

Pedagogical Design and Practice of the Case of Artificial Intelligence Course in Junior High Schools - Take “Intelligent Energy Saving Street Lamps” as an Example

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Abstract:

With the rapid development of the new generation of information technology, artificial intelligence education has gradually become an important part of secondary school education. Taking the junior middle school AI course in the middle school affiliated to Ningxia University as the research object, this paper designs and implements a teaching case of Intelligent Energy Saving Street Lamps by adopting the teaching method of Project Based Learning (PBL). The effects of project-based teaching on students' learning interest, knowledge understanding, programming skills and core literacy were analysed through a comparative experimental study. The findings show that project-based teaching can effectively enhance students' motivation, engagement and comprehensive quality. This paper summarises the effectiveness of project-based teaching and makes suggestions for future teaching practice.

Keywords:

Lower Secondary Education, Artificial Intelligence, Project-Based Learning; Instructional Design

1. Introduction

With the rapid development of artificial intelligence, it has a significant impact on the field of education. The AI curriculum in junior middle school IT education needs to keep pace with the times, and there are some problems with the current project-based teaching, such as ambiguous learning objectives, complicated and fragmented course content, and solidified learning evaluation mechanism. In order to solve these problems, this study firstly combed the project-based learning related literature and constructed the project-based teaching process based on specific principles. Secondly, it designs teaching practice cases in combination with the characteristics of S Middle School students and AI teaching content, and carries out quasi-experimental research in two eighth-grade classes in the school. The sample size of the research subjects is

small and narrow, and only two classes of eighth grade students in a middle school were selected, which is limited in representativeness. A follow-up study that increases the number of research subjects and expands the scope of the sample will enhance the general applicability and credibility of the study.

2. A Framework for the Design of Artificial Intelligence Instruction Based on Project-Based Learning

2.1. Principles of case teaching design for artificial intelligence courses

2.1.1. Create an instructional design that is aligned with the core literacy of the discipline

Artificial Intelligence (AI), as an important branch of computer science, has not yet been widely accepted by the academic community as a unified definition, and its cutting-edge and interdisciplinary nature makes it an open research subject. In 2022, the Ministry of Education launched the new Compulsory Education Curriculum Programme and Curriculum Standards, which makes a comprehensive plan for the information technology curriculum system, and especially specifies the objectives of the junior high school artificial intelligence course. [5] Based on the existing knowledge structure, physiological and psychological development level, and cognitive characteristics of junior high school students, the curriculum standard focuses on “basic knowledge and wide application of artificial intelligence”, “realisation technology and pathway”, and “ethics, safety and development of artificial intelligence in the environment of intelligent society”. The three core themes of “Ethics, Safety and Development Prospects of Artificial Intelligence” are designed to enable students to have a preliminary understanding and grasp the basic meanings.

2.1.2. Creating authentic and diverse classroom situations

In the practice of AI teaching, we can cleverly use the project learning method to integrate the knowledge points of the course into the real situation, and establish a meaningful connection and interaction between the two. In this way, we carefully construct a close to the real learning scenario for students, so that they can deepen their understanding and mastery of knowledge in the hands-on experience. This teaching strategy aims to activate students' enthusiasm for active learning and guide them to achieve in-depth comprehension and value perception of knowledge through active participation. Through the AI programme, students are able to cope with the challenges of daily life through computational thinking, which is required to be realised in real-life scenarios. This study takes “intelligent energy-saving street light” as a case study for this AI course, and proposes four strategies to create a good teaching scenario: firstly, ensure that the problem scenarios are both authentic and typical, so as to make them closely match real life; secondly, ensure that the key information required for problem solving is embedded in the scenarios, so as to guide students to explore knowledge within the scenarios; furthermore, elaborate the design of the scenarios so as to ensure that the students' knowledge can be explored within the scenarios. Secondly, ensure that the key information needed to solve the problem is embedded in the context, and guide students to explore knowledge in the context; furthermore, elaborate the design of the context to promote students' dual-track cognitive processing, aiming to enhance their higher-order thinking skills and comprehensive quality; finally, advocate the construction of a multifaceted and

composite real-world problem context, aiming to broaden and deepen the students' thinking horizons, so that the students can establish a close connection between the AI knowledge they have learnt and the real-life in the process of experiencing real-world scenarios.

2.1.3. Creation of learning-by-doing curriculum activities

The Artificial Intelligence curriculum is known for its distinctive hands-on and interdisciplinary intersectionality. Students in junior high school are curious by nature and are keen on hands-on practice and exploring the unknown. Therefore, in junior high school artificial intelligence teaching, we should focus on guiding students to embark on the “journey of artificial intelligence enlightenment”, encouraging them to do it themselves, actively try it out, and from the perspective of solving the practical problems around them, use open source hardware platforms to independently design, develop, and manipulate innovative works, so as to experience the whole process of artificial intelligence problem solving, so that Computational thinking is continuously iterated and sublimated through repeated practice and exploration. This kind of practical activity not only gives students a broad space for innovative thinking, but also enables them to get closer to AI in hands-on practice, and to deeply understand and master the principles and applications of related technologies.

2.2. Project-based instructional design process framework

The author refers to existing project-based learning frameworks and existing interdisciplinary project-based learning design processes, such as the project-based learning design framework proposed by Xuemei Xia et al. [1], the project-based learning model of junior secondary school subjects under the perspective of core literacy designed by Qiuyan Zeng [2], the project design model based on STEM education by Shengquan Yu et al. [3], and the three prototypes of interdisciplinary project-based learning in practice proposed by Xuemei Xia [4].

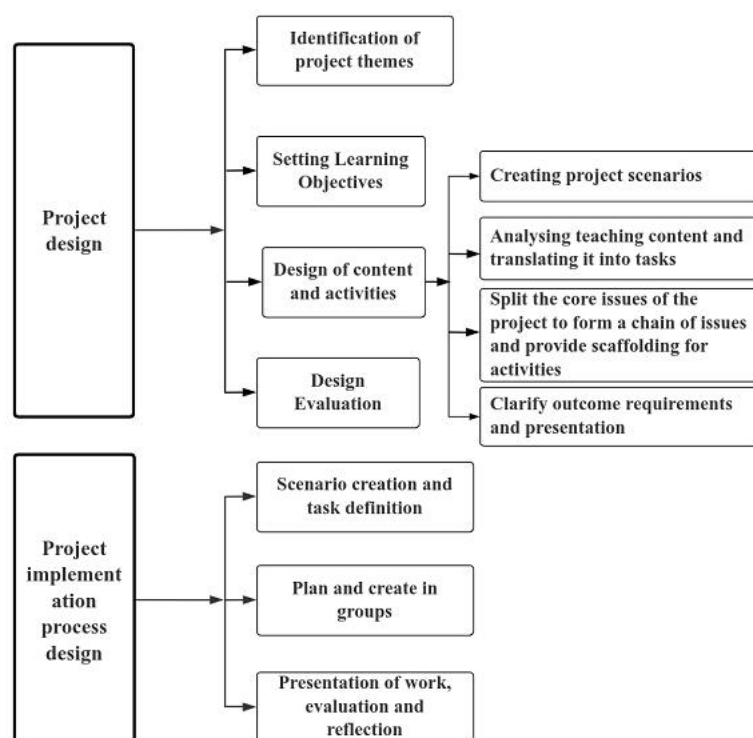


Figure 1. Project-based instructional design process framework.

Under the guidance of constructivist learning theory and the theory of “learning by doing”, this study takes project-based teaching as a practical path, and constructs a framework of project-based teaching design process, which mainly includes two important links, namely, project design and project implementation process design, and the specific structure is shown in Figure 1.

2.2.1. Project design

Project design is the basis for the implementation of interdisciplinary project-based teaching. Project groups constructed by heterogeneous subjects such as teachers of different disciplines and university experts, on the basis of studying the new 2022 edition of the curriculum and teaching materials, reconstruct the learning content around a suitable project theme, taking the disciplinary concepts of a certain discipline as the logical main line and integrating interdisciplinary knowledge, and in the process determine the learning objectives and project content, and design the project activities and learning evaluation. In the process of project design, attention should be paid to the reciprocal relationship between learning objectives, content and activities, and evaluation.

(1) Establishing the theme of the project

The establishment of project themes is the first step in the development of interdisciplinary project-based teaching. The source of the project theme can be the project theme provided in the new curriculum, the theme designed by the project group according to the local geographic environment and customs and culture, some social topics of people's concern, or the foreign project curriculum introduced and school-based. The theme of the project should be close to the students' real life, in line with the students' cognition, and able to arouse their interest and curiosity.

(2) Develop project learning objectives

Interdisciplinary learning is more demanding and challenging for teachers than single subject learning. Teachers' analyses and understanding of curriculum standards are critical to the development of learning objectives for interdisciplinary projects. In addition to analysing the curriculum standards of the main discipline in the project, it is also important to pay attention to the curriculum standards of the disciplines crossed by the project theme. Combined with the project theme, design the core questions of the project, look for the adapted academic objectives, content requirements and academic quality requirements in the curriculum standards, and clarify the scope of teaching. The new curriculum standards emphasise the core qualities of the disciplines, so the learning objectives should correspond to the core qualities of the disciplines when they are formulated. In addition, when formulating learning objectives, attention should be paid to the specification of behavioural verbs, and they should be closely related to the theme of the project and the core qualities of the discipline, and should not go beyond the requirements of the school year in which the students are placed, so as to avoid the phenomenon of “pulling up the seedlings to help them grow”.

There are four main pathways for delivering interdisciplinary teaching and learning in the primary science curriculum, but there will be multiple interdisciplinary pathways co-existing in more integrated projects. The core problem of the project is a driving question that students need to explore and solve, which should be challenging and require them to learn knowledge in order to solve it, but should not be too difficult, so teachers should consider students' cognition and acceptability when making the design. Real-life problems are authentic, complex and non-productive, and

relying only on single-subject knowledge will not work, requiring the integration of multidisciplinary knowledge to solve, so the process of students' problem-solving is to learn the knowledge embedded in the problem, and at the same time pointing to the formation of the core literacy of the discipline.

(3) Design of project content and activities

The new curriculum standard focuses on the cultivation of core literacy, emphasises the optimisation of curriculum structure and focuses on core concepts and learning themes. Teachers of different disciplines should conduct interdisciplinary project-based learning teaching and research around the project theme, analyse students' needs, break the boundaries between disciplines on the basis of clarifying the main disciplines that the project relies on and the disciplines that it crosses, create authentic project situations, analyse the corresponding teaching materials of each discipline on the basis of the core concepts of the disciplines, carry out structured integration of the content of knowledge of different disciplines, focus on the project theme and project core issues, design the project learning content in the form of tasks, disassemble the driving issues, and form a chain of issues and sub-tasks. Interdisciplinary project-based learning is different from subject teaching. Teachers should set a reasonable amount of class time and content, and make clear the expressive tasks and final outcome requirements of this interdisciplinary project. In designing the learning content and learning activities, attention should be paid to echoing the learning objectives and learning assessment.

The selection of content for interdisciplinary projects should be discipline-based and transcend disciplines. On the basis of reference to the content of the textbook, integrate knowledge from different disciplines, consider the systematic and complete nature of knowledge, avoid selecting fragmented content, and think about whether students have the ability to carry out sustained in-depth enquiry and draw appropriate conclusions.

Interdisciplinary project activities should be designed in a challenging way, so that students can participate in activities with a certain degree of difficulty, gain authentic practical experience, identify problems to be solved, learn the knowledge and skills contained in the tasks in the process of solving problems, gradually develop an attitude of willingness to explore, combine their existing knowledge and experience to generate an understanding of complex issues, and form the final product. In the process of carrying out project activities, teachers should focus on building an efficient learning framework for students, aiming to guide them to use multiple pathways and tools to obtain the information they need, to master the skills of organising and summarising information, and to be able to use the information appropriately and in a timely manner in order to answer questions or advance the project, which is aimed at systematically fostering the students' ability to search for, analyse and apply information. When designing activities, students should be provided with a variety of ways to participate and experience, such as role-playing, in which theme-related roles are designed for students to choose from, so that they can think about the problem from different perspectives. Teachers should focus on cultivating students' co-operation and communication skills, creating an environment for interpersonal communication, so that students can experience the importance of teamwork through exchanging information, sharing results and learning experiences, and working in groups. Teachers should inform students of the requirements of the final results of the project and the evaluation programme before the project begins.

The form of presentation of the final results of the project can be chosen by the students independently according to the content of the project, or a certain form can be specified by the teacher, such as handwritten reports, research reports presented in the form of digital devices such as PPT, Word or micro-video, and so on.

(4) Designing the evaluation of interdisciplinary projects

Project evaluation mainly consists of two aspects: process evaluation and project outcome evaluation. In the process of designing the evaluation of interdisciplinary project learning, attention should be paid to echoing the interdisciplinary project learning objectives and interdisciplinary project learning activities, reflecting the requirements for the cultivation of disciplinary core literacy. Attention should also be paid to the following issues: first, the evaluation design should be preceded by the end. Second, evaluation indicators should be clear and operational. Third, evaluation should be carried out throughout the project. Fourth, process evaluation and outcome evaluation should be given equal importance.

The main body of project evaluation should be diversified, divided into students' self-evaluation, intra-group mutual evaluation, group mutual evaluation, parents' evaluation, and evaluation by experts in the field. The evaluation content should be comprehensive and all-round, including the completion of works, improvement of abilities, group cooperation, and mastery of knowledge and skills. The means of evaluation should be diversified, using questionnaires, gauges, classroom observation and other methods of evaluation.

2.2.2. Design of the project implementation process

Project implementation consists of six steps: first creating a situation, then clarifying the task, then making a plan, next creating in groups, then presenting the work, and finally evaluating and reflecting, which is an important part of project-based teaching. In this process, the teacher implements the project design scheme, and the students acquire new knowledge by participating in inquiry activities, deepen their understanding of the knowledge in this lesson, and improve their problem-solving ability. Project-based teaching compared to conventional classroom teaching, need more time to carry out learning activities and project practice, so we should try to break the traditional classroom teaching classroom limitations, explore the combination of long and short classroom hours, at least once a week to arrange up to an hour and a half long classroom hours, which provides an important guarantee for the implementation of the project. Teachers should categorise the types of projects according to the content of the project theme, such as inquiry-based projects and practical projects. Then according to the actual needs of the project implementation process to do the corresponding refinement and adjustment.

(1) Creating the situation and defining the task

Authentic contexts enable students to enhance their sense of connection with the world around them and with real life, to develop a strong interest in the activities and tasks of the project, and to generate authentic experiences and learning experiences in project-based learning. The creation of context can be a historical event or an event that has aroused social concern, or it can be a real-life problem or phenomenon that can cause students to think. Teachers can use information technology to provide virtual environments and create immersive situations.

Teachers need to inform students of clear project tasks and project outcome requirements as well as evaluation rules, and guide them to complete tasks in practical projects driven by solving realistic problems in real situations.

(2) Plan and create in groups

After clarifying the requirements of the project tasks, the teacher provides learning scaffolds, such as learning task sheets. Students work in small groups to discuss, make plans for carrying out the project, divide the work, carry out inquiry and creation according to the project theme in a purposeful and planned way, and form a materialised product or work through hands-on operation. Teachers should give full play to students' initiative and provide certain guidance and assistance according to the actual situation.

(3) Presentation of work, evaluation and reflection

In the work exhibition session, teachers should pay attention to the presentation and communication of project results, and students present their project results in various forms, such as designing works, making models and producing PPTs. Teachers organise communication activities for the exhibition of project results according to the characteristics of the physical form of students' works. Teachers need to co-ordinate technical equipment and carry out the critique of the works, and may invite teachers of project-related disciplines, university experts, or parents and other subjects to participate in the evaluation. Group members report mainly includes: group project plan, cooperation, difficulties encountered and solutions, project results to be improved. As natives of the Internet era, the form of students' report is not limited to on-site verbal expression, but should make full use of digital devices, such as the use of computers to produce PPT and other forms of full display of the group's project work.

3. Teaching Design of Artificial Intelligence “Intelligent Energy-Saving Street Light” Practical Activities Based on Project-Based Learning

3.1. Identification of project themes

In this study, the eighth-grade students of S Middle School in Hainan Province are selected as the main teaching subjects, and the core teaching task is “designing and making an intelligent street light”, which aims to enable students to make use of what they have learnt in concrete practical situations, so as to improve their problem-solving ability. During the teaching process, students will work in small groups to carry out independent investigation and design, with the goal of building a smart street light that can adjust the light intensity according to changes in the surrounding environment. In this process, students will have the opportunity to deeply understand the functions and usage of various types of sensors, and familiarise themselves with the complete process of information acquisition and processing, so as to practically experience the basic concepts of AI technology and its actual operation mechanism.

3.2. Setting learning objectives C

This project lies in the integration of the three-dimensional goals into the disciplinary core literacy, as shown in Table 1.

Table 1. Learning Objectives.

Core Element	Learning Goal
information awareness	1. To enable students to understand the basic concepts and functions of intelligent street lights and their application value in modern society, so as to cultivate their interest and curiosity in information technology and intelligent devices. 2. To guide students to realise the important role of information in intelligent street lighting systems and how information can be collected, processed and applied through various sensors in order to achieve intelligent control of street lighting and energy saving effects.
computational thinking	The implementation of intelligent energy-saving street lights requires writing programmes to control functions such as switching and brightness adjustment of street lights. In this process, students can learn how to design algorithms to realise specific functions, thus developing algorithm design skills.
Digital Learning and Innovation	1. Students need to learn and master digital technologies related to intelligent energy-saving street lights, such as Internet of Things (IoT) technology and sensor technology. These technologies are the basis for realising the functions of intelligent energy-saving street lights, as well as for digital learning and innovation. 2. Students need to be digitally minded, able to think in terms of data, understand the value of data and be able to use digital technology to solve problems. Digital thinking will help students to better understand and respond to problems during the design, implementation and management of smart energy-efficient street lighting.
Information Society Responsibility	The application of intelligent energy-saving street lamps helps to save energy and protect the environment, and students should have a corresponding sense of social responsibility and concern for the sustainable development of society. When designing and producing intelligent energy-saving street lights, they should consider their practical contribution to society, such as improving lighting efficiency and reducing energy consumption. In addition, students should also pay attention to the issue of information security to ensure the data security of the intelligent street light system and prevent the information from being leaked or maliciously utilised.

3.3. Design of content and activities

In this study, after understanding the current situation and teaching schedule of the project-based teaching of artificial intelligence class in information technology in the eighth grade of a primary school in Hainan Province, we chose the textbook of the Science and Technology Board and relied on it to choose the project-based theme of “Intelligent Energy-Saving Street Lamps”, and rearranged the order and appropriately simplified and expanded the content of the original teaching of artificial intelligence to achieve the target results of the project. The specific teaching content is shown in Table 2.

Table 2. Instructional Content and Activities.

Project theme	Breakdown of tasks	Teaching content	Teaching activity	Timetable
Intelligent energy-saving street lamps	entry level	1. Introduce the background of the project, create a scenario and identify the specific requirements of the project;	1. Teachers use real-life scenarios to introduce the theme of the project and attract students' interest; 2. Explain the project process and evaluation methods with the	1 lesson

		2. Clarify the project process, learning styles and evaluation methods; 3. Form groups, determine group names, and set group rules.	student; 3. Grouping.	
	Intelligent energy-saving street lamps - automatic adjustment of brightness	1. Clarify the content of this project and pose questions to students through the scenarios created; 2. guide students to identify the sensors to be used from the components as well as other components; 3. Independent study of the usage of the required sensors in small groups based on the textbook; 4. Group discussion to design the “intelligent energy-saving street lamp + automatic brightness adjustment” design.	1. The teacher guides the students to explore and identify the components to be used; 2. Guide students to draw a design.	1 lesson
		1. According to the required components, write a programme to follow the change of LED lights according to the different brightness; 2. Groups work together to test procedures; 3. Groups present and evaluate each other.	1. Groups work together to explore and realise the function; 2. Teachers assist in answering queries.	1 lesson
	Intelligent energy-saving street light - automatic	1. The basic part of intelligent energy-saving street lamps	1. Groups work together to explore and realise the function;	1 lesson

	brightness adjustment + voice control	has been completed for project expansion; 2. Add voice control function and select the required voice control components; 3. Add a voice control module to the programme; 4. The group is debugged and the teacher knows the explanation.	2. Teachers assist in answering queries.	
	Intelligent energy-saving street light - automatic brightness adjustment + voice control + counting	1. Intelligent energy-saving streetlights continue to undergo project expansion; 2. Increase the counter (four-digit digital tube); 3. Add a counting procedure to the programme; 4. The team debugging, and ultimately achieve the people walk lights out, but also to do people voice control and pedestrian or traffic counting.	1. Groups work together to explore and realise the function; 2. Teachers assist in answering queries.	1 lesson
	Summary review Reporting Showcase	1. The procedure has been shaped and the group works together to build the scenario; 2. Through PPT production and physical display, complete the scoring, summarise the gains and shortcomings of this project-based activity, and lay the foundation for the subsequent project-based development.	1. Groups work together to build, complete the installation and test the programme; 2. Demonstrate reporting; 3. Scoring.	1 lesson

3.4. Design evaluation

Learning outcomes are evaluated using a multifaceted evaluation approach, including both direct and indirect evaluation. Direct evaluation refers to the analysis of process materials such as knowledge tests and project works; indirect evaluation uses tools such as questionnaires and interview outlines to assess students' knowledge, skills and literacy, as shown in Table 3.

Table 3. *Evaluation of Teaching and Learning.*

evaluation function	conceptual	Evaluation tools
diagnostic evaluation	The evaluation subjects were measured in terms of their interest in learning, attitude towards learning, and degree of motivation prior to teaching practice.	questionnaire
Formative evaluation	Examination of learners' learning outcomes in the teaching and learning process	Classroom Observation Record Sheet
Summative evaluation	Evaluation to measure the final impact of teaching and learning activities	Project Work Evaluation Form

4. Conclusions

With the rapid development of artificial intelligence, its impact on the field of education is far-reaching. The AI curriculum in junior middle school IT education needs to keep up with the times, and the current project-based teaching has problems such as ambiguous learning objectives, complicated and unsystematic curriculum content, and solidified evaluation mechanism. This study addresses these problems by combing the literature on project-based learning, constructing a teaching process based on specific principles, designing a teaching case and conducting a quasi-experimental study based on the situation of S middle school. It is concluded that project-based learning can help to increase students' interest in learning, promote problem solving, facilitate communication and cooperation, enhance knowledge understanding and operational skills to improve performance, and change learning attitudes to improve classroom participation.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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