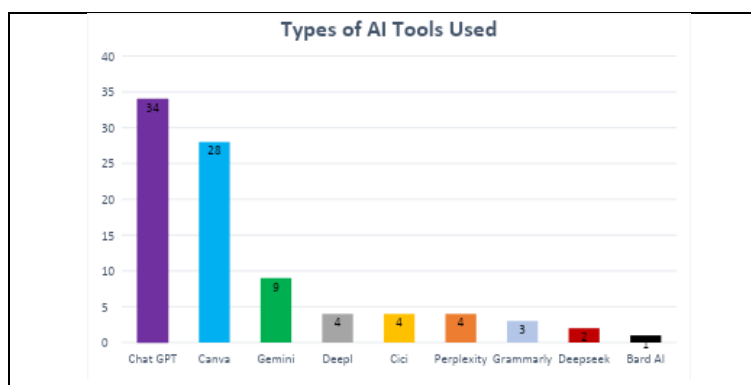


Figure 1. Types of AI Tools used

The results show that ChatGPT was the most frequently used, with 34 mentions, followed by Canva with 28 mentions, indicating a strong preference for tools that support text generation and visual content creation. Gemini was used by 9 participants, while other tools such as DeepL, Cici, Perplexity, and Grammarly were each mentioned by 3–4 users. Less

commonly used tools included Deepseek and Bard AI, each with only 2 mentions. These findings highlight the diverse range of AI tools accessed by participants, with a notable concentration on generative and design-based platforms that align with the creative and communicative demands of project-based learning in TEYL contexts.

Benefits of using AI tools

Being allowed to give more than one response, a total of 66 valid responses were collected regarding the first open question on how using AI tools give the participants benefits in PBL process as displayed in Table 5.

Table 5
Thematic analysis of benefits of using AI tools

Category	Theme	Counts	%
Benefits	Brainstorming ideas	20	30%
	Helping with the project	19	29%
	Practical	10	15%
	Easy to use	9	14%
	Interesting	4	6%
	Providing feedback	2	3%
	Interactive	2	3%
Total		66	100%

Table 5 shows that the most frequently reported benefit was brainstorming ideas (30%), followed closely by general project assistance (29%), suggesting that students relied on AI both for creative input and ongoing task management. Practicality (15%) and ease of use (14%) were also emphasized, while fewer students highlighted interactivity or feedback.

Students consistently described AI as a catalyst for idea generation. One participant explained in detail: *“There are advantages of using AI... it provides a variety of ideas and exercises for TEYL, which makes our project more interesting and tailored to children’s needs. AI helps us significantly during the project”* (P4). Another emphasized adaptability and speed: *“AI is helpful in providing creative ideas and references... it can customize language styles and topics based on the children’s needs”* (P2). Others valued its simplicity and accessibility, noting that *“It makes working with our project easier”* (P3) and *“AI is easy to access, we can use and learn anytime, anywhere”* (P6).

Drawbacks of using AI-powered writing tools

A total of 70 valid responses were collected regarding the second open question on what drawbacks of using AI tools in PBL process were like. Table 6 summarizes the analysis of participants’ responses.

Table 6
Thematic analysis of drawbacks of using AI tools

Category	Theme	Counts	%
Drawbacks	Unreliable	25	36%
	Overreliance	18	26%
	Reducing critical thinking	5	7%
	Reducing creativity	5	7%
	Less interactive	5	7%
	Monotonous	4	6%
	Counterproductive	3	4%
	Inaccessible/unfree	2	3%
	Reducing teacher’s role	2	3%
	Non-user-friendly	1	1%
Total		70	100%

Table 6 shows that participants identified several drawbacks of using AI in their TEYL project experience, which reveal concerns that complement their recognition of AI's benefits. The most frequently reported issue was that AI can be unreliable (36%), indicating doubts about the accuracy or appropriateness of AI-generated content. Various statements expressed during the interview depicted this concern such as:

"The drawback is that it is sometimes irrelevant to what we want, so we need to use AI more carefully and responsibly" (P2).

"Using AI can prevent us from trusting our own abilities, and AI does not always provide clear sources for the explanations we ask for. However, in fact AI is sometimes unreliable" (P5).

"AI is not always correct, anyway. If we give it general data or questions, AI will sometimes produce incomplete, incorrect, or inappropriate results" (P1).

The second rank response concerning the use of AI in PBL is overreliance with 18 times occurrence (26%). This reflects fears that frequent AI use might hinder independent learning. The following statements expressed by the participants during the interview prove this:

"Additionally, I think relying too much on AI can stifle creativity and hinder the development of an in-depth understanding of the material" (P4).

"The downside I found out is that so many people depend on AI, so they become too lazy to think for themselves." (P2).

"If we depend on AI, we will also not be able to think creatively because we will be accustomed to being helped by AI." (P3).

"In my opinion, AI can create a sense of dependence when completing a task or a project due to unlimited access it has." (P1).

These reflections highlight a paradox: AI was seen as both empowering and potentially disempowering. On the one hand, it accelerated productivity and provided quick solutions; on the other, it risked undermining critical thinking, independent problem-solving, and creativity—qualities essential in TEYL contexts. Thus, the findings point to the need for guided and mindful AI use, where its supportive role is emphasized without replacing learner autonomy.

Roles of AI tools

The analysis of participants' responses regarding the roles of AI in their TEYL project work revealed three dominant themes as presented in Table 7.

Table 7
Thematic analysis of drawbacks of using AI tools

Category	Theme	Counts	%
Roles	Finding and brainstorming ideas	40	73%
	Helping with project design	8	14%
	Providing feedback	7	13%
Total		55	100%

Table 7 shows that the most common role of AI in students' project work was idea generation (73%), followed by project design support (14%) and feedback provision (13%). This distribution highlights AI's dominant function as a cognitive aid, while also pointing to its emerging use in design and formative feedback. Overall, these findings suggest that AI was seen less as a replacement for learners' creativity and more as a supportive collaborator. Students valued it for accelerating the early stages of project work, offering structural

guidance, and giving preliminary feedback. However, they also emphasized that human judgment and group collaboration remained central to finalizing their projects. Table 8 presents some statements expressed by the participants during the interview.

Table 8
Interview results of roles of AI tools

Theme	Statement
Finding and brainstorming ideas	<i>AI helps me generate and find interesting ideas, which must then be developed through our group discussions. However, in my opinion, AI is essentially only a tool. For example, it can suggest ideas about interesting games for children and recommend learning media that are interesting and suitable for them but the one who decide and design is us through our project. (P5).</i>
	<i>AI can provide creative ideas that we would not usually think of. I use it to develop teaching ideas in my project. Additionally, AI can analyze and recommend which materials are suitable for elementary and young learners. But I only use AI to develop ideas. (P2).</i>
	<i>Using AI really helps me with projects because it speeds up and simplifies the process. For instance, I had trouble drafting a script in English. ChatGPT provided me with a clear and easy-to-understand sentence structure. To make my writing more organized and grammatically correct, I use Grammarly to check spelling and grammar. I use Canva to create designs because it has many automated templates, so I don't have to design from scratch. Using these tools has boosted my confidence and improved the quality of my projects. (P1).</i>
Helping with project design	<i>When we're stuck with the design, AI comes up with a design example and helps create a better design with our project. (P6).</i>
	<i>Sometimes when the idea that I have gotten is not fixed enough, I go to ChatGPT and ask it. From there I get help with the project I've been doing. (P1).</i>
	<i>AI helps me to make the project better. (P3).</i>
Providing feedback	<i>AI provides feedback related to the design we make that aligns with the program. (P2).</i>
	<i>AI can provide a detailed explanation of how the project will run and suggest activities for it. (P5).</i>

Discussion

The findings suggest that participants generally view AI positively, particularly regarding ease of use and their overall attitudes toward technology. This supports the Technology Acceptance Model (TAM), which posits that perceived ease of use is a crucial factor in technology adoption (Davis, 1989; Venkatesh & Davis, 2000). However, these findings go beyond simply confirming TAM by highlighting important pedagogical implications: AI tools allowed pre-service teachers to focus more on pedagogical reasoning and the creative aspects of project design. This aligns with constructivist theories (Piaget, 1976; Vygotsky, 1978), where digital tools serve as mediators in learning, enhancing students' ability to experiment within their zone of proximal development (ZPD). Notably, participants did not view AI as a passive content provider replacing their own agency. Instead, they saw it as an active collaborator and a supportive resource, echoing earlier research on the

cautious yet optimistic integration of technology in teacher education (Teo, 2011). This suggests a growing professional stance among TEYL pre-service teachers: they value technological affordances but remain mindful of their pedagogical roles.

Participants highlighted several key benefits of AI, including idea generation, simplifying project tasks, and saving time. These benefits position AI as a cognitive scaffold (Bruner, 1966) and a "mindtool" that facilitates knowledge construction rather than merely delivering content (Jonassen, 1998). This role fits well with the collaborative and problem-oriented nature of Project-Based Learning (PBL), which thrives on creativity and sustained inquiry (Thomas, 2000; Kokotsaki et al., 2016). However, participants also identified significant drawbacks, including concerns about content reliability, the risk of overreliance, and a potential decline in critical thinking. These issues reflect ongoing concerns in AI education research, such as superficial learning, bias, and plagiarism (Bender et al., 2021; Selwyn, 2019). Importantly, participants' recognition of these risks points to an emerging digital critical literacy (Ng, 2012; Long & Magerko, 2020), indicating that pre-service teachers are beginning to evaluate AI not just for its advantages, but also for its ethical and pedagogical limitations. This recognition also raises a deeper concern: if AI can provide quick answers, will students bypass the more effortful processes that foster creativity and critical thinking? This paradox highlights the pedagogical challenge of integrating AI—maximizing its support while avoiding overdependence.

The findings further suggest that pre-service teachers are not naïve adopters of AI. Their skepticism about the accuracy of AI reflects a growing digital literacy (Ng, 2012), and their concerns about losing autonomy echo calls for AI literacy frameworks in teacher education (Long & Magerko, 2020). In this regard, AI functions not only as a tool for productivity but also as a context for developing reflective and critical professional dispositions. For TEYL preparation, this awareness is essential: future teachers must foster innovation in their classrooms while modeling responsible and critical use of AI. By engaging critically with AI, pre-service teachers can learn to balance technological innovation with pedagogical responsibility.

The roles of AI—such as idea generation, project design, and feedback—illustrate that AI serves more as a thinking partner than as a replacement for learner agency. This aligns with Jonassen's (1998) concept of "Mindtools," where technology supports, but does not substitute for, cognition. The examples shared by participants show how AI accelerates initial brainstorming and provides structure, while final creative decisions remain in the hands of the students. This dynamic illustrates how AI can complement PBL by handling routine or generative tasks, thus allowing learners to focus more on reflection and pedagogy. In this way, AI enhances creativity and speeds up the early stages of project design, aligning with PBL's emphasis on authentic inquiry, where external resources inspire idea generation and collaborative exploration (Larmer et al., 2015).

A smaller, yet significant, role for AI was its use in providing feedback, which aligns with research on AI-supported self-regulated learning (Zimmerman, 2002) and holds pedagogical importance. This suggests a shift toward adaptive, dialogic forms of learning, where AI serves as a first responder in formative assessment. Such cautious positioning mirrors the principles of critical pedagogy (Freire, 1970), emphasizing that technology should support, not dominate, teaching practice. For teacher educators, this presents an opportunity to train TEYL pre-service teachers not only in using AI for efficiency but also in critically interpreting and refining AI-generated feedback.

The findings demonstrate a balanced stance among TEYL pre-service teachers: they embrace AI as an accessible, creative, and time-saving tool but remain cautious about its limitations and potential risks. Their perceptions reflect both enthusiasm for innovation and a critical awareness of the ethical and pedagogical challenges AI brings. This duality is

important for teacher education, as it suggests that pre-service teachers are not passive adopters but active negotiators of how AI fits into their professional identities. The key contribution of this study is to frame AI as a paradox: a powerful collaborator when used critically, but a potential limiter of autonomy when adopted unreflectively. For teacher educators and policymakers, the challenge is to harness AI's potential while safeguarding the uniquely human qualities of creativity, judgment, and critical thought.

CONCLUSION

This study examined how TEYL pre-service teachers perceive, evaluate, and utilize AI tools within project-based learning (PBL). Overall, participants adopted a balanced stance: they appreciated AI for its accessibility, ease of use, and ability to support brainstorming and project design, while also expressing concerns about content reliability, overreliance, and the risk of diminished critical thinking and creativity. These perceptions affirm the usefulness of TAM in understanding technology adoption while also pointing to the pedagogical tensions that arise when integrating AI into reflective and collaborative learning models like PBL.

By situating AI use at the intersection of teacher education, TEYL pedagogy, and PBL, this study contributes a nuanced perspective to ongoing debates about digital transformation in education. The findings underscore the need for AI literacy and reflective pedagogy in teacher preparation programs, ensuring that AI functions as a scaffold for creativity and professional growth rather than a substitute for teacher agency. In doing so, the study highlights both the opportunities and the cautions of AI integration, offering insights that can inform the design of TEYL curricula and the preparation of future teachers for responsible, learner-centered practice.

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