



# An Exploration of Project-Based Learning Supported by Artificial Intelligence

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**Abstract.** Considering the influence of Artificial Intelligence (AI) in education and its potential to improve the Project Based Learning (PBL) method, this study aims to construct an AI-supported PBL implementation process, including six stages: identifying a project, developing a plan, activity exploration, work production, results communication, and activity evaluation. The AI technology is fully utilized in order to make up for the shortcomings of traditional PBL in terms of efficiency and relevance. On this basis, it elaborates on the optimization of each stage of PBL through AI technology.

**Keywords:** artificial intelligence, project-based learning, implementation process.

## 1 Introduction

Since the 1990s, "core literacy" has become an important issue in global education reform. In view of this, the revision of China's high school curriculum standards has clearly set out the requirements, emphasizing the development of students' "core literacy as well as disciplinary core literacy"<sup>[1]</sup>. In terms of developing students' core literacy, project-based learning can greatly improve students' enthusiasm for learning, help mobilize students' autonomy in learning, promote active thinking and solve practical problems; in terms of cultivating students' disciplinary core literacy, project-based learning can help students to have a deeper understanding of knowledge by applying the learned disciplinary knowledge to practical situations, and by carrying out experiments, designs, creations or other forms of practical activities. deeper understanding of knowledge. With the remarkable development of AI technology and the rapid expansion of application fields, AI has become the world's cutting-edge technology and hot-spot issue, which is widely used in various fields of social development. Therefore, in this context, project-based learning has become an inevitable trend to embrace the era of artificial intelligence as an important learning mode to cultivate students' core literacy. AI has the potential to make up for the shortcomings of traditional project-based

portraits of students, full accounts of students' progresses in the project, and timely feedback, and thus to help teachers and students monitor the learning outcomes. To summarize, it is particularly important to face the opportunities and challenges of the "AI+Education" development era, and put forward the path of "AI-supported project-based learning" for the future.

## **2 Rationale for Artificial Intelligence to support project-based learning**

### **2.1 Characteristics of project-based learning**

Project-based learning is characterized by problems centered around authentic contexts, student-driven roles, integration of interdisciplinary knowledge, the need for teamwork, and reflection on and assessment of the learning process. According to Krajek, "project-based" science teaching means that teachers organize, guide, and conduct instructional activities through driving questions in which students collaborate with each other, use new learning technologies to engage in inquiry to answer questions, and develop and present results that characterize problem solving<sup>[2]</sup>. Therefore, in terms of regular teaching, project-based learning is mainly characterized by the following aspects. First, project-based learning is usually centered on real-world problems that are challenging and close to students' real lives, stimulating students' interest and participation. Second, in project-based learning, students play a leading role. They need to take the initiatives to explore and study the problems and develop strategies and methods to solve them. Third, project-based learning often integrates knowledge and skills from multiple subjects, prompting students to apply and deepen their interdisciplinary understanding in the process of problem solving. Fourth, most project-based learning requires students to work in teams and solve problems through collaboration, which helps develop students' communication skills and teamwork. At last, project-based learning not only focuses on the final outcome, but also emphasizes reflection and assessment during the learning process. Students need to reflect on and evaluate their learning at each stage of the project<sup>[3]</sup>.

### **2.2 Problems with project-based learning**

The current project-based learning still has many shortcomings, such as in the process of project implementation, students will encounter problems such as choosing too large a topic and being unable to complete the formulation of the plan, and in the process of project evaluation, there is the phenomenon of not being able to accurately assess the learning effect, and so on. From the perspective of students, project-based learning has the following main problems: First, project-based learning requires students to have strong self-management and time management skills. They need to take the initiative to find problems, gather information, and analyze and solve them, so their time management ability is one of the abilities needed for project-based learning. Secondly, teamwork is the key to whether project-based learning can achieve good results, but

many teams may encounter a series of problems due to inappropriate division of labor, thus reducing the learning effect. Third, the openness of project-based learning often overwhelm some students, and students who are new to project-based learning tend to copy the teacher's project examples, and there is no depth in the selection of topics<sup>[4]</sup>.

From the teachers' perspective, project-based learning has the following main problems: First, in project-based learning, teachers play the role of leaders and facilitators, not just knowledge transmitters, and are required to provide students with the necessary resources (e.g., learning materials, tools, and technological support) and provide guidance throughout the project process, which means that teachers usually need to spend more time than in traditional teaching methods. This means that teachers usually need to spend more time than traditional teaching methods to prepare materials, design projects, and provide continuous guidance, which invariably increases the burden on teachers and leads to increased pressure and excessive workload. Second, project-based teaching requires teachers to have strong curriculum design skills and problem-oriented teaching methods. This may be a challenge for teachers who are used to traditional teaching. In project-based learning, there is often an emphasis on student autonomy and inquiry. However, this can sometimes lead to a situation where teachers provide too much freedom, resulting in students feeling lost or unsure of how to proceed. Third, compared to traditional teaching, in PBL (project-based learning), student performance is often more difficult to measure using traditional grading criteria. This is because PBL emphasizes students' overall development and practical skills, not just knowledge memorization and understanding. Student performance includes aspects of teamwork, creative problem-solving skills, critical thinking, project management, and communication skills. These skills and competencies are difficult to quantify using traditional grading scales.

### **2.3 The role of artificial intelligence in supporting project-based learning**

The learning content of project-based learning is presented in the form of project activities, emphasizing the problems in real situations as task-driven, and students need to make use of resources for cooperative inquiry and continuous innovation, so as to better understand the subject knowledge and thus improve their comprehensive ability<sup>[5]</sup>. Project-based learning in the artificial intelligence environment can better enhance the effect of students' project-based learning and solve several difficulties in the implementation of project-based learning. For the characteristics of project-based learning, the support that artificial intelligence can provide and the application of specific functions, see Table 1.

**Table 1.** Artificial intelligence support for project-based learning

Characteristics of PBL	Support of AI	Specific functions
Exploration of authentic contextual issues: Closely related to students' real life	Creating authentic problem solving situations	Virtual Reality (VR) technology is utilized to simulate various situations in the real world, and Augmented Reality (AR) technology is used to superimpose digital information into the real world, providing students with a more vivid and interactive learning experience.
Student leadership: Self-directed exploration and research questions	Technical support to provide personalized learning resources and enhance student autonomy	Analyze students' learning preferences, interests, and history using an Artificial Intelligence (AI) recommendation system to provide personalized learning content. Provide instant learning support and feedback through AI virtual assistants to help students understand complex concepts or solve problems in their learning, thus fostering self-directed learning.
Integration of interdisciplinary knowledge: Integration of interdisciplinary knowledge and skills	Integrating multidisciplinary content to provide students with a broader perspective	Integrate information from different disciplines using intelligent algorithms to process and analyze large amounts of data and information from different disciplines. Provide students with information from a multidisciplinary perspective through AI technology.
Working in teams: Students work together in teams to solve problems	Promote communication and collaboration in the learning process and increase the effectiveness of teamwork	Utilizes an AI-integrated online platform to enable real-time sharing of information and progress. Project management software to help student teams assign tasks, set deadlines and prioritize.
Emphasis on reflection and evaluation: Reflection and evaluation at each stage of learning	Analyze strengths and weaknesses in student programs to provide more accurate assessments	Using AI analytics tools to track student performance in programs

### 3 The implementation process of AI-supported project-based learning

The basic model of project-based learning consists of seven main steps: identifying the project, developing the plan, exploring the activity, producing the work, communicating the results, and evaluating the activity, as shown in Figure 1 below.

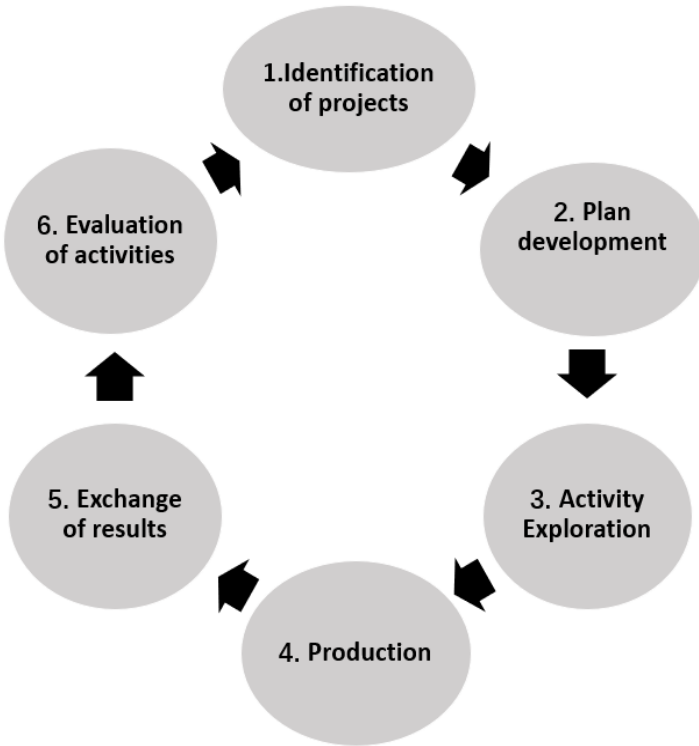


Fig. 1. Basic model of project-based learning

The AI-supported project-based learning implementation process is based on the above main steps. Compared with traditional project-based learning, the AI-supported project-based learning process is more intelligent, personalized, and dynamic, providing more accurate guidance and support, as well as increasing the interactivity and technological integration of the learning process. This is shown in Figure 2.

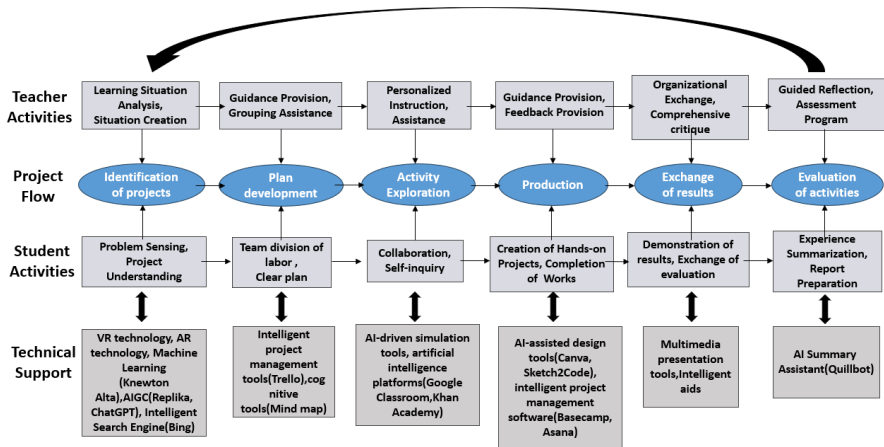


Fig. 2. The implementation process of AI-supported project-based learning

### 3.1 Identification of projects

At this stage, teachers need to analyze the learning situation and create a context. First of all, analyze the current students' original knowledge base, cognitive ability, learning style and interest development, etc. The students' learning history, interest and ability level can be analyzed through artificial intelligence technology, for example, through the Knewton Alta adaptive learning platform to analyze the students' interactions on the platform and the completion of homework. This is then combined with the overall situation of the class in order to determine the selection of the project. Make the project more relevant to the level of the students, so as to ensure that project-based learning can be carried out smoothly. When creating situations, teachers can use artificial intelligence technology and immersive learning tools, such as VR and AR, to create more vivid and realistic learning environments, enhance the immersive experience of students, and effectively stimulate their interest in learning and enthusiasm for inquiry, so as to elicit the driving questions and guide the students to select the project.

Students should perceive the problem and understand it after seeing the topic. This process primarily involves analyzing and researching the problem to identify key aspects of the problem and potential solution paths. If students have questions about the topic, they can use intelligent search engines such as Bingchat and Baidu AI to find relevant information. In addition, they can ask questions to chatbots such as Replika, ChatGPT to experience near-human conversations to further explore the problem and topic.

### 3.2 Plan development

At this stage, teachers should provide guidance to students in developing their plans. To ensure that each team is able to maximize its potential in the project, teachers can introduce artificial intelligence technology and use intelligent assistive teaching

systems, such as Socrative software, to gain insight into the learning process of the students and group them according to their learning profile and needs. After grouping, teachers should guide students to determine their respective roles and responsibilities in the team so that each member can contribute in the area they are best at. The ultimate goal of conducting a project is to enable students to comprehensively enhance their knowledge and skills in the relevant subject area through in-depth inquiry and practical application. Therefore, teachers should clarify the form of the intended outcomes and the requirements of the activities, and guide students to formulate a project plan<sup>[6]</sup>.

Students try to analyze the subject knowledge included in the project, the steps of the activities, and the methods and tools needed to complete the project using cognitive tools such as mind maps under the guidance of the teacher. At the same time, AI technology can be used as an aid, for example, through the Trello project management tool, which integrates various AI plug-ins (Trello AI plug-in, Cronofy plug-in, etc.) and machine learning tools to predict the time and resources needed at different stages of the project, to help the students to develop a more effective project plan, thus compensating for the limitations of the students in developing the project plan. After making a project plan, students should divide up the work of the team, and can use AI assistants such as "Zia" in Pluralsight Flow software and Zoho Projects software to analyze the skills, experience, and learning history of the team members, so as to intelligently match the appropriate tasks. This matching is based on each member's abilities and preferences, ensuring that tasks are assigned to maximize individual strengths and interests. At the same time, it allows for a balanced distribution of tasks to avoid overloading some members and underloading others.

### 3.3 Activity Exploration

In this session, the teacher should provide resources and scaffold instruction for students. Provide students with some basic material resources around the project activities and tasks, and assist them in gathering more resources related to the project as a starting point for activity-based inquiry. At the same time, teachers should help students assess the reliability and relevance of the information and teach them how to integrate and utilize it effectively. During the activity-based inquiry process, personalized scaffolded instruction is provided by capturing students' project-based learning performance through the Edmodo educational technology platform. Teachers also need to collect students' formative data and value their feedback so that they can make timely adjustments to the progress and tasks of project-based learning.

During the activity inquiry phase, students access teacher-provided materials and additional resources generated by the AI platform related to the project topic at AI platforms such as Google Classroom and Khan Academy, in addition to collaborating and communicating with each other on the platforms. To increase students' learning interest and help them better understand theoretical knowledge in real-world applications, students can use AI-powered simulation tools (Bloomberg Terminal, FlexSim, NASA, etc.) to test and validate their hypotheses in virtual environments, conduct experimental design and data analysis, and collaborate and communicate with each other through teamwork to explore various and ideas through teamwork and mutual

communication, thus promoting knowledge sharing and idea generation within the team. This not only strengthens collaboration among students, but also stimulates innovation and new approaches to problem solving.

### **3.4 Production**

In the work production process, teachers should provide students with help and guidance feedback, can use Socrative assessment tools to track students' progress in real time, automatically assess the quality of students' work as an objective basis for feedback, and help students according to the feedback, at the same time, can be used through AI-assisted interactive feedback platforms, such as Google Classroom, to provide students with specific and constructive feedback on their work in a more efficient manner. At the same time, AI-assisted interactive feedback platforms, such as Google Classroom, can be used to more efficiently provide specific and constructive feedback on students' work, thereby improving the quality of students' work.

Each project team completes the work according to the established plan. During the production stage, students can use AI-assisted design tools, such as Autodesk Dreamcatcher software that can generate multiple design options for students to choose and optimize; Canva graphic design tool that can automatically lay out and identify images; Sketch2Code tool that can automatically convert hand-drawn sketches into HTML code to make the completion of the work more efficient and innovative. In addition, intelligent project management software such as Asana, Monday.com, and Basecamp can help students plan the project process, assign tasks, and track progress more efficiently, ensuring smooth teamwork and on-time completion of the work.

### **3.5 Exchange of results**

At this stage, teachers should organize students to present their results and make comprehensive comments on the results. Teachers should set the project presentation time and presentation method according to the teaching plan, combined with the teaching objectives of each project. When students present their results, set the rules for evaluation and give a comprehensive critique.

Students should prepare materials to be used for the presentation such as PPTs, posters, models, or other visual aids depending on how the presentation is to be presented. In preparing the presentation materials, the mindshow website can be used to help create PPTs as well as the Canva tool to create visually appealing presentations and infographics. In addition, during the presentation process, the class should be briefed on the group's activity plan, collaboration, and project results, and teams should evaluate other teams' presentations as they are presented through the Mentimeter software to complement each other's strengths and weaknesses.

### **3.6 Evaluation of activities**

Evaluation of the activity is the last key component. Teachers should organize meetings for students to summarize and reflect on the project and provide a platform for students



to share and discuss. Students are guided to assess their own performance in the project, such as the challenges and gains they encountered in the project, as a way to help them summarize the knowledge and skills they have learned in the project and how these learnings can be applied to future learning or life situations, and they are also encouraged to think about how they can apply the experiences and learnings in the project to other areas or future projects. Diversified assessment methods can provide a comprehensive understanding of students' performance in the project from different perspectives. Therefore, teachers should guide students to complete self-evaluation, group mutual evaluation and group self-assessment, and organize parents, domain experts and other diversified subjects to evaluate the results of students' project-based learning. At the same time, with the help of the Edmodo platform, students' interactions and contributions in the course of the project are analyzed, and their performance and progress are objectively assessed<sup>[7]</sup>.

Students share their experiences on the project in a wrap-up meeting, reflecting on their performance on the project, such as coping with difficulties, as well as their performance in teamwork, problem solving, and innovation, and using AI summary assistants such as Quillbot, Microsoft Azure Text Analytics, which can automatically identify important content and learning outcomes in the project report, to organize and summarize key learning points from the project. In addition, a summary report is required that describes in detail the project process, learnings, individual contributions and reflections.

The innovation of Artificial Intelligence-enabled Project-Based Learning (PBL) is the integration of advanced AI technologies into the traditional PBL model, which greatly improves the personalization, efficiency, and interactivity of learning. Specifically, this approach improves student engagement and learning outcomes by predicting required project resources through project management tools (e.g., Trello and Cronofy) integrated with AI plug-ins, providing students with personalized learning content using adaptive learning platforms (e.g., Knewton Alta), and creating realistic learning environments using VR and AR technologies. In addition, AI-assisted design tools (e.g., Autodesk Dreamcatcher, Canva) and intelligent project management software (e.g., Asana, Monday.com) are used to help students become more efficient in the production of their work and project management. This approach provides a more efficient, personalized, and technology-driven learning framework for the education sector, enabling students to better adapt to future learning and work environments, as well as providing more support and facilitation for teachers in teaching and in the assessment process.

## 4 Conclusions

This study analyzes the current situation of PBL and the main problems it faces from the aspects of students and teachers, such as imprecise assessment, low efficiency and lack of personalized learning support. In response to these problems, an AI-supported PBL implementation process is constructed to optimize the learning process, improve the teaching efficiency, personalize the learning content, and promote students' in-depth

learning and problem-solving ability in real environments through the application of AI technology.

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