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BLENDING OF ARTIFICIAL INTELLIGENCE (AI) TOOLS IN PROJECT-BASED LEARNING (PBL) WITH REFERENCE TO THE UNDERGRADUATE STUDENTS

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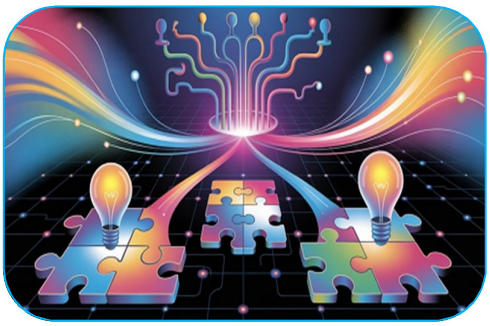
ABSTRACT



Project-Based Learning (PBL) is an educational approach rooted in constructivist principles. It focuses on addressing real-world issues and promotes learning through collaborative exploration and iterative thought among learners. This method shifts the educational focus from simply memorizing facts to developing and enhancing skills. Nevertheless, PBL encounters several obstacles in actual teaching practices, particularly in three areas: tailored project design, ongoing process guidance, and sophisticated evaluation feedback.

As digital transformation in education accelerates and large-scale model technology advances, the incorporation of Generative AI into PBL offers support for its effective execution. Generative AI can aid in refining project design for teaching, facilitate personalized exploration processes for high school students, and enable comprehensive skill assessments for undergraduate learners. Currently, the use of Generative AI in PBL is still in a research phase.

This research focuses on creating a design that emphasizes the value of artificial intelligence in enhancing the quality of learning, particularly when utilizing active methodologies such as project-based learning (PBL). The study examined teachers' perceptions of PBL that integrates AI compared to those that do not in the context of secondary higher education. A sample of 385 undergraduate teachers participated in this research, which explored perceived efficacy, the personalization of learning through AI, and levels of motivation.

This article breaks down the use of Generative AI in the phases of project design, execution, and assessment. Using the teaching project of constructing an exchange network as a case study, this framework suggests a method for prompt language design of Generative AI in PBL project development. Lastly, it assesses the potential risks associated with Generative AI. This research offers a framework and example for intelligent innovation within PBL.

KEYWORDS: *Artificial intelligence, Project-based learning, Teacher perception technology, Active pedagogies, Transformation in education.*

INTRODUCTION

Project-Based Learning (PBL) is an educational theory rooted in constructivism. It transforms the educational model through a cyclical process of "real problem driven - in-depth exploration of practice - collaborative knowledge construction - continuous reflection and iteration". PBL encourages a shift in educational objectives from "memorizing knowledge" to "developing skills," with its efficacy

supported by OECD educational monitoring data. Nonetheless, traditional PBL encounters three primary obstacles when applied on a large scale: personalized project design, dynamic guidance during the process, and precise evaluation feedback. As digital transformation in education accelerates, the integration of generative artificial intelligence (Generative AI) to establish a new paradigm of "human-machine collaboration" is poised to be a crucial method for overcoming the challenges in PBL implementation.

Generative AI facilitates knowledge reconstruction and content generation using large language models (LLMs) and diffusion models. Its role in education is evolving from merely a tool to becoming a cognitive partner. Currently, models such as GPT-4 have demonstrated considerable strengths in generating textbooks and providing intelligent question-answering systems. Generative AI possesses distinctive advantages throughout the complete PBL cycle: it can create dynamic knowledge graphs to enhance project design at the beginning, act as an intelligent tutoring system to assist the inquiry process in the middle, and support multi-dimensional capability profiling at the conclusion.

The utilization of Generative AI in PBL remains in the exploratory phase. This article examines the integration model of Generative AI with PBL. First, the application scenarios of Generative AI in project design, implementation, and evaluation were analysed. Next, using the development of an exchange network project as a case study, a prompt structure for designing PBL projects with Generative AI was presented. Finally, the potential risks associated with using generative AI in PBL were discussed.

REVIEW OF LITERATURE

Blended learning, a pedagogical approach that merges online and traditional face-to-face instruction, is recognized as a highly effective strategy in astronomy education. It supports both the teaching of astronomy content and the professional development of teachers. Through a combination of in-person seminars and online learning activities, this method facilitates both individual and collaborative learning experiences, thereby strengthening educators' subject matter expertise and pedagogical competence.

Bersamin et al., 2024: Blended Learning (BL) is an instructional approach that combines the strengths of traditional in-person teaching with online learning methods. In existing literature, BL is conceptualized in various ways.

Oliver and Trigwell (2005a): Describe it as a fusion of different media and pedagogical techniques, while Bliuc et al. (2007) emphasize the integration of physical and technology-mediated interactions.

Staker and Horn (2012: Define BL as a structured educational program that merges online content delivery with face-to-face supervision. Despite these differing perspectives, the common thread across these studies is the hybrid nature of BL, which integrates both online and in-person learning components. Blended learning is a learning model that combines traditional learning methods with online experiences and spaces. It allows students to learn through a combination of face-to-face classroom and digital learning activities. Blended learning offers greater flexibility and accessibility, allowing students to learn at their own pace and learning style. However, despite having many advantages, blended learning can also lead to digital disruptions that can negatively impact students' mental and physical health.

Solórzano Solórzano et al., 2024: Artificial Intelligence (AI) is a field within computer science dedicated to the creation of systems or machines capable of executing tasks that typically necessitate human cognitive abilities this includes the ability to learn from data, recognize patterns, make decisions, and adapt to new situations. AI can be applied in various forms, including machine learning, natural language processing, computer vision, and robotics. The main goal of AI isto create systems that can think and act autonomously, improving efficiency and effectiveness in various fields, such as health, transportation, and education.

Fleischmann, 2024: AI is described as a digital tool or software that leverages artificial intelligence to improve the design of materials in language classrooms and support learning by processing natural language and identifying data patterns. Artificial Intelligence (AI is defined as a system that can

perform tasks that typically require human intelligence. AI has the ability to transform raw sensory inputs into usable information and actions, and can act autonomously in real-world environments without human supervision.

Wilhelm et al., 2024: Artificial Intelligence (AI) is a comprehensive term within computer science that pertains to the development of algorithms designed to replicate human cognitive abilities, including learning, perception, problem-solving, and decision-making. AI encompasses diverse methodologies, such as machine learning (ML) and deep learning, and incorporates various technologies and techniques, notably algorithmic decision-making.

SIGNIFICANCE OF THE STUDY

The significance of blending AI in PBL for secondary students lies in its ability to personalize learning, improve subject comprehension, and develop crucial future-ready skills like critical thinking and problem-solving. This approach enhances student engagement by creating dynamic environments and offers teachers data-driven insights for better instruction. Furthermore, it prepares students for an AI-driven world by making them comfortable using AI as a tool.

AI can adapt learning paths to individual student needs, providing a more personalized and effective experience than traditional methods. Studies show that students using AI-enhanced PBL have better subject comprehension compared to those in a control group without AI. Integrating AI creates a dynamic environment that can significantly increase student engagement and motivation. Blending AI with PBL fosters the critical thinking and problem-solving skills necessary for real-world challenges. It provides students with practical experience using AI tools, preparing them for a workforce that is increasingly reliant on AI. This method helps students learn to use AI as a partner to amplify their own abilities, a skill that is crucial for navigating the future workplace.

AI can provide teachers with real-time feedback and insights into how students are learning, allowing for more informed teaching decisions. AI tools can help overcome some of the difficulties in implementing project-based learning, such as helping with initial project planning and idea generation. AI allows for the evaluation of a student's entire project process, from brainstorming to final product, providing a more comprehensive view of their understanding than traditional tests alone.

OBJECTIVES OF THE STUDY

The objectives of the present study are:

1. To understand the PBL enhanced through AI is more efficient when it comes to student engagement and learning outcomes than traditional PBL.
2. To know the main challenges and obstacles for teachers using AI in PBL.
3. To observe the impact of the AI tools affecting the degree of personalized learning available, and how does this impact student motivation throughout PBL activities.

HYPOTHESIS OF THE STUDY

The researcher has formulated the below mentioned hypothesis for the study:

"Project-based learning (PBL) with artificial intelligence (AI) is perceived positively by undergraduate teachers" because it enhances personalization, motivation, and learning effectiveness compared to PBL without AI.

RESEARCH METHODOLOGY

A qualitative and quantitative comparative design process was conducted with a 5-point Likert scale questionnaire evaluating crucial elements such as perceived effectiveness, student motivation, and learning personalization with and without AI. This method allows for an in-depth analysis of potentially sizable inequities among groups of variables. A total of 385 undergraduate teachers from three learning stages of education were included.

Research Design

This research would be an applied analytical research which would be quantitative as well as qualitative in nature. The research would be having comparison, quantitative recording as well as recording of people opinion and views. Both primary as well as secondary data would be required for the research. The method for primary data collection would be structured questionnaire method and interview method. The questionnaire would be designed as per the requirements of the research area in the due course.

METHODS OF DATA COLLECTION

For the said research primary as well as secondary data will be required. The data would be collected through following sources:

Primary Data: The primary data is collected from various sources such as Questionnaires, Informal Interviews and Observations.

Secondary Data: The secondary data is collected through various sources such as Reports, Committee Reports, Reference Books, Publish Research Papers and Websites.

Universe and Sample Size

As the population of the undergraduate teachers is indefinite and it is very difficult to decide the sample size for the researcher. Therefore, the researcher has used Cochran's sample size formula to decide the sample size of the undergraduate teachers.

Justification of Sample:

Cochran's sample size formula is used.

$$n = \frac{z^2 * \hat{p}(1-\hat{p})}{\varepsilon^2}$$

Where:

- n is the sample size
- z is the z-score
- p̂ is the population proportion
- ε is the margin of error (confidence interval)

Calculation-

$$n = \frac{1.96^2 * 0.50(1-0.50)}{0.05^2}$$

$$\boldsymbol{n = 385}$$

Where:

- z = 1.96 (Based on a 5% margin of error. Data are assumed two-tailed (i.e. a margin of error of 2.5% on each end of a normal distribution curve), thus a value of 0.9750 will be looked up within the z-score table.)
- p̂ = 50% or 0.50 (This value is often pulled from previous research/ literature. If unsure, use 50%.)
- ε = 5% or 0.05 (Same value used to get the z-score estimate but provided as a decimal/ percentage.)

RESULTS OF THE STUDY

This study seeks to evaluate the perceptions of 385 secondary, and higher education teachers in the debate regarding the inclusion of artificial intelligence (AI) in project-based learning (PBL) and traditional methods. The results are reported based on the descriptive and inferential analyses performed.

The descriptive statistics indicate the overall distribution of the teachers' perceptions within each of the groups with and without AI integration in PBL. The central tendency and dispersion features for each group are presented in Table 1. The average perception score in the AI-integrated group was 4.17 (standard deviation = 0.47), but in the group without AI, the mean was 3.49 (standard deviation = 0.57). Also, there was no overlap of the 95% confidence intervals for the mean for each group, which indicates a significant difference between the two conditions.

The positive difference in the means suggests that the integration of AI in PBL is perceived by the teachers as a factor that is likely to contribute to a better learning experience than that obtained with the traditional method. The smaller standard deviation found in AI-integrated PBL hints towards a more homogeneous and better perception among individual teachers that are acquainted with this new methodology, teach it, or evaluate it. The normality of distribution of the perceptions of the teachers was tested in both groups using the Shapiro–Wilk test. As shown in Table 2, the group with AI present did not follow the normality assumption ($p = 0.004$); however, the group without AI did not show significant deviation from a normal distribution ($p = 0.373$).

Table 1. Descriptive statistics

		Method		Statistics	Std.
		Mean		4.17	0.03
		95% confidence	Lower	4.12	
		interval for the mean	Upper	4.23	
		5% trimmed mean		4.18	
		Median		4.16	
		Variance		0.22	
	1	Standard deviation		0.47	
		Minimum		2.89	
		Maximum		5	
		Range		2.11	
		Interquartile range		0.65	
		Skewness		−0.23	0.14
Perception		Kurtosis		−0.41	0.28
		Median		3.49	0.03
		95% confidence	Lower	3.43	
		interval for the mean	Upper	3.56	
		5% trimmed mean		3.49	
		Median		3.54	
		Variance		0.33	
	2	Standard deviation		0.57	
		Minimum		1.67	
		Maximum		5.	
		Range		3.33	
		Interquartile range		0.75	
		Skewness		−0.07	0.14
		Kurtosis		0.29	0.28

A Mann–Whitney U test for independent samples was performed to assess whether this difference in likelihood perception was statistically significant between both groups. We chose this non-parametric analysis approach because of the shape of the data distribution. These results suggest that

integrating/not integrating AI into PBL results in a statistically significant difference in perception. The standardized test statistic was Z = −13.69, con- firming the additional evidence implying the presence of a significant difference between the perception of PBL with AI and the perception of PBL without AI. This evidence leads to the conclusion that teachers hold considerably more positive than negative views about the impact of AI on PBL.

Finally, to quantify the observed differences, the effect size (r) for the Mann–Whitney U test was computed and is shown in Table 4. The outcome was r = 0.56, which would be considered a large effect according to most classification systems. Such a great effect size suggests that AI tools have effects that are, for a teacher, highly favourable in the PBL model. This finding indicates the practical value of AI-enhanced educational innovations and highlights the importance of such tools in real-life conditions. This not only emphasizes the presence of a considerable difference in teachers' perceptions but also suggests that there are practical implications of AI in PBL for future implementations and research in such methodologies.

Table 2. Mann–Whitney U test

Total N	600
Mann–Whitney U	15,924.0
Wilcoxon W	61,074.0
Test statistic	15,924.0
Standard error	2123.08
Standardized test statistic	−13.69
Asymptotic significance (two-tailed test)	0.00

The results provide deeper insights into the statistical analyses of these questions, indicating the range and divergence in the views held by teachers of various educational levels on the role of AI and its use in the PBL methodology. In general, these results suggest a propensity for the use of AI in PBL that is far more positive and cohesive among teachers based on the context of the implementation or review of the use of AI in PBL

MAJOR FINDINGS OF THE STUDY

- This study examines teachers' perceptions of integrating AI in project-based learning (PBL). It reveals that educators generally hold favourable views on the role of AI in enhancing project-based learning in comparison to conventional methods.
- Positive outcomes pertaining to AI in educational settings have been reported in various studies, showing that AI-enhanced natural science learning environments boost students' motivation, academic performance, and collaborative problem-solving skills.
- The findings align with this study's results, indicating that teachers see AI as a supportive tool that improves project management while facilitating personalized instruction for students.
- The perspectives have contributed to the insights gained in the current research, which further clarified the factors that enhance PBL's effectiveness, ultimately guiding the creation of an AI-optimized teaching model.
- Educators noted that adaptive feedback and real-time self-assessment tools are beneficial in mitigating student anxiety and enhancing motivation. Although this research did not specifically measure anxiety reduction, earlier studies emphasize its significance in improving student confidence and suggest it could be a topic for future investigation.
- The study highlights the significant benefits of incorporating AI into project-based learning (PBL), while also acknowledging the challenges, concerns, and necessary precautions. A notable concern is the potential for excessive dependence on AI systems, which cannot substitute for the essential

human interactions vital for students' holistic development and the cultivation of soft skills like empathy and teamwork.

- Additionally, the effective implementation of AI necessitates considerable investments in system infrastructure and teacher professional development, which may not be feasible in all educational settings, particularly in under-resourced and low-funded institutions.

Challenges of Generative AI in PBL Observed During the Study

Opportunities and challenges coexist in the utilization of Generative AI in education. The following outlines the obstacles associated with Generative AI in project-based learning (PBL).

- There is a potential for inaccuracies when using Generative AI to create teaching materials. Artificial intelligence may produce outdated, incorrect, or fabricated data. Therefore, implementing a dual verification system that combines AI checks with human oversight is essential.
- The integration of Generative AI can lead to ethical dilemmas and issues surrounding academic integrity. The lines surrounding academic plagiarism have become increasingly unclear. The teaching resources generated could pose copyright challenges. Additionally, ensuring the originality of students' work is complicated, and there is a risk of violating data privacy.
- An overreliance on artificial intelligence for guidance, prompts, and support may diminish students' ability to learn independently.
- Variations in technological infrastructure across regions may obstruct the pursuit of educational equity. Areas with limited resources are often constrained by inadequate hardware and network bandwidth. As such, considerations for lightweight technology and distributed systems should be taken into account.

CONCLUSION

Blending AI with Project-Based Learning (PBL) in secondary schools can significantly enhance student engagement, critical thinking, and future readiness by creating personalized learning experiences and preparing students for an AI-driven workforce. This integration empowers students to take more ownership of their learning and develop essential skills like using AI as a tool for research, content creation, and task automation, while still requiring human judgment, creativity, and fundamental knowledge to succeed.

AI should augment, not replace, the teacher. Instructors are still crucial for providing context, facilitating group work, and guiding students to critically evaluate AI-generated results. Students still need a strong foundation of fundamental knowledge and judgment to use AI effectively and ensure their contributions are valid. The goal is to use AI to amplify human capabilities, not displace them, creating learning experiences where human skills like judgment, creativity, and ethical reasoning are central.

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