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Exploration of a New Educational Model Based on Generative AI-Empowered Interdisciplinary Project-Based Learning

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ABSTRACT

This study explores a novel educational model of generative AI-empowered interdisciplinary project-based learning (PBL). By analyzing the current applications of generative AI technology in information technology curricula, it elucidates its advantages and operational mechanisms in interdisciplinary PBL. Combining case studies and empirical research, the investigation proposes implementation pathways and strategies for the generative AI-enhanced interdisciplinary PBL model, detailing specific applications across three phases: project preparation, implementation, and evaluation. The research demonstrates that generative AI-enabled interdisciplinary project-based learning can effectively enhance students' learning motivation, interdisciplinary thinking capabilities, and innovative competencies, providing new conceptual frameworks and practical approaches for educational model innovation.

1. Introduction

With the advancement of artificial intelligence technology, the application of generative AI in education has become increasingly widespread, demonstrating significant potential in interdisciplinary project-based learning (PBL). Traditional teaching methods predominantly focus on single-subject knowledge transmission, often neglecting interdisciplinary integration and the cultivation of innovative thinking, whereas solving complex modern societal problems requires the synthesis of multidisciplinary knowledge. Interdisciplinary PBL addresses this gap by integrating knowledge across disciplines to guide students in exploring authentic, multifaceted challenges, fostering innovative thinking, problem-solving skills, and collaborative competencies. Leveraging its capabilities in information retrieval, synthesis, and creative generation, generative AI provides robust support for interdisciplinary PBL. It can rapidly construct multidisciplinary knowledge frameworks, elucidate interdisciplinary connections, and dynamically generate personalized learning pathways and materials, thereby addressing the limitations of traditional educational resources.

This study aims to investigate the operational mechanisms of generative AI in interdisciplinary PBL and analyze its application strategies and value across project preparation, implementation, and evaluation phases. Through case studies and practical explorations, it reveal-show generative AI empowers interdisciplinary PBL to facilitate deep learning and innovative practices among

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teachers and students.

2. The Operational Mechanisms of Generative AI in Interdisciplinary Project-Based Learning

Compared to traditional teaching models, teachers leveraging generative AI can design challenging, authentic problem scenarios that simulate complex societal, scientific, or engineering issues, providing students with immersive and interactive learning environments. Such contextual design stimulates students' curiosity, guiding them to apply interdisciplinary knowledge to solve real-world problems, thereby cultivating innovative thinking and problem-solving skills. The operational mechanisms of generative AI in interdisciplinary PBL are manifested through the following key processes:

2.1 Personalized Learning Pathway Design

Teachers utilize generative AI to intelligently analyze learning needs and dynamically generate personalized learning materials tailored to project themes, effectively addressing the limitations of traditional resources in interdisciplinary integration. By evaluating students' project performance, the AI recommends suitable learning resources and tasks, enabling students to better comprehend and apply interdisciplinary knowledge.

2.2 Multi-Turn Dialogues and Role-Playing Simulations

In interdisciplinary PBL, generative AI facilitates students' understanding of complex issues through multi-turn dialogues and role-playing simulations. For instance, students interact with AI to assume roles from diverse disciplinary backgrounds, exploring multidisciplinary solutions to problems, thereby enhancing interdisciplinary thinking capabilities.

2.3 Project Guidance and Creative Assistance

Generative AI provides students with targeted guidance during project implementation, including methodological support, data analysis suggestions, and literature review frameworks. In tasks involving programming or design, it assists students in completing complex creative work, reducing project difficulty and improving efficiency. Teachers leverage generative AI to help students build personalized learning frameworks, designing highly customized learning pathways based on individual learning histories, behavioral patterns, and preferences.

2.4 Fostering Innovative Thinking and Team Collaboration

By offering diverse solutions and innovative ideas, generative AI stimulates students' creative thinking. In team-based projects, it serves as a virtual assistant, supporting task allocation, progress tracking, and outcome presentation, thereby enhancing collaborative competencies.

2.5 Enabling Self-Directed Learning Pathways

Through data analytics and intelligent recommendations, generative AI tailors personalized learning pathways for students in interdisciplinary PBL. It dynamically adjusts learning content and task difficulty based on individual learning behaviors, interests, and knowledge mastery levels.

2.6 Real-Time Feedback and Evaluation

Generative AI analyzes students' learning behaviors and project progress in real time, delivering targeted feedback and evaluations. Its intelligent assessment and feedback mechanisms monitor learning outcomes and progress continuously, offering precise recommendations for pedagogical adjustments. This approach addresses the limitations of traditional evaluation methods, which often prioritize outcomes over the learning process itself.

3. Implementation Pathways and Strategies for Generative AI-Empowered Interdisciplinary Project-Based Learning

In interdisciplinary PBL scenarios, this study focuses on the domain of interdisciplinary project-based learning and integrates the intrinsic mechanisms of generative AI to analyze its core value propositions in empowering PBL. Based on the roles of generative AI in interdisciplinary PBL processes, we categorize its applications into two dimensions: stakeholders (teachers and students) and project phases (preparation, implementation, and evaluation). The analysis highlights the intelligent support functions provided to teachers and the smart assistance tools offered to students, as summarized in Table 1.

Table 1. Strategies for Generative AI-Empowered Interdisciplinary PBL

Stakeholder	Project Preparation Phase	Project Implementation Phase	Project Evaluation Phase
Teacher	Project Planning & Design	Project Support & Guidance	Outcome Assessment & Reflection
Student	Topic Selection & Preparation	Integration & Execution	Outcome Presentation & Exchange

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3.1 Intelligent Support for Teachers in Project-Based Instruction

Generative AI serves as a critical smart tool to assist teachers in implementing project-based learning (PBL).

During the Interdisciplinary Project Preparation Phase, teachers leverage AI to integrate multidisciplinary knowledge, curate diverse teaching resources and case studies, and rapidly generate interdisciplinary project design frameworks. These frameworks include project objectives, task breakdowns, and expected outcomes, enabling the creation of comprehensive and systematic project plans. AI helps teachers design differentiated instructional plans with integrated and challenging project scenarios, ensuring alignment with the diverse needs of students at varying proficiency levels.

During the Interdisciplinary Project Implementation Phase, generative AI acts as a virtual teaching assistant, providing real-time pedagogical feedback to teachers. It supports adaptive teaching strategies by offering personalized guidance tailored to each group's performance in PBL activities.

During the Interdisciplinary Project Evaluation Phase, generative AI facilitates intelligent assessment, feedback, and post-project reflection. Teachers utilize learning data collected throughout the project to conduct multi-dimensional evaluations. AI further assists in generating actionable recommendations for iterative improvements, enabling teachers to refine and update project designs.

3.2 Intelligent Assistance for Students in Interdisciplinary Project-Based Learning

Across all three phases of interdisciplinary PBL, generative AI offers students on-demand, personalized smart assistance.

During the Project Preparation Phase, students use generative AI to brainstorm project-driven questions and creative ideas. By exploring AI-generated project proposals and reviewing relevant literature, they rapidly familiarize themselves with project themes, identify novel areas of interest, and leverage AI-generated content as a springboard for innovation, ultimately formulating their project plans.

During the Project Implementation Phase, generative AI streamlines resource retrieval, freeing students from tedious manual research. It enables seamless integration of knowledge across disciplines to construct interdisciplinary frameworks. Students employ AI to execute complex creative tasks (e.g., coding, design) and treat the AI as a multidisciplinary tutor, engaging in iterative questioning and critical dialogue to deepen their understanding of project challenges.

During the Project Evaluation Phase, generative AI generates detailed assessment reports, helping students evaluate their performance, engage in self-reflection, and synthesize learning outcomes.

4. Practical Exploration of Generative AI-Empowered Interdisciplinary Project-Based Learning

This study investigates how generative AI empowers both teachers and students to address real-world, complex problems through interdisciplinary PBL. The process is divided into three phases: preparation, implementation, and evaluation. Throughout the project, students are expected not only to apply disciplinary knowledge but also to understand how to transfer this knowledge to real-life contexts. Below, we use the "Creation of a Promotional Poster for Changyu Wine" project as a case study to illustrate the practical pathways of generative AI-enhanced interdisciplinary PBL.

4.1 Interdisciplinary Project Preparation Phase: Generative AI Empowers Teachers and Students in Project Design

Teachers leverage the robust data collection, generation, and creative capabilities of generative AI to design projects rooted in real-world contexts. By integrating cutting-edge disciplinary knowledge with students' lived experiences and interests, teachers formulate meaningful instructional tasks.

In the "Creation of a Promotional Poster for Changyu Wine" project, the task originates from an authentic corporate need: in a competitive market, how can the brand's unique identity be highlighted to capture consumer attention? This becomes the core challenge of the project. Teachers use AI tools, such as Wenxin Yiyan, to provide project topic suggestions, sparking creativity and inspiration. Simultaneously, generative AI assists students in brainstorming, generating innovative project ideas and approaches to ensure the topic is both creative and practical. For example, students use AI tools to collect, filter, and organize materials related to wine history, wine culture, graphic design, and information technology. By integrating knowledge from multiple disciplines, students quickly acquire rich background knowledge and a research foundation, saving time and improving the efficiency of subsequent project phases.

4.2 Interdisciplinary Project Implementation Phase: Generative AI Supports Teachers and Students in Project Execution

During the implementation phase, teachers act as guides, students as learners, and generative AI as a facil-

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itator, supporting the interdisciplinary PBL process. The specific empowerment pathways include below.

Project Launching, the teacher introduces the task of creating a promotional poster for Changyu Wine, aiming to deepen students' understanding of wine culture, enhance their graphic design and IT skills, and foster teamwork and communication. Using AI, the teacher analyzes students' learning behaviors and interests, guiding them to identify core problems and establish design criteria. The poster must showcase unique creativity and innovative presentation, highlighting Changyu Wine's brand identity and cultural significance. It should have strong visual and promotional appeal to attract consumer attention and enhance brand recognition. It must adhere to graphic design principles, such as color coordination, layout composition, and typography. It should effectively utilize IT tools, such as image editing software. Team members must collaborate effectively with clear roles and responsibilities.

The teacher guides students in developing project plans. Students are divided into groups of 5-6 based on interests and expertise, such as graphic design, marketing, and wine culture. The teacher explains the project background, objectives, and requirements, emphasizing the creation of a promotional poster. Groups use generative AI to retrieve news, social media trends, and academic papers, generating multiple draft ideas. Through brainstorming and market research, teams discuss creative concepts, sketch designs, and refine layouts, color schemes, and visual elements. The teacher provides AI-driven suggestions to optimize designs.

During project execution, the teacher monitors group progress, offering guidance as needed. For technical challenges, specialized support from art teachers is provided, supplemented by generative AI resources. Finally, students use generative AI to refine their posters, ensuring optimal results.

4.3 Interdisciplinary Project Evaluation Phase: Generative AI Empowers Teachers and Students in Project Assessment

Teachers and students use generative AI to produce diverse project outputs, such as detailed reports, slides, charts, animations, and audiovisual materials. Teachers input predefined evaluation criteria, and generative AI, leveraging its powerful data analysis capabilities, generates comprehensive evaluation reports. These reports provide insights into students' performance across various dimensions. Generative AI offers self-assessment tools, enabling students and teachers to reflect on their work, identify areas for improvement, and engage in deeper post-evaluation reflection.

5. Conclusion

In summary, this exploration of generative AI-empowered interdisciplinary project-based learning (PBL) pathways reveals the significant potential and practical value of generative AI in education. The practical investigation demonstrates that generative AI provides intelligent support functions for teachers and personalized smart assistance for students across the preparation, implementation, and evaluation phases of projects. This, in turn, facilitates the integration and application of interdisciplinary knowledge.

Looking ahead, as generative AI technology continues to advance and its educational applications deepen, it will play an increasingly expansive and profound role in interdisciplinary PBL. By driving innovation in educational models and enhancing the overall quality of education, generative AI will contribute significantly to cultivating the creative talents needed in the new era.

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